The Impact of ESG Information Disclosure on Total Factor Productivity: An Empirical Study Based on Chinese Listed Firms

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Abstract. With the growing global emphasis on sustainable development and corporate social responsibility, ESG (Environmental, Social, and Governance) information disclosure has become a crucial factor in corporate management and investment decision-making. Based on data from A-share listed firms in China from 2011 to 2021, this paper explores the impact of ESG information disclosure on firms' total factor productivity (TFP). The findings reveal that ESG disclosure significantly enhances corporate TFP. Mechanism tests indicate that the efficiency-boosting effect of ESG primarily operates through three pathways: alleviating financing constraints, promoting innovation, and enhancing corporate reputation. Further analysis demonstrates that ESG disclosure has a more pronounced impact on TFP improvement in heavily polluting firms, state-owned enterprises, and firms with higher corporate governance quality. The conclusions of this study provide a theoretical foundation and policy references for maximizing the advantages of ESG and enhancing corporate TFP, offering valuable insights for promoting high-quality and sustainable economic development.

Keywords: ESG information disclosure, Total factor productivity, Financing constraints, Innovation capacity, corporate reputation.

1. Introduction

In recent years, as global issues such as climate change, resource scarcity, and wealth disparity have become increasingly prominent, the focus on sustainable development has intensified. Governments, businesses, and the public worldwide have deepened their understanding of environmental protection, social responsibility, and governance mechanisms, making sustainable development an urgent global agenda. In 2015, the United Nations introduced the 2030 Agenda for Sustainable Development, outlining 17 Sustainable Development Goals (SDGs) and urging countries to intensify efforts in environmental, social, and governance areas. China has also underscored the importance of sustainable development on multiple occasions, particularly with the release of the Measures for the Lawful Disclosure of Corporate Environmental Information at the end of 2021. This regulation explicitly defined carbon disclosure requirements for the first time and established specific guidelines for disclosure subjects, content, timelines, and supervisory mechanisms, aiming to encourage firms to adopt environmentally friendly business practices.

Against the above backdrop, ESG information disclosure has gradually emerged as a critical tool for corporate sustainability and has garnered widespread attention from regulatory bodies and the academic community worldwide. Especially in China, with the advancement of economic transformation and green development, more and more listed firms have begun to emphasize and disclose their ESG performance information. Based on existing literature, this study enriches the understanding of the economic consequences of ESG disclosure on corporate's total factor productivity (TFP) through empirical analysis, advancing research on TFP determinants and uncovering the heterogeneity of ESG's impact. Compared to previous studies, this paper makes the following marginal contributions:

In the first place, this paper enriches research on the economic consequences of ESG disclosure. While prior studies have explored ESG's impact on financial performance (Li et al., 2021) and corporate reputation (Sun et al., 2023), relatively few have examined its influence on corporate

productivity, particularly TFP. By analyzing data from Chinese A-share listed firms between 2011 and 2021, this study provides empirical evidence that ESG disclosure significantly enhances corporate TFP, offering more specific support for policymakers and businesses.

Next, it broadens the scope of TFP determinants. Traditionally, academics tend to focus on factors such as technological innovation and capital investment as primary drivers of corporate TFP (Zheng & Zhang, 2018). This paper incorporates ESG disclosure into the analytical framework, revealing how businesses, in the process of fulfilling their social responsibilities, can leverage environmental, social, and governance factors to drive high-quality development. This finding expands the conventional research perspective on TFP and provides new directions and methodological guidance for future research.

Additionally, this paper explores the heterogeneous effects of ESG disclosure across different types of firms. It finds that ESG disclosure has a more pronounced positive impact on TFP in heavily polluting firms, state-owned enterprises, and firms with higher corporate governance quality. This suggests that corporate characteristics and external environments influence the effectiveness of ESG disclosure, offering deeper insights into the diversity and complexity of ESG's impact.

2. Theoretical Analysis and Research Hypothesis

As sustainability continues to gain global attention, ESG information disclosure, as an important information carrier for firms to demonstrate their environmental, social and governance performance, its quality and comprehensiveness influence investors, consumers and the public's perception and evaluation of corporate sustainable development practices, and it plays a significant role in enhancing the company's market competitiveness and social image (Wang & Yang, 2022). With the market's growing focus on ESG information, firms are continuously optimizing their ESG management by strengthening environmental protection, fulfilling social responsibilities, and improving corporate governance structures. These efforts help alleviate financing constraints (Zou & Sun, 2024), stimulate innovation vitality (Fang & Hu, 2023), and enhance corporate reputation (Sun et al., 2023). The combined positive effects of these factors create more favorable internal and external conditions for firms' long-term development and the improvement of total factor productivity (TFP). Based on existing theories and research, this study discusses the positive impact of ESG disclosure on corporate TFP through three key pathways: alleviating financing constraints, promoting innovation, and enhancing corporate reputation.

