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Sustainable Development in the Textile and Apparel Industry: ESG Performance, Digital Transformation, and Corporate Value

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Article

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ABSTRACT

As China progresses with its "dual carbon" strategy and the deepening concept of sustainable development, there is a growing focus among consumers and investors on the environmental, social, and governance (ESG) performance of businesses. As a high-pollution and resource-intensive traditional manufacturing industry, the ESG practices within the textile and apparel sector require further exploration to understand their influence on corporate value. This research study utilizes data from publicly traded firms in the textile and apparel sector spanning 2013 to 2023. Using a two-way fixed effects approach, accounting for both temporal and individual heterogeneity, we analyze how ESG metrics influence firm value and the underlying mechanisms. The findings indicate that ESG performance in textile and apparel companies contributes to enhancing corporate value; the ability of a company to innovate partially mediates the effect of ESG performance on corporate value; a company's level of digitalization positively moderates the connection between ESG performance and firm value. This research highlights the unique characteristics of ESG practices in the textile and apparel industry, enriches the theoretical framework of corporate sustainability, and provides practical insights for government and corporate decision-makers.

KEYWORDS

textile and apparel companies, ESG performance, corporate innovation capability, digitalization level, corporate value

INTRODUCTION

With the global economy transitioning toward sustainability, Environmental, Social, and Governance (ESG) performance has emerged as a crucial framework for assessing corporate sustainability. ESG metrics reflect a company's fulfilment of environmental and social responsibilities while indicating the transparency and soundness of its governance structure. The United Nations Sustainable Development Goals (SDGs) have prompted governments worldwide to strengthen environmental regulations, encouraging companies to reduce carbon emissions and improve social responsibility fulfilment [1]. Meanwhile, the widespread use of financial instruments such as the Dow Jones Sustainability Index (DJSI) and MSCI ESG Ratings has made ESG performance a key determinant, influencing not only a company's market reputation but also its financing costs and investor confidence [2,3]. Specifically,

ESG investing has become mainstream in capital markets, with the global sustainable investment fund size surpassing \$35 trillion, accounting for one-third of global assets under management [4]. In this context, how companies optimize ESG management to enhance their competitiveness has become a critical factor in corporate strategic management and capital market evaluations of long-term value. The textile and apparel industry faces greater challenges and pressure regarding ESG governance due to its resource-intensive nature, high pollution emissions, and globalized supply chains. Existing data indicates that this sector consumes approximately 215 trillion litres of water annually, ranking second globally in water usage, and contributes 8%-10% of global carbon emissions, making it one of the most polluting industries [5]. Moreover, the rise of fast fashion has exacerbated resource wastage and waste emissions, with China being the most affected, generating around 20 million tons of textile waste annually, with less than 10% recycled [6]. Furthermore, labour rights issues, unsafe working environments, and insufficient corporate social responsibility (CSR) practices in the supply chain pose significant social responsibility risks to the industry. For instance, The catastrophic collapse of the Rana Plaza building in Bangladesh in 2013, which resulted in the deaths of more than 1,000 individuals, sparked global discussions on the transparency of supply chains and the protection of labour rights in the apparel industry [7].

As consumer awareness of sustainable consumption increases, market demand for green supply chains, renewable materials, and environmentally friendly production technologies has grown rapidly. Research shows that Generation Z consumers are increasingly inclined to pay extra for sustainable products due to their focus on environmental issues, green visions, and green benefits [8]. Meanwhile, institutional investors often consider ESG performance when evaluating a company's value [9]. Against this backdrop, global apparel brands have increased ESG investments, with H&M implementing its "Conscious Action" sustainability plan [10], Nike promoting its "Zero Carbon, Zero Waste" strategy [11], and Inditex, the parent company of Zara, pledging to achieve carbon neutrality by 2040 [12].

In recent years, a wealth of empirical research has indicated that a company's performance in ESG plays a positive role in boosting its market value, capital acquisition ability, and overall financial success. Qian suggests that robust ESG performance bolsters the green innovation capacity of enterprises and capital acquisition ability, thereby improving its market competitiveness [13]. Especially in the current context where the environment is increasingly valued, companies can effectively mitigate environmental risks and earn high ratings from capital markets and consumers by reducing resource consumption, lowering carbon emissions, and improving production efficiency [14]. The application of environmental technologies [15] and the fulfilment of social responsibilities [16] not only enhance a company's brand image but also promote its long-term competitiveness in the market. Additionally, the transparency of corporate governance and the fulfilment of social responsibilities are regarded as the foundation for long-term corporate development [17]. Although the academic community widely

acknowledges a positive correlation between ESG performance and enterprise value, research specific to certain industries remains limited, and it remains unclear whether existing ESG theoretical frameworks and empirical findings apply to the textile and apparel sector. Furthermore, with the ongoing development of digital technologies, digital transformation levels have become a key factor in driving companies to improve production efficiency, reduce costs, enhance management effectiveness, and boost sustainability. Digital technologies, by reducing agency costs and enhancing corporate reputation, give businesses a leg up in managing their environmental footprint, fulfilling social responsibilities, and optimizing governance structures [18]. Through efficient resource management and intelligent process optimization, digital technologies provide the technical support needed for companies to attain green transformation and high-quality development [19,20]. Nonetheless, there remains a significant shortage of methodical empirical research studies on the ways digital technologies can assist companies in improving ESG performance and ultimately promoting corporate value growth.

To address this research void, this paper seeks to tackle the following three inquiries:

1. What is the connection between ESG performance and corporate value within the textile and apparel sector?
2. What role does corporate innovation capacity play in the effect of ESG on its worth?
3. How does the digitalization level moderate this relationship?

