

The Impact of ESG Scores on Firm Value and Financial Performance: The Mediating Role of Green Finance and Green Economy

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Abstract

This article investigates the influence of environmental, social, and governance (ESG) scores on firm value and financial performance, focusing on the mediating role of green finance and the green economy. The study uses annual 2015–2021 data from Taiwanese listed companies, as reported in the Taiwan Economic Journal. The study includes individual ESG scores, TESG total scores, and financial data such as Tobin's Q and return on equity in a regression analysis of empirical data. The results indicate that both individual ESG scores and overall TESG score positively and significantly influence firm value and financial performance. The issuance of green bonds and the development of green energy companies partially mediate the relationship between ESG scores and firm value and financial performance. The findings highlight the urgency of issuing green bonds to drive the development of the green economy. The study's findings speak to the need for substantial financial and technological resources and robust regulatory infrastructures in addressing climate change. In particular, the findings aid the development of the green economy.

Keywords: ESG Score, Firm Value, Financial Performance, Green Bonds, Green Economy.

JEL Classifications: G11, G32, Q56

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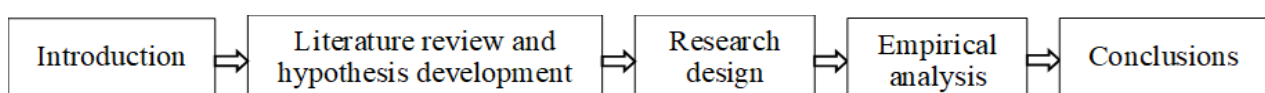
1. Introduction

Environmental, social, and governance (ESG) has become increasingly central since the 2010s. Numerous studies have explored the relationship between corporate responsibility and firm value and financial performance. Mixed findings on the implications of ESG have been presented in the literature (e.g., Edmans, 2011; Krüger, 2015; Flammer, 2015; Saeidi et al., 2015). In particular, Zhu and Lai (2016) observe that the financial performance of a company significantly influences the prioritization of ESG concerns by executives.

In particular, researchers have the implications of the emerging field of green finance (i.e., financing directed toward green enterprises or green initiatives) on the financial performance of banks (Scholtens & Dam, 2007). Thus, banks provide the financial lifeblood that makes the consonance between corporate value and sustainability possible. Green bonds enable the infusion of capital into sustainable development projects, which can potentially lead to an economic transformation that combines sustainability and resilience. Consequently, the trend of achieving sustainability goals through economic means is gaining prominence.

This study differs from previous studies in several respects. Crucially, it explores the effects of individual ESG scores and TESG total scores on firm value and financial performance. It also examines how the factors of green finance and green economy might enhance the relationship between ESG and firm value and financial performance. Furthermore, this study introduces an innovative approach to measuring the sustainable social responsibility of Taiwanese listed companies. The empirical results have practical implications for investors, managers, and policymakers. In the context of Taiwan's 2050 net-zero transformation goal, mechanisms such as green bonds and the development of green energy companies can effectively encourage company managers to engage in ESG activities. These activities promote sustainability by mitigating short-term opportunism and garnering investor approval for company management. This, in turn, enhances investor confidence, enhances the company's image and value, and improves financial performance. The results suggest that investors should consider companies with strong ESG performance for investment because robust corporate governance can enhance the value and financial performance generated by ESG-related activities.

The structure of this study is outlined as follows: the second section presents a literature review and hypotheses development. The third section outlines the research design, including the data sources, main variables, and empirical model. The fourth section presents the empirical results. The fifth and final section concludes the study.



2. Literature Review and Hypothesis Development

This literature review has four segments. The first segment covers literature on the relationships of ESG scores with firm value and financial performance. The second segment covers literature on the development of green finance. The third segment covers literature on the development of the green economy. The fourth segment covers the literature on the relationship between green finance and the green economy.

2.1. ESG Scores, Firm Value, and Financial Performance

The crux of ESG lies in the harmonizing of sustainability and firm financial performance, which is essential to ensuring that businesses continue to support sustainability initiatives. Thus, the question of whether ESG promotes firm financial performance is of practical and theoretical importance.