2.1. Analysis of the Financing Constraint Alleviation Pathway

In modern economies, a company's ability to secure financing directly affects its capacity for innovation and expansion. According to the theory of information asymmetry, the disparity in information between firms and external investors often results in financing constraints, limiting access to capital. Ju (2013) pointed out that financing constraints hinder firms from sustaining high-cost R&D and innovation investments, ultimately affecting production efficiency. A lack of funds often prevents firms from expanding capacity or enhancing productivity, particularly in capital-intensive industries where inadequate financing severely impedes technological advancement and equipment upgrades. Sufficient financial support enables firms to carry out equipment purchases and R&D activities smoothly, and respond effectively to market and technological uncertainties, thus improving TFP (Wang et al., 2021). Additionally, the agency theory suggests that conflicts of interest between management and shareholders may lead to resource misallocation and efficiency losses. When financing is constrained, corporate managers may prioritize short-term gains over long-term innovation and efficiency (Shleifer & Vishny, 1989). Therefore, adequate financial resources are critical to ensuring sustained investment in production and innovation, ultimately enhancing TFP.

ESG information disclosure can effectively alleviate the financing constraints of firms and provide strong financial support for the improvement of TFP. According to signaling theory, by proactively performing ESG responsibilities and disclosing relevant information promptly, firms can deliver

more effective signals to the market, increase market transparency, and reduce the degree of information asymmetry (Yuan et al., 2022). This recognition effect enhances corporate appeal in capital markets, thus alleviating financing constraints. Furthermore, firms with strong ESG performance face lower operational risks (Dong & Sun, 2023), as investors consider ESG as a key factor in risk assessment. As a result, investors tend to prefer firms with better ESG performance. Financing constraints significantly hinder TFP growth (Hopenhayn, 2014). Financing constraints limit an enterprise's access to capital, thus preventing it from fully utilizing its production potential and technological innovation capabilities, leading to less efficient resource allocation and lower total factor productivity. Especially in an environment of high economic volatility and policy uncertainty, ESG information disclosure, as an important means for firms to demonstrate their compliance and soundness, helps to enhance their financing ability and further supports their long-term investment and productivity improvement. Therefore, ESG information disclosure can enhance the reputation and recognition of firms in the capital market, attract more socially responsible-oriented investors and credit support from banks, thus realizing low-cost financing and stable capital inflow, and enhancing the efficiency of capital allocation of firms, thus promoting the enhancement of total factor productivity of firms.

2.2. Analysis of the Innovation Promotion Pathway

Innovation is the core driver of a company’s long-term growth and TFP improvement. According to the resource-based view, a firm's unique internal resources and capabilities are the foundation of competitive advantage, with technological innovation playing a critical role in efficient resource utilization and optimization. On one hand, innovation enhances the optimization of production processes and improvement of technology, as well as providing differentiated products and services to help improve the core competitiveness of firms, so as to optimize the allocation of resources, lead to a sustained increase in productivity, and enable them to maintain long-term competitive advantages in the marketplace (Su & Li, 2021). On the other hand, enhanced innovation capabilities help firms achieve superior resource efficiency, maintain technological leadership, and achieve continuous TFP growth. Solow (1956) asserted that TFP growth primarily stems from technological progress and improved resource allocation efficiency. For some firms, short-term technological advancements may be limited, and improved efficiency in resource allocation is the truly sustainable mode of endogenous productivity growth. Additionally, research by Comin and Hobijn (2010), Zheng, and Zhang (2018) suggests that strengthening R&D capabilities can reduce dependency on traditional production factors such as capital and labor, leading to significant cost reductions and TFP improvements. Therefore, the accelerated development of corporate innovation will have a positive impact on the core competitiveness of firms and the resource allocation efficiency of the industry as a whole, and ultimately lead to the enhancement of the total factor productivity of firms.

ESG information disclosure enhances corporate innovation ability effectively through three aspects: responsibility-driven, access to capital, and societal trust. In terms of responsibility-driven, ESG information disclosure can truly reflect the degree of attention paid by firms to environmental protection, social responsibility and corporate governance, which will force firms to research, develop and apply new technologies and processes in energy saving and emission reduction, thus promoting the enhancement of corporate innovation ability. Fan & Fu (2021) argue that environmental disclosures force investors and consumers to focus more on corporate environmental performance, and to vote with their feet, pushing firms to upgrade their green technologies and promoting green R&D, thus improving their TFP. In terms of capital access, ESG information disclosure reduces information asymmetry through open and transparent information transfer, attracts support from external investors and stakeholders, and provides strong support for corporate innovation activities (Li & Xu, 2024). ESG information disclosure indicates a company's excellent performance in environmental protection, social responsibility and corporate governance, which conveys a company's sound development and long-term planning, making it easier to obtain external financial support for technology R&D and innovation. Finally, from a social trust perspective, high-quality

ESG disclosures convey a company's commitment to sustainability, enhancing its credibility in capital markets and attracting long-term investors. Moreover, firms excelling in ESG are more likely to receive policy incentives such as tax benefits and financial subsidies, which lower innovation costs and enhance innovation capabilities (Ma & Hu, 2022). The above findings indicate that the capital market has a high degree of attention to the ESG performance of firms, and good ESG disclosure helps firms to attract more innovation resources, which will further support their innovation activities and thus ultimately enhance their total factor productivity.