As the foremost global textile exporter and supplier, China is crucial to the international textile supply chain [21]. Therefore, studying the ESG performance of China's textile and apparel sector holds significant importance. This study uses data from 408 annual observations of listed textile and apparel companies in China spanning 2013 to 2023. Drawing on stakeholder and signalling theories, we examine the link between ESG performance and corporate value, exploring how sustainable development strategies influence business value. Additionally, using the theory of synergy, we focus on the role of digitalization in the mechanism, exploring whether digitalization amplifies the ESG value of textile and apparel companies.

This research offers three primary theoretical contributions. First, it deeply explores the specific impact pathways of ESG performance on corporate value, especially in resource-intensive and pollution-prone industries, and how to balance ESG and business performance. By incorporating corporate innovation capacity as a mediating factor, we identify that ESG practices, through driving technological and management innovations, further enhance corporate value, providing more targeted theoretical support for related fields. Second, in existing ESG research, the role of digitalization as a moderating variable has not been sufficiently discussed. This study is the first to systematically analyze how digital technologies enhance ESG performance in the textile and apparel industry by improving environmental

monitoring, optimizing supply chain transparency, and increasing resource utilization efficiency, thus strengthening the impact of ESG practices on corporate value, filling a gap in the theoretical research. Finally, while most research on ESG and corporate value focuses on the financial or high-tech industries, this study focuses on the textile and apparel industry, a more conventional manufacturing realm. Examining the unique characteristics of this industry, reveals the distinct influence of ESG performance on high-pollution, resource-dependent industries, providing new case studies and theoretical extensions for the applicability of ESG research in different industries.

THEORETICAL ANALYSIS

This research delves into how well textile and apparel companies perform on ESG metrics and how that affects their value growth. We're framing our investigation using Stakeholder Theory and Signaling Theory to get under the hood and see how ESG fits into the bigger picture of corporate strategy.

Stakeholder Theory

Freeman introduced Stakeholder Theory, which argues that businesses should not limit their strategic planning to merely catering to shareholder interests; instead, they ought to take into account all stakeholder groups involved in the business activities of the company [22]. The central idea of this theory is that firms should carefully balance the expectations and demands of multiple stakeholders while building long-term, stable relationships to achieve sustainable development. With the growing emphasis on CSR and sustainability, Stakeholder Theory has become a key framework in ESG research. By implementing environmental protection measures, fulfilling social responsibilities, and optimizing governance structures, firms can not only meet shareholder expectations but also gain the trust and support of consumers, employees, suppliers, and governments. This, in turn, boosts the firm's market competitiveness and long-term value [23]. In the textile and apparel industry, companies that adopt green production, enhance social responsibility, and strengthen governance structures can meet policy requirements, increase brand loyalty, and carve out a bigger slice of the market pie. Particularly in the context of global supply chains and environmental protection, a company's ESG performance can help secure resources and support, further strengthening its long-term competitiveness.

Signaling Theory

Signalling Theory suggests that in environments with information asymmetry, market participants use certain signals to convey their characteristics to external stakeholders, thereby influencing their decision-making [24]. In economic activities, firms generally possess more knowledge about their internal conditions than investors, consumers, and other stakeholders. Therefore, they often utilize specific external actions or characteristics to communicate key information and reduce market

deviations arising from information asymmetry. The fundamental assumption of the Signaling Theory is that information in the market is incomplete, and the behaviours of different participants can send signals about their quality, capabilities, or prospects, thus influencing market perceptions and decisions [25]. In the context of ESG, a company's ESG practices can be viewed as a signalling method to external stakeholders. By actively fulfilling environmental responsibilities (e.g., carbon reduction, sustainable supply chain management), social responsibilities (e.g., labour rights protection, social welfare investments), and governance responsibilities (e.g., transparent disclosures, board independence), companies signal their long-term strategic orientation and risk management capabilities. In the textile and apparel sector, strong ESG performance not only strengthens investor trust and lowers capital costs [26] but also enhances consumer brand loyalty and improves market image [27]. In light of increasingly stringent environmental regulations and social responsibility expectations, ESG practices serve as a signal of a company's competitive advantage, demonstrating its commitment to sustainable development to governments, consumers, and the capital market.

RESEARCH HYPOTHESIS

ESG Performance and Corporate Value

ESG performance is a core indicator for evaluating a company's sustainability capabilities. Through ESG practices, companies balance the interests of stakeholders, improve relationships with shareholders, consumers, suppliers, and society, and ultimately achieve the synergistic enhancement of both economic and social value [28]. In terms of the environmental dimension, companies can reduce information asymmetry, lower financing costs, and secure more capital support by proactively disclosing environmental information [29]. Regarding social responsibility, a company's adherence to business ethics and fulfilment of social responsibilities helps establish a positive corporate image, reduce capital costs, enhance brand reputation, and increase intangible assets, thereby bringing long-term benefits to the company while meeting societal development requirements [30]. On the corporate governance front, improvements in ESG performance can help companies optimize internal governance systems, effectively reduce agency risks, and achieve sustainable growth in corporate value [31]. ESG practices such as adopting green production technologies, improving governance efficiency, and attracting high-quality talent and social capital can drive resources toward high-value areas, thereby improving financial performance.