Stakeholder theory is primarily used to explain the relationships of ESG with firm value and financial performance. This theory posits that a firm's value is primarily constituted by its ability to satisfy stakeholder demands. ESG plays a crucial role in reducing information asymmetry between companies and stakeholders, thereby decreasing investment risks and inducing risk-averse effects among investors (Frydman & Wang, 2020). Therefore, this study hypothesizes that positive correlation ESG scores on several metrics are positively correlated with firm value and financial performance.

Studies have reported mixed findings on the relationship between ESG and firm performance. Specifically, studies have indicated that the relationship between ESG and financial performance is positive (e.g., Cochran & Wood, 1984; McGuire et al., 1988; Waddock & Graves, 1997; Orlitzky, Schmidt, & Rynes, 2003; Barnett & Salomon, 2006; Galema et al., 2008; Martínez-Ferrero, & Frias-Aceituno, 2015; Friede et al., 2015; Chen & Xie, 2022), negative (e.g., Brammer et al., 2006; Barnea & Rubin, 2010; Ciciretti et al., 2023; Hong & Kacperczyk, 2009; Pedersen et al., 2021; Price & Sun, 2017), and parabolic—where companies perform well when they either engage very extensively in ESG or not at all (e.g., Brammer & Millington, 2008; Barnett & Salomon, 2012). Some studies have also demonstrated a nonsignificant relationship (e.g., Theodoulidis et al., 2017; McWilliams & Siegel, 2000).

The literature on the relationship between ESG factors and financial performance is inconsistent. Studies with positive outcomes emphasize that a focus on ESG factors can enhance long-term financial performance, including reducing investment risks, enhancing shareholder value, improving stock returns, and attracting ESG-focused investors. Conversely, negative outcomes suggest that ESG investments may initially decrease financial performance because ESG initiatives take up resources.

This inconsistency in the literature may be due to differences between industries, regions, ESG evaluation methodologies, research methodologies, or long-term versus short-term points of focus. Specifically, sustainability efforts may eat into the bottom line of firms in some industries but boost

the competitiveness of firms in other industries. Furthermore, regional differences in regulatory landscape may also explain this inconsistency.

The aim of this study is to provide an innovative examination of green finance and the green economy to gain a more comprehensive understanding of the relationship between ESG and financial performance. This study seeks to offer more accurate, specific, and actionable recommendations to assist companies and investors navigate the complex relationship between ESG and financial performance.

Despite such inconsistency, a majority of studies have reported positive findings. This study proposes the following hypotheses:

- H1. ESG scores and firm value have a positive relationship.
- H2. TESG total score and firm value have a positive relationship.
- H3. ESG scores and financial performance have a positive relationship.
- H4. TESG total score and financial performance have a positive relationship.

2.2. *Green Finance*

Green finance, also known as sustainable finance, involves financial investment schemes aligned with sustainable development initiatives—such as renewable energy and the circular economy. These initiatives involve channeling substantial funds into projects that promote sustainable development, while also aiming to reduce activities with negative environmental effects. Green finance is based on a business model that seeks to harmonize environmental protection and long-term corporate profitability. Green finance projects usually come in the form of green bonds, green financing, and green insurance.

Inconsistent findings have also been reported by studies on the relationship between CSR and the board of directors (e.g., Nadeem et al., 2017; Seckin-Halac et al., 2021), and the effects of CSR on stock returns (e.g., Kotchen & Moon, 2011 ; Ortas et al., 2013 ; Kim & Kim, 2014 ; Cellier & Chollet, 2016 ; Zhou et al., 2021 ; Feng et al., 2022 ; Xu et al., 2023; Meng-tao et al., 2023; Yu et al., 2023). Nevertheless, the wealth of research on this topic indicates the need for novel research on ESG in the bond market.