2.3. Analysis of the Corporate Reputation Pathway

ESG disclosure significantly enhances corporate reputation, which in turn fosters TFP growth. From a resource acquisition perspective, reputation transaction theory posits that corporate reputation is an intangible asset accumulated in long-term operation, with scarcity and inimitability, and has a significant effect on enhancing the acquisition of corporate resources. Jiang and Wu (2023) suggest that the visibility and reputation that reputation brings to firms can enable them to reduce transaction costs and production costs in market competition, which in turn has a significant impact on enhancing their financial performance, increasing their competitiveness and market share, thus promoting high-quality development and improving their total factor productivity. On the one hand, a higher reputation can help firms obtain more low-cost credit resources, thereby easing financing constraints and increasing TFP. On one hand, higher reputation can help firms obtain more low-cost credit resources, which in turn alleviates financing constraints and increases total factor productivity. On the other hand, high-reputation firms usually attract more stakeholder support (Maden, 2012), including higher-quality employees, suppliers, and customer partnerships, all of which can further optimize resource allocation, reduce costs, and thus enhance total factor productivity. In addition, high-reputation firms are more likely to obtain government policy support and social recognition, which enhances their risk-resistant ability in market fluctuations and policy changes, and helps firms achieve sustained productivity improvement. Research has shown that reputational capital is an important guarantee for firms to enhance market competitiveness and productivity, especially in the rapidly changing market environment, reputation can significantly reduce the operating costs and policy risks of firms (Qi et al., 2017). From the perspective of internal control, high-reputation firms will push themselves to continuously improve total factor productivity to maintain the environmentally friendly and responsible social image they portray. Lv et al. (2022) noted that polluting firms with high public concern will pay extra attention to corporate environmental protection in order to maintain their reputation and image, reduce the risk of being penalized by regulation, and also push firms to accelerate technological transformation and upgrading to improve total factor productivity. This not only makes the company's management and operation more efficient, but also further consolidates its green and responsible social image, forming a self-reinforcing virtuous cycle.

ESG information disclosure, as an important measure of corporate social responsibility, can significantly enhance the public image and reputation. On one hand, firms' ESG performance signals to society that they value environmental protection and social responsibility, which can strengthen the trust and recognition of all sectors of society, accumulate more social capital resources, and win wider support and resources for them in the capital market and at the policy level (Dong et al., 2024). For example, through transparent disclosure, firms can not only attract more responsible investors, but also win consumers' favor and loyalty. This reputation effect further promotes the market demand for corporate products and services. On the other hand, ESG information disclosure not only improves firms' social image, but also raises employees' sense of approval and belonging to a certain extent, increasing their loyalty and dedication to the company, which indirectly enhances the productivity and competitiveness of the company (Mao and Wang, 2023). At the same time, ESG information disclosure is not only an effective way for firms to demonstrate their compliance and sustainability capabilities, but also enhances their reputation and credibility in the capital market. Thus, it promotes the cooperation between firms and the government, regulators and the public. A good corporate

reputation can help firms maintain a stable market position and policy support when the external environment changes. This gives firms a greater advantage in resource acquisition and cost control, and further promotes the improvement of their productivity. Therefore, through high-quality ESG information disclosure, firms can not only shape a positive social image and brand reputation, but also achieve efficient allocation of resources and productivity enhancement in long-term development.

Based on the above analysis, this paper proposes the following hypotheses:

H1: ESG information disclosure improves firms' total factor productivity (TFP).

H2: ESG information disclosure enhances firms' total factor productivity by alleviating financing constraints, promoting innovation and improving corporate reputation.

3. Research Design

3.1. Data Source and Sample Selection

This paper selects data from Chinese A-share listed firms between 2011 and 2021 as research samples, and filters the data in the following sequence: (1) excluding ST firms; (2) removing samples from the financial sector; (3) eliminating firms with missing key variables. After the aforementioned filtering, a total of 28,661 samples remains. Furthermore, to mitigate the influence of extreme values on the research findings, a 1% winsorization was applied to continuous variables at both ends.

The data for this study is primarily sourced from the following avenues: (1) Huazheng Index has been evaluating the ESG performance of A-share listed firms since 2009, and its ESG rating data is widely recognized and utilized within academia. This data is derived from the WIND database; (2) Corporate financial and governance data are sourced from the CSMAR database and the China National Research Data Service Platform (CNRDS); (3) Environmental pollution-related data are mainly obtained from the National Bureau of Statistics and the statistical yearbooks of various provinces.

3.2. Variable Definitions.

3.2.1. Total Factor Productivity (TFP_lp)

TFP measures the contribution of all factors—such as technological progress, organizational improvements, and economies of scale—to output growth, beyond the mere increase in input factors. It serves as a critical indicator of high-quality corporate development. Existing literature primarily employs the LP and OP methods to estimate TFP. Compared with traditional econometric approaches, the OP method effectively addresses sample selection bias. However, its application requires firms to report a strictly positive real investment value, which leads to a substantial loss of samples. In contrast, the LP method, which refines the OP approach by using intermediate input as a proxy variable, minimizes sample loss while effectively mitigating endogeneity concerns (Lu & Lian, 2012). Therefore, this paper adopts the LP method to estimate TFP as the dependent variable in the baseline regression analysis.

3.2.2. ESG Information Disclosure (ESG)

This paper utilizes Huazheng ESG rating data as a proxy variable to assess corporate ESG performance. Compared with other rating systems, Huazheng ESG rating is more closely aligned with the actual conditions of Chinese firms, offering a longer time span and better adaptability to China's specific developmental context. The rating system introduces an innovative three-tier analytical framework and employs a weighted average method to ensure scientific evaluation. It comprehensively incorporates various publicly disclosed data sources, including corporate reports, regulatory authority websites, and media reports, ensuring a thorough assessment (Sheng et al., 2024). The ESG ratings categorize listed firms' ESG performance into 9 levels, ranging from C, CC, CCC, B, BB, BBB, A, AA, to AAA. Following the methodology of Fang and Hu (2023), this paper assigns numerical values from 1 to 9, with higher values indicating superior ESG performance.