The unique characteristics of the textile and apparel industry further emphasize the importance of ESG practices. Compared to non-high-pollution industries, the ESG performance of companies in heavily polluting industries has a more significant positive impact on corporate value [32]. The textile and apparel sector, being resource- and pollution-intensive, has more urgent needs in terms of

environmental governance and social responsibility. ESG practices effectively help textile and apparel companies upgrade their technology, optimize management practices, and promote high-quality development [33]. Additionally, consumer demand for green products forces textile and apparel companies to embrace sustainable development. By adopting ESG practices such as renewable energy and energy-saving technologies, companies can significantly reduce their carbon footprint and contribute to sustainability goals [34]. Moreover, corporate sustainability requires meeting a range of indicators, including environmental compliance, carbon impact, and biodiversity conservation, and strong governance is crucial to fulfilling these sustainability criteria in the textile and apparel sector [35]. The global supply chain nature of textile and apparel companies means they must face multiple pressures in their ESG practices, including international regulations, consumer preferences for green products, and investor concerns about corporate responsibility.

Therefore, ESG practices in the textile and apparel industry are not only vital for survival but also a key path toward achieving sustainable development goals. Accordingly, we hypothesize that:

H1: A company's strong ESG performance significantly and positively affects its corporate value.

ESG Performance, Corporate Innovation Capability and Corporate Value

Corporate innovation capability is vital for enhancing competitiveness and value creation. For textile and apparel firms, innovation centres on creating new fabrics, products, or processes to achieve optimal resource allocation and maximize market value [36]. Acquisition of external technological resources [37] and internal resource allocation [38] are crucial factors driving innovation. ESG practices create conditions that allow companies to acquire resources, optimize governance structures, and foster innovation: The external environmental commitments made by textile and apparel companies can help avoid moral hazards and adverse selection issues during the organizational planning phase. Simultaneously, stakeholders will enhance oversight and constraints on the company, thereby promoting the advancement of environmentally friendly research and development technologies and innovative activities within textile and apparel firms [39,40]. Additionally, based on signalling theory, the disclosure of social responsibility information can enable companies to earn the confidence and favour of stakeholders, accordingly obtaining more financial resources and innovative knowledge necessary for corporate innovation. This can mitigate issues such as information asymmetry or financing constraints, motivating companies to intensify innovation and R&D efforts, and thereby creating economic value [25,41]. In terms of resource allocation and strategic planning, a transparent corporate management mechanism guides management to prioritize projects that promote long-term sustainable development and value enhancement, reducing short-sighted behaviours that may arise in innovation activities, and thus enhancing corporate innovation capability [33]. This study argues that strong ESG performance, through the integration and optimization of resources, drives innovation in

areas such as green technologies and business models, further enhancing corporate value. Specifically, ESG performance enhances the external resource acquisition capabilities of textile and apparel companies, while optimizing internal governance structures to increase innovation efficiency. Innovation capability thus becomes a critical mediating mechanism through which ESG performance translates into corporate value. Accordingly, we hypothesize that:

H2: Corporate innovation capability mediates the relationship between ESG performance and corporate value.

ESG Performance, Digital Transformation and Corporate Value

Amidst the burgeoning global digital economy, an increasing number of textile and apparel companies are actively engaging in digital transformation. This transformation process not only involves the upgrading of corporate structures and management models but also includes the smart automation of production processes and the enhancement of market responsiveness [38]. Companies with a high level of digitalization are often better able to integrate ESG strategies more efficiently and optimize resource management through technological means. For instance, smart manufacturing based on big data analytics can greatly lower energy consumption during production, thereby improving environmental management performance [42]; blockchain technology can enhance supply chain transparency, which in turn boosts market trust in a company's ESG commitments [43]. In the clothing trade, companies can optimize supply chain management through digital platforms, reducing waste and improving production efficiency while simultaneously enhancing ESG disclosures. This, in turn, increases investor and consumer recognition of the company [44]. Textile and apparel companies with higher levels of digitalization tend to improve operational efficiency, reduce production and sales costs, effectively implement ESG practices, and expand their consumer market share amid increasing market competition, thus driving the growth of the industry chain value for these companies [45]. Accordingly, we hypothesize that:

H3: The level of digitalization positively moderates the relationship between ESG performance and corporate value.

ESG Performance, Digital Transformation and Corporate Innovation Capability

A company's ESG practices not only contribute to enhancing its reputation and market value, but also promote corporate innovation capabilities by driving green innovation, optimizing resource utilization, and increasing research and development investments. The implementation of an ESG strategy requires substantial innovation input, particularly in areas such as environmental management and sustainable product development [46]. However, when converting ESG objectives into innovative outcomes, the level of digitalization may affect the efficiency and effectiveness of this process.

Technologies like artificial intelligence and big data analytics can optimize green R&D decisions and improve resource allocation efficiency [47]; the Internet of Things (IoT) can enhance production intelligence, enabling companies to more effectively implement energy-saving, emission-reduction, and sustainable manufacturing practices [48]. For the textile and apparel industry, when companies focus on developing ESG-related product lines, digital transformation can help them design textile products more intelligently [49] and optimize production processes [32]. Additionally, digital tools can improve a company's knowledge management capabilities in the implementation of its ESG strategy, thereby facilitating the development of more innovative sustainable solutions [50]. Accordingly, we hypothesize that:

H4: The level of digitalization positively moderates the relationship between ESG performance and corporate innovation capability.

RESEARCH DESIGN

Sample Selection and Data Sources

This research centres on textile and apparel firms traded on the Shenzhen and Shanghai stock exchanges in China, spanning from 2013 to 2023. It aims to investigate how corporate ESG performance influences long-term competitive edge and market valuation. There are three main reasons for selecting this industry. First, China holds the title of the world's leading producer and exporter of textiles, occupying a significant position in the global economy. Studying this industry provides valuable insights for global sustainable development. Second, the textile and apparel industry faces significant environmental and social responsibility pressures, making the impact of ESG performance on corporate value growth particularly pronounced. This effect is especially evident in the context of China's implementation of the "dual carbon" goals and the growing trend of green consumption. Finally, publicly listed companies provide transparent data, offering high representativeness and comparability, thus providing reliable data support for this study and facilitating an in-depth analysis of how ESG practices contribute to corporate innovation capability and value growth.

Empirical analysis data is obtained from the Guotai'an database, corporate annual filings, and the Wind database. The Guotai'an database contains financial data, industry data, and corporate governance information for Chinese companies, making it a reliable source for studying China's capital markets and corporate behaviour. The annual reports of listed companies provide a wealth of information on corporate financial status, management analysis, shareholder structure, and ESG factors, making them an important source for firm-level analysis. The Wind database, one of the main sources of data for China's capital markets, includes corporate financial data, stock market data, and industry analysis,

providing essential support for the analysis of financial performance and stock market performance in this study.

To ensure a more accurate empirical analysis, we cleaned the raw data by first tossing out any companies labelled ST or *ST, along with those that had missing data. We then winsorized the continuous variables at the 1st and 99th percentiles to keep extreme outliers from throwing off the results. The final dataset used in this study consists of unbalanced panel data with 408 firm-year observations.

Variable Definition and Measurement

Explained variable

Corporate value: The dependent variable under scrutiny is corporate value, quantified through Tobin's Q. Unlike short-term financial metrics, Tobin's Q captures the long-term growth potential anticipated by external investors, making it a go-to gauge for corporate value in scholarly studies [51,52]. Drawing from Tobin's Q theory, the formula employed in this study is structured as follows: $\text{Tobin's Q} = [\text{Market Value of Circulating Shares} + (\text{Non-circulating Shares} \times \text{Net Asset per Share}) + \text{Book Value of Liabilities}] / \text{Total Assets}$

Core explanatory variable

To gauge corporate ESG performance, this study leverages the CSI ESG ratings. The CSI ESG Index, which draws extensively from international ESG principles while incorporating China's unique disclosure landscape and corporate traits, constructs a comprehensive and up-to-date evaluation framework. The CSI ESG rating classifies listed companies into nine categories, ranging from C to AAA. This study adopts the approach of Lian et al. [53], assigning values from 1 to 9 (from low to high) according to the CSI ESG rating to measure the ESG performance of textile and apparel companies.

Mediating Variable

Corporate Innovation Capability: Existing studies on corporate innovation capacity primarily measure it from two perspectives: input and output. Input is mainly represented by R&D expenditure [54] or the ratio of R&D expenditure to operating income [55]; output is typically represented by the number of patents granted [56] or the ratio of new product output to operating income [57]. This study measures corporate innovation capability from the input perspective, using the ratio of R&D expenditure to operating income as the indicator of innovation capability.

Moderating Variable

Corporate Digitalization Level: Existing literature often measures corporate digitalization levels using annual report text mining methods. Annual report text mining refers to using Python technology to extract and analyze the frequency of keywords related to digitalization policies, technological R&D, and other relevant topics in the annual reports of listed companies [58]. This study measures the digital transformation capability of textile and apparel companies by summing the frequency of five specific keywords (artificial intelligence technology, big data technology, blockchain technology, cloud computing, and digital technology application) in their annual reports, and then applying the natural logarithm to this total frequency.

Control Variables

Based on previous research, this investigation incorporates a set of key control variables to ensure a comprehensive analysis: company size (Size), current ratio (Liquid), ratio of tangible assets (Tangible), ratio of fixed assets (Fixed), price-to-book ratio (PB), listing age (ListAge), financial leverage (FL), gross profit margin (GrossProfit), and the proportion of shares held by the largest shareholder (Top1). These variables are included to control for additional factors impacting.

The specific definitions and measurement approaches are detailed in Table 1.

Tab.1 Definition of variables

Variable type	Variable name	Variable symbol	Variable definition
Explained variable	Tobin's Q	Tbq	(Market capitalization outstanding + non-marketable shares x net assets per share + book value of liabilities)/total assets
Core explanatory variable	Environmental, Social, and Governance Score	ESG	CSI ESG rating score assignment
Intermediary variable	Firm innovation capacity	Innovate	R&D expenditure as a percentage of operating revenue
Moderating variable	Digital transformation	Digit	Selected keywords related to the digitization of annual reports of five types of companies and the word frequencies were subjected to natural logarithmic processing.
Control variables	Firm size	Size	The natural logarithm of total assets
	Liquidity	Liquid	Current assets/current liabilities
	Ratio of tangible assets	Tangible	The ratio of tangible assets to total assets at the end of the period
	Ratio of fixed assets	Fixed	Net fixed assets / Total assets
	Price-to-book ratio	PB	Price per share/net assets per share

Variable type	Variable name	Variable symbol	Variable definition
Control variables	The number of years of listing	ListAge	ln (current year – year of listing + 1)
	Financial leverage	FL	(Net profit + income tax expense + finance costs) / (Net profit + income tax expense)
	Gross Profit Margin	GrossProfit	(Operating revenue - Operating costs) / Operating revenue
	The largest shareholder holds shares.	Top1	Proportion of shares held by the largest shareholder to total share capital

Model Design

To assess how ESG performance influences corporate value in the textile and apparel sector, this research formulates the subsequent regression model (1):

$$Tbq_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \sum_1^m \alpha_m Controls_{i,t} + \sum Year + \sum Firm + \varepsilon_{i,t} \quad (1)$$

In Model (1), *i*: individual companies; *t*: years. *Tbq_{i,t}*: the ESG performance of the company; *Controls_{i,t}*: each control variables, which include company size (Size), current ratio (Liquid), proportion of tangible assets (Tangible), proportion of fixed assets (Fixed), price-to-book ratio (PB), listing age (ListAge), financial leverage (FL), gross profit margin (GrossProfit), and the percentage of shares held by the largest shareholder (Top1). The year represents the controls year; the Firm represents the control of the individual enterprise and $\varepsilon_{i,t}$ represents the random disturbance term.