3.2.3. Control Variables

Drawing on previous research, this paper incorporates a range of control variables, including firm size *(Size)*, leverage ratio *(Lev)*, return on assets *(ROA*), cash flow ratio *(Cashflow)*, revenue growth rate *(Growth)*, book-to-market ratio *(BM)*, the largest shareholder's ownership proportion *(Top1)*, and the firm's establishment age *(FirmAge)*. Additionally, the paper controls for year fixed effects *(Year)* and industry fixed effects *(Ind)* to account for temporal trends and inter-industry differences.

Table 1. Variables and Definitions

Variable Type	Variables	Variable Symbol	Variable Interpretation
Dependent variable	Total factor productivity	*TFP_lp*	Calculated using the LP method
Independent variable	ESG information disclosure	*ESG*	Value 1~9 according to Huazheng ESG rating from low to high
Control variables	Firm size	*Size*	Natural logarithm of total assets of firms
	Leverage ratio	*Lev*	Total liabilities/total assets
	Return on assets	*ROA*	Net profit/total assets
	Cash flow ratio	*Cashflow*	Monetary funds/total assets
	Revenue growth rate	*Growth*	Difference between current and prior year's operating income minus 1
	Book-to-market ratio	*BM*	Book value/total market value
	The largest shareholder's ownership proportion	*Top1*	Number of shares held by the largest Shareholder/total number of shares
	Firm's establishment age	*FirmAge*	Natural logarithm of the number of years the company has been established plus 1
	Annual effect	*Year*	Annual fixed effects
	Industry effect	*Ind*	Industry fixed effect

3.3. Model Construction

In order to study the impact of firms' ESG information disclosure on total factor productivity, this paper constructs the following econometric model:

$$TFP\_lp_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \alpha_2 Controls_{i,t} + \sum Year + \sum Ind + \varepsilon_{i,t} \quad (1)$$

In model (1), *i* represents individual firms and *t* represents the year; *TFP_lp* is an independent variable indicating the total factor productivity of listed company *i* in year *t*; ESG is the independent variable indicating the Huazheng ESG rating of listed company i in year *t*; *Controls* are the main control variables chosen in this paper; *Year* and *Ind* denote the year fixed effect and industry fixed effect, respectively; and ε is the random disturbance term. The positive, negative and significant performance of the coefficient α_1 reflects the impact of firms' ESG information disclosure on firms' total factor productivity, which is the main focus of this paper.

4. Empirical Results and Analysis

4.1. Descriptive Statistical Analysis

Table 2 presents the descriptive statistics of the main variables in this paper. As shown in the table, the dependent variable (*TFP_lp*) has a mean value of 8.389, with a standard deviation of 1.052, a median of 8.290, and minimum and maximum values of 6.129 and 11.212, respectively. These figures indicate that the total factor productivity of the sampled firms is relatively concentrated, approximating a normal distribution, though some degree of fluctuation remains. The independent variable, *ESG*, has a mean value of 4.097, a standard deviation of 1.127, a minimum of 1, and a maximum of 8, suggesting significant variation in ESG performance levels across firms. The

descriptive statistics of other control variables fall within normal ranges and are largely consistent with findings in existing literature.

Table 2. Results of Descriptive Statistics of Variables

Variables	Sample Size	Mean Value	Standard Deviation	Minimum	Median	Maximum
TFP_lp	28661	8.389	1.052	6.129	8.290	11.212
ESG	28661	4.097	1.127	1.000	4.000	8.000
Size	28661	7.683	1.236	4.787	7.603	11.179
Lev	28661	0.427	0.206	0.056	0.419	0.901
ROA	28661	0.038	0.065	-0.249	0.038	0.214
Cashflow	28661	0.046	0.068	-0.156	0.045	0.241
Growth	28661	0.173	0.402	-0.561	0.111	2.475
BM	28661	1.038	1.143	0.094	0.665	7.047
Top1	28661	0.340	0.148	0.085	0.317	0.742
FirmAge	28661	2.898	0.328	1.792	2.944	3.526

4.2. Baseline Regression

Table 3 presents the results of the baseline regression analysis. In column (1), where only the core independent variable *ESG* is included, the regression coefficient of *TFP_lp* is 0.1940, which is positively significant at the 1% level. Columns (2) and (3) sequentially incorporate the control variables and fixed effects for year and industry. The regression coefficients of *ESG* in these models are 0.0663 and 0.0464, respectively, both remaining positively significant at the 1% level. Taking column (3) as the benchmark, it can be observed that for each level increase in *ESG*, a firm's total factor productivity rises by 4.64%. These findings demonstrate that, from both statistical and economic significance perspectives, corporate ESG disclosure contributes to enhanced total factor productivity, thereby confirming hypothesis H1.

Table 3. Baseline Regression Results

Variables	(1)	(2)	(3)
	TFP_lp	*TFP_lp*	*TFP_lp*
ESG	0.1940***	0.0663***	0.0464***
	(35.201)	(16.674)	(12.449)
Size		0.3697***	0.4043***
		(81.108)	(89.450)
Lev		1.2906***	1.1477***
		(41.709)	(39.330)
ROA		3.1441***	2.9578***
		(30.679)	(31.646)
Cashflow		-0.1070	0.0924
		(-1.339)	(1.226)
Growth		0.2113***	0.2025***
		(15.907)	(16.110)
BM		0.1913***	0.1471***
		(37.958)	(28.562)
Top1		0.2618***	0.3063***
		(8.820)	(10.877)
FirmAge		0.2180***	0.0147
		(17.454)	(1.115)
_cons	7.5942***	3.6536***	3.6671***
	(330.748)	(75.294)	(65.956)
Year	NO	NO	YES
Industry	NO	NO	YES
N	28661	28661	28661
Adj.R2	0.0432	0.5601	0.6263

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels respectively; t-values in parentheses; same below.

4.3. Robustness Tests

Different rating agencies adopt varying evaluation frameworks and weighting criteria when constructing ESG rating systems. The Huazheng ESG rating focuses on the unique characteristics and policy demands of the Chinese market, making it well-suited for localized ESG assessment, whereas Bloomberg's ESG rating follows international standards, offering a global comparative perspective. These differences may result in heterogeneity in ESG ratings across data sources (Hawn et al., 2018). To mitigate potential biases stemming from misjudgment, this study replaces the original independent variable (ESG) with the Bloomberg ESG rating index (*ESG_p*) and re-estimates Model (1). As shown in column (1) of Table 4, the regression coefficient of *ESG_p* on total factor productivity (*TFP_lp*) remains positively significant at the 1% level, confirming the robustness of the previous findings.

Table 4. Robustness Tests

	Replace the Independent Variable	Replace the Dependent Variable	Exclude the Specific Years
Variables	(1) *TFP_lp*	(2) *TFP_op*	(3) *TFP_lp*
ESG		0.0539***	0.0204***
		(14.610)	(21.231)
ESG_p	0.0456***		
	(11.049)		
Size	0.4020***	0.1165***	0.3607***
	(80.207)	(25.936)	(51.150)
Lev	1.1457***	1.1879***	1.2674***
	(35.192)	(41.595)	(25.490)
ROA	3.0470***	2.8589***	3.5845***
	(29.027)	(31.747)	(22.713)
Cashflow	-0.0448	0.3018***	-0.1507
	(-0.541)	(4.136)	(-1.243)
Growth	0.1933***	0.1987***	0.1869***
	(13.904)	(16.266)	(9.454)
BM	0.1490***	0.1774***	0.0987***
	(25.940)	(35.310)	(15.662)
Top1	0.3280***	0.3260***	0.3429***
	(10.528)	(11.694)	(8.081)
FirmAge	0.0154	0.0250*	-0.0628***
	(1.066)	(1.915)	(-2.970)
_cons	3.6802***	4.0876***	3.9457***
	(60.607)	(74.012)	(43.540)
Year	YES	YES	YES
Industry	YES	YES	YES
N	23092	28661	10551
Adj.R2	0.6283	0.4727	0.6429

The OP and LP methods each have their own strengths in addressing endogeneity and dynamic adjustments in heterogeneous contexts. The LP method, by using intermediate inputs as proxy variables, effectively mitigates endogeneity issues in production function estimation. However, its applicability is more suited to scenarios where intermediate inputs are highly correlated with production factors (Levinsohn & Petrin, 2003). In contrast, the OP method, which relies on investment decisions as proxy variables, better captures the dynamic characteristics of production functions in cases of significant corporate investment adjustments (Olley & Pakes, 1996). Therefore, this study replaces the original dependent variable (TFP_lp) with the OP-estimated total factor productivity (TFP_op) and re-estimates Model (1). As shown in column (2) of Table 4, the regression

coefficient of ESG information disclosure (ESG) on TFP_op remains positively significant at the 1% level, further supporting the robustness of the results.

Extreme events often bring significant policy interventions and market fluctuations, potentially distorting the normal relationships between research variables. For instance, the 2015 stock market crash may have impacted corporate ESG activities, while emergency fiscal and monetary policies during the 2020 COVID-19 pandemic could have altered the dynamic mechanisms of corporate productivity (Zhang et al., 2020). Consequently, this study excludes data from 2015 and 2020 and re-runs the regression analysis. As shown in column (3) of Table 4, the regression coefficient of ESG information disclosure (ESG) on total factor productivity (TFP_lp) remains positively significant at the 1% level, once again demonstrating that ESG disclosure enhances corporate total factor productivity.

5. Path Tests and Heterogeneity Analysis

5.1. Path Tests

5.1.1. Mitigating Financing Constraints

Innovation promotion effect. Financial constraints that firms encounter during the financing process may hinder their ability to freely access capital to support production and operations, thereby suppressing investment and innovation activities, ultimately reducing TFP. ESG disclosure can alleviate financing constraints by reducing information asymmetry, gaining investors' trust, and securing financial support while lowering debt financing costs (Zou & Sun, 2024). Following the methods of Wei et al. (2014) and Kaplan & Zingales (1997), the KZ index is employed as a proxy indicator for financing constraints (KZ), with results shown in column (1) of Table 5. Additionally, to comprehensively consider both corporate financial characteristics and external industry features, the WW index (WW), as proposed by Ju et al. (2013) and Whited & Wu (2006), is adopted to assess financing constraints by comparing investment opportunities with actual investments, with the results displayed in column (2) of Table 5. In both cases, the regression coefficients of ESG are significantly negative at the 1% level, indicating that ESG disclosure, regardless of the measurement approach, effectively alleviates financing constraints and enhances total factor productivity.