To verify the mediating effect between ESG performance and firm value, this study sets regression models (2) and (3) based on a regression model (1), as follows:

$$Innovate_{i,t-2} = \beta_0 + \beta_1 ESG_{i,t} + \sum_1^m \beta_m Controls_{i,t} + \sum Year + \sum Firm + \varepsilon_{i,t} \quad (2)$$

$$Tbq_{i,t} = \gamma_0 + \gamma_1 ESG_{i,t} + \gamma_2 Innovate_{i,t-2} + \sum_1^m \gamma_m Controls_{i,t} + \sum Year + \sum Firm + \varepsilon_{i,t} \quad (3)$$

In models (2) and (3), *Innovate_{i,t-2}*: the intermediary variables of enterprise innovation, in which the intermediary variables are advanced for two periods to control the lagging impact of enterprise

innovation on enterprise value. To fully demonstrate the causal relationship, this paper subsequently supplements the empirical analysis of the impact of enterprise innovation on enterprise value.

To explore the moderating effect of enterprise digitization level on ESG performance and enterprise value, this study further sets regression models (4) and (5), which are as follows:

$$Tbq_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \alpha_2 Digit_{i,t} + \alpha_3 ESG_{i,t} \times Digit_{i,t} + \sum_1^m \alpha_m Controls_{i,t} + \sum Year + \sum Firm + \varepsilon_{i,t} \quad (4)$$

$$Innovate_{i,t-2} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 Digit_{i,t} + \beta_3 ESG_{i,t} \times Digit_{i,t} + \sum_1^m \beta_m Controls_{i,t} + \sum Year + \sum Firm + \varepsilon_{i,t} \quad (5)$$

In models (4) and (5), $Digit_{i,t}$: the enterprise digitization level; $ESG_{i,t} \times Digit_{i,t}$: the interaction term between the enterprise ESG performance and the enterprise digitization level. Specifically, Model (4) is the test of the moderating effect of digitalization level on ESG performance and enterprise value. Model (5) examines the moderating effect of the digital level on ESG performance and firm innovation. The research model of this study is shown in Figure 1.

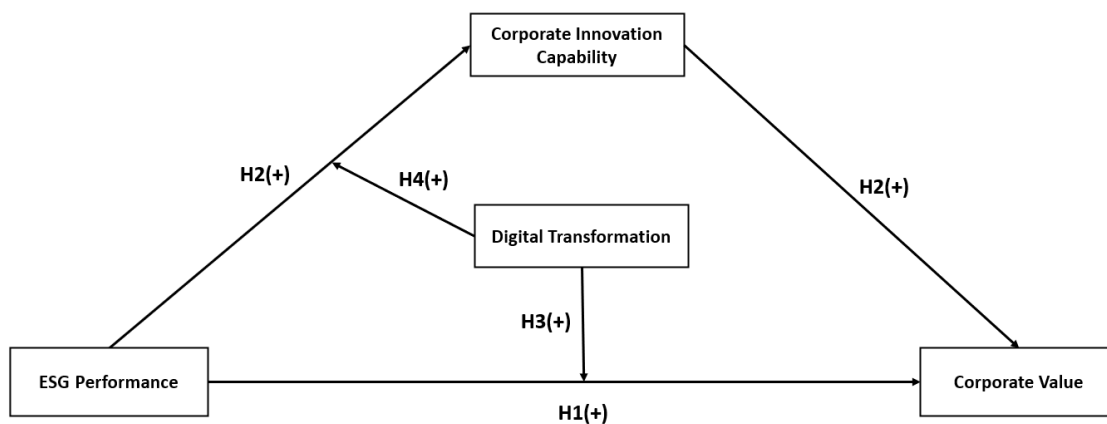


Figure 1. Research Model

EMPIRICAL RESULTS AND DATA ANALYSIS

Descriptive Statistics and Correlation Analysis

Table 2 provides a summary of the descriptive statistics for each variable. A closer look reveals that the maximum and mean values of the explained variable, Tbq , vary considerably, highlighting a notable disparity in the value of textile and apparel companies. The average value for the primary explanatory variable, ESG , stands at 4.186, suggesting that, on average, the ESG ratings of the sampled textile and apparel firms are above grade B. Table 3 examines the correlations between the explained variable,

core explanatory variable, and each control variable. The findings point to a significant negative correlation between Tbq and ESG. However, since the direction of the correlation coefficient does not align with the theoretical direction of the regression coefficient, it is necessary to incorporate control variables when analyzing the link between ESG and corporate value. Most of the other control variables also exhibit correlations with corporate value. Furthermore, the variance inflation factor (VIF) test results in Table 2 indicate that all variable VIF values are below the threshold of 10, indicating minimal multicollinearity concerns.