5.1.2. Innovation Promotion Effect

Innovation promotion effect. TFP reflects the extent of technological progress and efficiency improvements in the production process, serving as a crucial indicator of a firm's innovation capability. As discussed earlier, technological advancements and efficiency improvements, which are direct outcomes of innovation activities, are key drivers of TFP growth and play a pivotal role in industrial transformation. Consequently, when corporate innovation capabilities are enhanced through ESG disclosure, TFP is expected to increase accordingly. Innovation capabilities are quantified from two dimensions: input and output. First, the firm’s annual R&D investment is measured by the ratio of annual R&D expenditure to total assets (*R&D*), with the results shown in column (3) of Table 5. Second, following the methodology of Fang and Hu (2023), the total number of inventions, utility model, and design patent applications plus one is logarithmically transformed to measure innovation output (*Patent*), with the results displayed in column (4) of Table 5. The regression coefficients of ESG are significantly positive at the 1% level, demonstrating that ESG disclosure facilitates corporate technological innovation, thereby driving TFP improvement.

5.1.3. Reputation Value Effect

Reputation value effect. Corporate reputation embodies a firm's market and societal image, credibility, and brand value. As previously analyzed, a strong corporate reputation can attract high-quality resources and partnerships, enhance consumer trust and loyalty, and reduce transaction and production costs, ultimately improving TFP. A high-quality ESG rating effectively showcases corporate responsibility, bolstering public trust and brand image. Following the approach of Guan

and Zhang (2019), this study selects 12 corporate reputation evaluation indicators to calculate a reputation score. Firms are then divided into ten groups based on their reputation scores, with each group assigned a value from 1 to 10 (*Rep*), serving as a proxy for corporate reputation. The results, shown in column (5) of Table 5, indicate that the regression coefficient of ESG is significantly positive at the 1% level, suggesting that ESG disclosure enhances corporate reputation, which in turn contributes to improved TFP.

Based on the above analysis, hypothesis H2 is confirmed: ESG disclosure enhances total factor productivity by alleviating financing constraints, promoting innovation, and improving corporate reputation.

Table 5. Path Tests

Variables	(1)	(2)	(3)	(4)	(5)
	KZ	*WW*	*R&D*	*Patent*	*Rep*
ESG	-0.0713***	-0.0065***	0.0005***	0.1488***	0.2278***
	(-9.598)	(-19.448)	(5.510)	(18.819)	(20.564)
Size	-0.0869***	-0.0292***	0.0018***	0.5265***	1.0024***
	(-10.451)	(-75.477)	(18.227)	(59.269)	(83.295)
Lev	6.1161***	0.0036	-0.0055***	0.0924*	-0.7024***
	(111.250)	(1.420)	(-8.590)	(1.650)	(-8.434)
ROA	-4.6738***	-0.2234***	0.0178***	1.5993***	25.3603***
	(-26.910)	(-30.291)	(8.003)	(9.711)	(80.181)
Cashflow	-12.6521***	-0.0910***	0.0110***	-1.1554***	1.2323***
	(-87.741)	(-14.808)	(6.901)	(-8.250)	(6.100)
Growth	-0.1629***	-0.0480***	-0.0000	0.0367	0.2545***
	(-5.718)	(-36.317)	(-0.122)	(1.638)	(8.226)
BM	-0.1137***	-0.0158***	-0.0029***	0.0061	0.2652***
	(-13.887)	(-36.593)	(-28.618)	(0.566)	(17.405)
Top1	-0.6004***	-0.0261***	-0.0064***	-0.2912***	0.8451***
	(-11.098)	(-10.503)	(-10.000)	(-4.731)	(10.558)
FirmAge	0.2249***	0.0051***	-0.0047***	-0.2546***	-0.0880**
	(7.948)	(4.118)	(-14.310)	(-8.825)	(-2.254)
_cons	1.8801***	-0.6830***	0.0040***	-2.9464***	-4.5601***
	(15.613)	(-131.818)	(3.032)	(-24.099)	(-27.255)
Year	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES
N	16254	13849	25039	25039	24016
Adj.R2	0.7846	0.7355	0.3994	0.4497	0.6323

5.2. Heterogeneity Analysis

5.2.1. Industry Pollution

Industry pollution. In highly polluting industries, firms often face heightened environmental risks due to the nature of their operations. Through ESG disclosure, such firms can comprehensively communicate their environmental protection efforts and achievements, effectively addressing public concerns, enhancing their social image, and mitigating financing constraints arising from information asymmetry with banks and other investors (Fan & Fu, 2021). This, in turn, attracts investors who prioritize sustainable development. Moreover, transparent ESG information disclosure can inspire firms to adopt greener and more efficient production technologies and management practices, thereby improving productivity while achieving environmental and social goals. Consequently, the positive impact of ESG disclosure on TFP is expected to be more pronounced in highly polluting industries.