Table 2. Descriptive statistics

Variable	Mean	Standard deviation	Minimum	Maximum	VIF
Tbq	1.748	1.028	0.782	7.780	
ESG	4.186	1.047	1	7	1.41
Innovate	2.302	1.326	0	5.590	1.38
Digit	1.547	1.223	0	4.317	1.62
Size	22.11	0.986	20.06	25.11	2.09
GrossProfit	0.303	0.181	0.017	0.696	1.64
Liquid	2.290	1.551	0.546	9.721	1.44
Fixed	0.221	0.135	0.010	0.546	1.66
Tangible	0.919	0.098	0.390	0.998	1.28
FL	1.212	0.752	0	6.016	1.14
Top1	28.02	18.97	0.086	76.22	1.14
PB	2.649	2.023	0.574	12.99	1.49
ListAge	2.148	0.766	0	3.367	1.44

Table 3. Correlation analysis

Variable	Tbq	ESG	Size	Liquid	Tangible	Fixed	PB	List Age	FL	Gross Profit	Top 1
Tbq	1										
ESG	-0.287***	1									
Size	-0.483***	0.315***	1								
Liquid	0.118**	-0.004	-0.312***	1							
Tangible	-0.022	0.158***	0.030	0.141***	1						
Fixed	-0.008	0.117**	-0.141***	-0.170***	0.249***	1					
PB	0.847***	-0.299***	-0.474***	0.043	0.013	-0.013	1				
List Age	0.054	-0.008	0.332***	-0.319***	0.057	0.107**	-0.164***	1			
FL	-0.113**	-0.085*	0.153***	-0.214***	0.001	0.029	-0.121**	0.074	1		
Gross Profit	-0.075	0.140***	0.015	0.209***	-0.246***	-0.387***	-0.068	-0.303***	-0.172***	1	
Top 1	-0.058	0.058	0.080	0.004	-0.086*	-0.107**	0.022	-0.220***	0.141***	0.129***	1

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

Benchmark Regression Test

A Hausman test was conducted based on the model and hypotheses, and the results indicated p-value presents a level of significance ($p < 0.05$), provides a solid basis for our choice of a fixed-effects model and also ensures the reliability of the empirical analysis. In the course of the study, we have strictly controlled the fixed effect factors for both the individual and annual dimensions of the firms. The key findings of the benchmark regression analysis have been systematically presented in Table 4. Looking at the impact of control variables on enterprise value alone, the data show a high degree of consistency with existing research in the academic community: Size, Tangible, and GrossProfit all have a significant negative effect on enterprise value, in contrast to the other control indicators, which show a significant positive effect.

On top of the above analytical framework, we extend our research perspective to the mechanism of ESG performance on firm value. The data show a significant positive association between ESG and Tbq (regression coefficient 0.068, 5% significance level), a result that remains robust after controlling for the underlying variables. The direction and significance of the effect of all control variables remain stable. These findings all corroborate the idea that for the textile and apparel industry, superior ESG practices are effective in enhancing firm value, and the H1 hypothesis is thus strongly supported.

Table 4. Baseline regression results

Variable	(1) Tbq	(2) Tbq
ESG		0.068** (2.25)
Size	-0.285*** (-4.13)	-0.293*** (-4.28)
Liquid	0.059** (2.57)	0.059*** (2.62)
Tangible	-0.710* (-1.83)	-0.828** (-2.13)
Fixed	0.415 (0.97)	0.416 (0.98)
PB	0.330*** (18.42)	0.330*** (18.56)
List Age	0.603*** (6.32)	0.634*** (6.62)
FL	0.060** (1.99)	0.067** (2.21)
Gross Profit	-0.534 (-1.51)	-0.548 (-1.56)
Top 1	0.001 (0.44)	0.001 (0.30)
Constant	6.354*** (3.88)	6.300*** (3.87)
Company	YES	YES
Year	YES	YES
N	408	408
R ²	0.764	0.768

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

Endogeneity Test

Empirical findings are often biased by endogeneity problems. This research introduces the instrumental variable (IV) method to overcome this methodological chronicity. Drawing on the methodology by Wu [59], we select the average ESG performance of industries within the same city and year (IV_ESG) as the instrumental variable. This choice is based on the following logic: the homogeneity of the geographical environment makes the ESG performance among local companies show a certain degree of correlation, while the regional ESG average, as a macro-level aggregated indicator, has no direct correlation with the value of individual firms. This characteristic fulfils the dual requirements of correlation and homogeneity that instrumental variables should have. Table 5 presents the results of the endogeneity test for the model. The first-stage regression (column 1) shows that the regression coefficient of IV_ESG on ESG is as high as 0.906 ($p < 0.01$), confirming the strong link between instrumental variables and firms' ESG performance. Furthermore, the Cragg-Donald Wald F-statistic reaches 407.509, which far exceeds the critical value of 16.38, strongly refuting the possibility of weak instrumental variables. Meanwhile, the Kleibergen-Paap rk LM test presents a significant positive value, eliminating the concern of identification problems. In the second stage regression (column 2), the ESG regression coefficient after instrumental variables treatment is 0.084, which remains robust at the 5% significance level, fully confirming that the positive contribution of ESG performance to firm value stands up to the endogeneity problem.

Table 4. Endogeneity test results

Variable	(1) first ESG	(2) second Tbq
IV_ESG	0.906*** (18.54)	
ESG		0.084** (2.04)
Control variables	Yes	Yes
Company	Yes	Yes
Year	Yes	Yes
R ²	—	0.768
Kleibergen-Paap rk LM statistic		31.470***
Cragg-Donald Wald F statistic		407.509 [16.38]

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

Robustness Test

To rule out the potential impact of variable selection and time-related issues on the model results, this study performs robustness checks using two methods: variable substitution and time lag.

Variable Substitution Method

In this approach, we replace Tobin's Q (Tbq) with the Return on Assets (ROA) as the measure of corporate value. The calculation for ROA is as follows: Total Profit / Total Assets. The outcomes of this analysis are presented in Column (1) of Table 6. ESG shows a strong positive correlation with ROA at the 5% significance level, underscoring that robust ESG practices significantly enhance return on assets. This finding confirms the robustness of the study's results.