Following the approach of Li et al. (2021), this study classifies firms based on the Industry Classification Guidelines for Listed Firms issued by the China Securities Regulatory Commission (CSRC) in 2012, dividing the sample into highly polluting firms (*Pollution*=1) and non-heavily

polluting firms (*Pollution*=0). The regression results, as shown in Table 6, indicate that for highly polluting firms, the regression coefficient of *ESG* is 0.0555 and is positively significant at the 1% level, while for non-polluting firms, the coefficient is 0.0426. In column (3) of Table 6, the interaction term *ESG×Pollution* is also positively significant at the 1% level, consistent with the grouped regression findings, confirming that ESG disclosure has a stronger impact on TFP improvement in more polluting firms.

Table 6. Heterogeneity Analysis: Industry Pollution

	(1)	(2)	(3)
	Heavily polluting firms	Non-heavily polluting firms	Interaction item validation
	TFP_lp	*TFP_lp*	*TFP_lp*
ESG	0.0555***	0.0426***	0.0350***
	(9.083)	(9.337)	(7.775)
Pollution			0.1056***
			(3.053)
ESG×Pollution			0.0398***
			(5.380)
Size	0.4322***	0.3932***	0.4028***
	(50.154)	(75.500)	(89.078)
Lev	0.6559***	1.3255***	1.1499***
	(13.634)	(37.620)	(39.577)
ROA	2.7034***	3.0104***	2.9677***
	(18.171)	(26.329)	(31.900)
Cashflow	0.5683***	-0.1496*	0.0779
	(4.246)	(-1.693)	(1.041)
Growth	0.1709***	0.2090***	0.2036***
	(7.670)	(14.025)	(16.239)
BM	0.1163***	0.1400***	0.1398***
	(13.172)	(22.538)	(27.111)
Top1	0.3938***	0.2150***	0.2874***
	(8.024)	(6.374)	(10.232)
FirmAge	0.0463*	-0.0193	0.0051
	(1.902)	(-1.246)	(0.391)
Year	YES	YES	YES
Industry	YES	YES	YES
N	8411	20250	28661
Adj.R2	0.6323	0.6439	0.6309

5.2.2. Nature of ownership of firms

Due to their unique nature and strategic position, state-owned enterprises (SOEs) often bear greater social responsibilities. Governments frequently impose explicit social responsibility obligations on SOEs while offering policy and financial support in return. Additionally, the strong political connections between SOEs and the government necessitate exemplary fulfillment of social responsibilities at a national level (Wang & Yang, 2022). As a result, SOEs are under greater public and media scrutiny, prompting them to allocate more resources and effort toward ESG-related initiatives. Accordingly, compared to non-SOEs, ESG disclosure is expected to have a more pronounced effect on TFP in SOEs.

Based on this premise, the sample is divided into SOEs (*SOE*=1) and non-SOEs (*SOE*=0). The regression results, as shown in Table 7, indicate that in SOEs, the *ESG* regression coefficient is 0.0897 and is positively significant at the 1% level, whereas in non-SOEs, the coefficient is only 0.0264. In column (3) of Table 7, the interaction term *ESG×SOE* is also positively significant at the 1% level, consistent with the subgroup regression results, confirming that ESG disclosure has a stronger impact on TFP improvement in SOEs.

Table 7. Heterogeneity Analysis: Nature of Ownership of Firms

	(1)	(2)	(3)
	SOE	Non-SOE	Interaction item validation
	TFP_lp	*TFP_lp*	*TFP_lp*
ESG	0.0897***	0.0264***	0.0173***
	(12.914)	(6.091)	(4.009)
SOE			-0.2791***
			(-8.337)
ESG×SOE			0.0850***
			(11.186)
Size	0.4146***	0.3862***	0.4005***
	(54.537)	(67.782)	(88.583)
Lev	1.1354***	1.0991***	1.1446***
	(21.260)	(31.117)	(39.108)
ROA	4.0758***	2.8039***	3.0119***
	(20.998)	(26.577)	(32.148)
Cashflow	0.0409	0.1356	0.0902
	(0.310)	(1.498)	(1.200)
Growth	0.2467***	0.1923***	0.2061***
	(10.868)	(12.825)	(16.412)
BM	0.1073***	0.2061***	0.1391***
	(15.604)	(21.951)	(26.874)
Top1	0.6256***	0.0764**	0.2602***
	(12.367)	(2.196)	(9.112)
FirmAge	0.0493*	-0.0211	-0.0032
	(1.799)	(-1.395)	(-0.242)
Year	YES	YES	YES
Industry	YES	YES	YES
Adj.R2	0.6449	0.5944	0.6288

5.2.3. Corporate governance Quality

High-quality corporate governance typically signifies well-established internal governance mechanisms, including a clear governance structure, effective decision-making processes, and robust oversight mechanisms. Such mechanisms ensure the accuracy and reliability of ESG disclosures, thereby enhancing investor confidence (Yang et al., 2023). Moreover, high-quality governance emphasizes transparency, leading firms to proactively, comprehensively, and promptly disclose ESG-related information. This transparency enables external stakeholders to gain insights into the firm's sustainable development status, thereby enhancing market reputation, attracting investment, fostering innovation, and optimizing resource allocation—ultimately improving TFP.

Following the approach of Zhou et al. (2018), this study selects eight corporate governance variables and employs principal component analysis to construct a comprehensive corporate governance quality index. Firms with values above the median are classified as high-governance-quality firms, while the remaining are classified as low-governance-quality firms. The regression results, as shown in Table 8, reveal that in firms with high governance quality, the *ESG* regression coefficient is 0.0707 and is positively significant at the 1% level, whereas in firms with low governance quality, the coefficient is only 0.0248. In column (3) of Table 8, the interaction term *ESG×Govern* is also positively significant at the 1% level, consistent with the subgroup regression findings, indicating that ESG disclosure has a stronger impact on TFP improvement in firms with higher governance quality.

Table 8. Heterogeneity Analysis: Corporate Governance Quality

	(1)	(2)	(3)
	Firms with high governance quality	Firms with low governance quality	Interaction item validation
	TFP_lp	*TFP_lp*	*TFP_lp*
ESG	0.0707***	0.0248***	0.0484***
	(13.453)	(4.866)	(12.548)
Govern			-0.0728***
			(-4.344)
ESG×Govern			0.0372***
			(9.994)
Size	0.4051***	0.3730***	0.3839***
	(68.194)	(52.803)	(79.639)
Lev	1.2452***	0.9349***	1.1423***
	(29.708)	(22.499)	(37.697)
ROA	3.7079***	2.5534***	3.0966***
	(25.698)	(21.305)	(31.514)
Cashflow	0.0003	0.0990	-0.0113
	(0.003)	(0.930)	(-0.145)
Growth	0.2071***	0.2187***	0.2063***
	(12.078)	(12.055)	(16.109)
BM	0.1196***	0.2415***	0.1461***
	(20.332)	(19.504)	(27.258)
Top1	0.4514***	-0.2182***	0.0405
	(11.396)	(-4.932)	(1.204)
FirmAge	0.0401**	-0.0561***	-0.0345**
	(2.004)	(-3.156)	(-2.523)
Year	YES	YES	YES
Industry	YES	YES	YES
Adj.R2	0.6386	0.5582	0.6279

6. Conclusion and Recommendations

With the intensification of global environmental issues, the impact of the COVID-19 pandemic, and the increasing pressure of domestic economic restructuring, firms are playing a more significant role in driving high-quality economic development. This study provides an in-depth theoretical analysis of the impact of ESG disclosure on corporate total factor productivity (TFP) and its underlying mechanisms, using data from A-share listed firms in China from 2011 to 2021 for empirical testing. The key findings are as follows: (1) ESG information disclosure significantly enhances corporate TFP. This conclusion remains robust even after changing the measurement methods of key variables and excluding the impact of special years. (2) In terms of paths, ESG disclosure primarily promotes TFP through three pathways: alleviating financing constraints, fostering innovation, and enhancing corporate reputation. (3) The positive impact of ESG disclosure on TFP is more pronounced in highly polluting firms, state-owned enterprises (SOEs), and firms with higher corporate governance quality. The findings of this study highlight the long-term significance of ESG disclosure in improving corporate productivity from both theoretical and empirical perspectives, providing valuable insights for policymakers.

Based on the above findings, the following recommendations are proposed:

At the policy level, (1) The government should expedite the development and implementation of standardized ESG disclosure frameworks, clearly defining content and format requirements while strengthening supervision and enforcement. This would enhance the transparency and credibility of ESG disclosures, encouraging firms to systematically assess and manage their social and environmental responsibilities. Particularly for heavily polluting and state-owned enterprises,

disclosure indicators should be further refined to ensure accuracy and comprehensiveness, thereby reinforcing the guiding role of regulatory policies. (2) The government should introduce incentive measures such as tax benefits and green financial support to encourage firms that actively disclose ESG information and demonstrate outstanding performance. These incentives can help alleviate financial constraints and offset the additional costs incurred by firms implementing environmental and social responsibility initiatives. In turn, such policies will encourage more firms to voluntarily assume social responsibility and enhance TFP. (3) The government should support firms in increasing investments in research and development (R&D) within the ESG framework, particularly in areas such as green technology, clean energy, and sustainable business models. Financial subsidies and dedicated funding programs can help firms improve resource efficiency, reduce environmental costs, and build a positive social reputation. Encouraging ESG-driven technological advancements will foster a productivity-enhancing mechanism driven by innovation, providing intrinsic momentum for the coordinated development of the economy and the environment.

At the firms' level, (1) Firms should deeply embed ESG principles into their corporate development strategies, recognizing the critical role ESG plays in enhancing long-term value and competitiveness. ESG considerations should be incorporated into strategic planning and daily operations by promoting green production, minimizing resource waste, and strengthening internal governance to optimize resource allocation efficiency. (2) Firms should standardize and improve the quality of their ESG reports, ensuring accuracy, completeness, and transparency. Regularly publishing high-quality ESG reports can showcase achievements in environmental protection, social responsibility, and governance, attracting investors and business partners while strengthening public trust and recognition. (3) Firms should proactively invest in the R&D of green technologies and environmental projects to boost innovation capabilities. Leveraging technology to drive improvements in production efficiency and environmental performance can create a win-win situation for economic and social benefits. Specifically, efforts should focus on energy conservation, pollution control, and resource recycling to explore green transformation pathways. This not only reduces operational costs but also generates new growth opportunities, meeting market demands for sustainable development.

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