Time Lag Method

To further test the robustness of the model, we apply a one-period lag to the core explanatory variable, ESG, to address potential reverse causality concerns. The lagged ESG variable is denoted as ESG_lag, and the results are presented in Column (2) of Table 6. The regression coefficient for ESG_lag is 0.062 ($p < 0.10$). This suggests that the lagged effect of ESG still has a meaningful and positive impact on corporate value, reinforcing the model's robustness.

Table 5. Robustness test results

Variable	(1) ROA	(2) Tbq
ESG	0.008** (2.18)	
ESG_lag		0.062* (1.72)
Size	0.014* (1.86)	-0.404*** (-2.96)
Liquid	0.004 (1.43)	0.108*** (3.11)
Tangible	0.000 (0.01)	-1.729*** (-3.28)
Fixed	-0.067 (-1.35)	0.506 (0.86)
PB	0.007*** (3.55)	0.341*** (14.19)
List Age	0.002 (0.16)	0.675*** (3.47)
FL	0.007**	0.059

Variable	(1) ROA	(2) Tbq
	(2.05)	(1.54)
Gross Profit	0.312***	-1.009**
	(7.77)	(-2.02)
Top 1	0.000	0.000
	(1.23)	(0.16)
Constant	-0.416**	9.562***
	(-2.27)	(2.99)
Company	YES	YES
Year	YES	YES
N	391	280
R ²	0.333	0.781

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

Mediating Mechanism Test

To delve deeper into the intrinsic transmission path of ESG performance in the textile and apparel industry in terms of its effect on firm value, this research focuses particularly on the key intermediary link of corporate innovation to carry out the analysis. Table 7 presents the results of the mediating mechanism test for corporate innovation. The regression results of Column (1) reveal: that there is a close association between ESG and Innovate, which is reflected by a significant positive coefficient of 0.190 ($p<0.01$). This demonstrates that ESG performance significantly promotes corporate innovation. The regression results of Column (2) indicate that both ESG ($p<0.05$) and Innovate ($p<0.10$) have positive coefficients concerning Tbq. This suggests that after incorporating corporate innovation into the model, ESG performance continues to significantly influence corporate value. Additionally, the supplementary analysis of the effect of corporate innovation on corporate value, presented in Column (3), shows a positive and significant regression coefficient of 0.065 for Innovate($p<0.05$). This indicates that corporate innovation plays a positive role in enhancing corporate value. Together with the foundational regression results, it can be inferred that ESG performance in the textile and apparel industry influences corporate value through the pathway of corporate innovation, with innovation acting as a partial mediator. Therefore, Hypothesis H2 is supported.

Table 6. Mechanism test result

Variable	(1) Innovate	(2) Tbq	(3) Tbq
ESG	0.190*** (2.95)	0.066** (2.17)	
Innovate		0.055* (1.97)	0.065** (2.36)
Size	-0.262* (-1.70)	-0.297*** (-4.12)	-0.287*** (-3.95)
Liquid	-0.006 (-0.11)	0.085*** (3.45)	0.082*** (3.30)
Tangible	-0.745 (-0.83)	-1.428*** (-3.43)	-1.278*** (-3.09)
Fixed	1.457 (1.56)	-0.006 (-0.01)	0.004 (0.01)
PB	0.049 (1.22)	0.316*** (16.81)	0.315*** (16.65)
List Age	0.197 (0.89)	0.727*** (7.02)	0.688*** (6.70)
FL	-0.015 (-0.24)	0.060** (2.02)	0.055* (1.83)
Gross Profit	0.268 (0.35)	-0.162 (-0.45)	-0.171 (-0.47)
Top 1	0.002 (0.35)	-0.001 (-0.48)	-0.001 (-0.31)
Constant	6.288* (1.71)	6.784*** (3.94)	6.747*** (3.89)
Company	YES	YES	YES
Year	YES	YES	YES
N	376	376	376
R ²	0.158	0.777	0.773

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

Moderating Effect Test

The results of the moderating effect test are shown in Table 8. Column (1) tests the moderating effect of digitalization on the relationship between ESG performance and corporate value. As shown in the results, the regression coefficient for ESG on Tbq is 0.053, and the interaction term between ESG and Digit on Tbq is 0.035. Both coefficients are significant at the 10% level, indicating that the level of digitalization positively moderates the effect of ESG performance on corporate value. Thus, Hypothesis H3 is supported. Column (2) presents the moderating effect of digitalization on the relationship

between ESG performance and corporate innovation. The regression coefficient for ESG on Innovate is 0.209 ($p < 0.01$). However, the interaction term between ESG and Digit on Innovate has a coefficient of -0.046, which is not statistically significant. This suggests that digitalization does not moderate the effect of ESG performance on corporate innovation, thus failing to support Hypothesis H4. Although most textile and apparel companies have incorporated digital transformation practices into manufacturing processes and equipment, they still largely rely on foreign technologies. Key digital technologies, core equipment, and industrial software remain unmastered, which hampers their ability to meet the specialized requirements of technological innovation in the textile and apparel industry [60]. Consequently, for the textile and apparel companies at the current stage, digitalization fails to play a moderating factor between ESG performance and corporate innovation.

Table 7. Adjustment effect test results

Variable	(1) Tbq	(2) Innovate
ESG	0.053* (1.73)	0.209*** (3.14)
ESG×Digit	0.035* (1.75)	-0.046 (-1.02)
Digit	-0.025 (-0.86)	0.051 (0.78)
Size	-0.272*** (-3.86)	-0.304* (-1.92)
Liquid	0.064*** (2.81)	-0.011 (-0.22)
Tangible	-0.981** (-2.47)	-0.606 (-0.67)
Fixed	0.385 (0.91)	1.479 (1.58)
PB	0.331*** (18.66)	0.045 (1.11)
List Age	0.630*** (6.55)	0.211 (0.95)
FL	0.062** (2.06)	-0.008 (-0.13)
Gross Profit	-0.544 (-1.55)	0.287 (0.37)
Top 1	0.000 (0.07)	0.002 (0.51)
Constant	6.117***	6.906*

Variable	(1)	(2)
	Tbq	Innovate
	(3.72)	(1.86)
Company	YES	YES
Year	YES	YES
N	408	376
R ²	0.771	0.162

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

DISCUSSION AND CONCLUSION

Research Conclusions

This research explores how ESG performance influences corporate value within the textile and apparel industry, examining the mediating effect of corporate innovation and the moderating effect of digitalization. Based on empirical analysis, the following conclusions are drawn:

- (1) ESG performance has a significant positive effect on corporate value. This finding confirms the positive role of ESG in long-term value creation, challenging the traditional view that ESG investments may increase corporate costs in the short term [61,62].
- (2) Corporate innovation partially mediates the relationship between ESG performance and corporate value. This mechanism addresses the limitations of existing research, which has often examined the ESG-corporate value relationship in the textile and apparel industry from a single-dimensional perspective [14] or through simple linear associations [63].
- (3) Digital transformation positively moderates the impact of ESG performance on corporate value but does not moderate the effect of ESG on corporate innovation. The findings suggest that digitalization amplifies the positive influence of ESG performance on corporate value by improving ESG implementation efficiency and optimizing resource allocation. However, digital technologies such as big data and artificial intelligence primarily optimize production and market analysis, contributing little directly to fundamental innovation in textile and apparel firms. Moreover, the digital transformation of China’ s textile and apparel industry is still in its developmental stage, with core technologies and industrial software heavily reliant on imports. These factors may further constrain the role of digital technology in facilitating corporate innovation through ESG initiatives.

Theoretical Contributions

First, this study expands the industry perspective on the impact of ESG performance on corporate value. Previous research has emphasized the industry heterogeneity of ESG practices’ effects [64]. By focusing on the textile and apparel industry, this study further expands empirical evidence on the

effectiveness of ESG practices in highly polluting industries, providing a theoretical foundation for the sector's sustainable development.

Second, prior research on ESG and corporate value in the textile and apparel industry has often lacked an in-depth exploration of the underlying mechanisms. This study fills this gap by incorporating corporate innovation as a mediating factor, revealing its crucial role in translating ESG efforts into value creation. This contributes to a deeper understanding of corporate innovation's role in sustainable development and offers a more explanatory theoretical framework for future research.

Finally, unlike studies that analyze the causal relationship between digital transformation and ESG practices [65,66], this study broadens the scope of ESG research by introducing digital transformation as a moderating variable. Moreover, contrary to the prevailing view that digital transformation promotes corporate innovation [67], this study finds that its impact varies across industries. This underscores the necessity of developing industry-specific ESG strategies and highlights the importance of aligning digital investments with sectoral characteristics to maximize benefits.

Managerial Implications

For Textile and Apparel Enterprises: (1) Enhance ESG Practices to Strengthen Overall Competitiveness: Textile and apparel enterprises should prioritize environmental responsibility and green innovation. Adopting advanced sustainable production technologies, such as waterless dyeing and recycled materials, can help meet the growing consumer demand for eco-friendly products. (2) Integrating ESG with Innovation: Establishing dedicated R&D departments or collaborating with research institutions can facilitate the transformation of ESG-driven innovation into marketable products, thereby enhancing competitive advantages. (3) Accelerate Digital Transformation to Optimize Resource Allocation: To maximize the impact of ESG on corporate value, companies should integrate digital tools such as big data, the Internet of Things (IoT), and blockchain, particularly in areas such as supply chain transparency and product traceability.

For External Investors: Investors should incorporate ESG ratings as a critical evaluation metric when selecting investment targets. In particular, investors should prioritize companies in high-pollution industries that have demonstrated strong green transformation performance. Moreover, financial support through green bonds or ESG-themed funds can foster innovation and market expansion, ensuring long-term returns.

For Government and Regulatory Authorities: (1) Strengthen ESG Evaluation and Disclosure Systems: Governments should establish ESG disclosure standards specifically for the textile and apparel industry, clearly defining environmental governance and corporate transparency requirements to strengthen regulatory compliance. (2) Enhance Policy Incentives: Policy instruments such as subsidies, tax incentives, and green loans should be introduced to encourage textile and apparel enterprises to invest

in green production technologies, innovation, and digital transformation. (3) Promote Industry Collaboration and Technology Sharing: Regulatory bodies should collaborate with industry associations to establish platforms for the sharing of green technologies, reducing dependency on foreign technologies and enhancing overall competitiveness.

Limitation and Future Research

Despite its contributions, this study has several limitations. First, it focuses solely on publicly listed textile and apparel firms in China, limiting generalizability to SMEs. Second, while panel data analysis is employed, external macroeconomic factors affecting ESG performance and corporate value are not fully accounted for. Third, digital transformation is a multifaceted process, and future studies should adopt a more granular approach by distinguishing different aspects of digitalization and incorporating external variables such as policy shifts and market fluctuations. Additionally, applying advanced econometric models could provide deeper insights into the interplay between digital transformation, ESG management, and corporate performance, offering a more comprehensive framework for sustainable development in the textile and apparel industry.

Author Contributions

Conceptualization – Song R; methodology – Song R and Qu H; formal analysis – Song R and Tian B; investigation – Song R; resources – Song R and Tian B; writing-original draft preparation – Song R; writing-review and editing – Tian B, Qu H and Li H. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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