Green bonds have emerged as the most rapidly developing financial instrument in green finance, attracting considerable attention for their role in enhancing firm value and financial performance. Green bonds are a type of thematic bond, where the funds raised are exclusively allocated to green investment projects and must receive certification from the Taipei Exchange (hereinafter called TPEX). Studies have indicated that economic uncertainty, exacerbated by fiscal constraints, negatively influences green innovation (Cui et al., 2023). Investments in environmental protection can foster green financial innovation (Eiadat et al., 2008). Furthermore, some studies have suggested

that green financial innovation can address and manage stakeholder needs (Barnett, 2007). Additionally, research indicates that green finance can attract more investments (Dowell et al., 2000). Green bonds promote sustainable development and benefit from favorable regulation and high-quality disclosures (Bhutta et al., 2022). Most studies have suggested that green finance, particularly green bonds, positively influences firm value and financial performance. This study focuses on green bonds within green finance and proposes the following hypotheses:

H5. ESG scores, green bonds, and firm value have a positive relationship.

H6. TESG total score, green bonds, and firm value have a positive relationship.

H7. ESG scores, green bonds, and financial performance have a positive relationship.

H8. TESG total score, green bonds, and financial performance have a positive relationship.

2.3. *Green Economy*

Unchecked economic development degrades the environment, and such environment degradation, in turn, stymies economic development. The Intergovernmental Panel on Climate Change of the United Nations has indicated the existential threat of climate change, which brings unprecedented challenges to global environmental governance. Thus, economic growth and sustainability must be balanced with each other. This balance is exemplified in the concept of the green economy (e.g., Lu et al., 2018; Shin et al., 2022). In December 2019, the European Union unveiled the European Green Deal, a commitment to mitigate the environmental effects of climate change. The goal is to achieve net-zero greenhouse gas emissions by 2050, effectively utilize resources, and develop a more competitive economic system. Subsequently, in January 2020, the European Union announced the European Green Deal Investment Plan, promoting sustainable finance to assist European businesses in transitioning to a green economy, attain sustainable corporate governance, and meet their CSR objectives. Derwall et al. (2005) argue that companies with higher environmental performance can generate higher returns. Nobletz (2022) states that global green energy companies represent the current economic landscape and channel funds toward low-emission societies. Cortez et al. (2022) reveal that the financial performance of green energy portfolio companies outperforms the market, attributing this success primarily to contemporary performance improvements in green investment portfolios. Molina-Azorín et al. (2009) posit that green environmental management reduces operating costs, producing a positive effect on financial performance and enhancing competitiveness. Liu et al. (2023) suggest a positive correlation between the profitability and profitability capability of green enterprises.

The literature generally highlights the positive effects of the green economy on financial performance. In this study, the term “green economy” refers to the development of companies in the renewable energy sector from Taiwanese listed companies, with a specific focus on solar energy,

wind power, 2050 net-zero carbon emissions, and the development of energy storage system concept stocks. The study proposes the following hypotheses:

H9. ESG scores, green economy, and firm value have a positive relationship.

H10. T ESG total score, green economy, and firm value have a positive relationship.

H11. ESG scores, green economy, and financial performance have a positive relationship.

H12. T ESG total score, green economy, and financial performance have a positive relationship.

2.4. Green Finance and Green Economy

Green bonds, green loans, and green insurance are some financial tools used in green finance (Chatziantoniou et al., 2022). Green finance is the financial lifeblood of the green economy, and the green economy provides opportunities that give green finance organizations a return on their investment; thus, both are symbiotic with each other. Given the increasingly intense focus on sustainability, various countries and regions have introduced policies to promote the development of green finance and the green economy.

In particular, environmentally friendly projects and companies tend to possess greater long-term competitiveness because of their robustness to environmental risks and changes; such robustness is increasingly prized by businesses.

Wang et al. (2022) indicates that green finance drives sustainable development. It guides sustainable green investments and supports national sustainable development efforts. Yang et al. (2022) emphasize the critical importance of measuring green financing and clean energy through ESG for key decisions in green economic development. Green financial products contribute positively to the development of the green economy and can provide stable financial returns for investors over the long term. Therefore, incorporating elements such as green bonds and the development of green energy companies into investment decision-making processes can enhance the long-term performance of portfolios. The study proposes the following hypotheses:

H13. ESG scores, green bonds, green economy, and firm value have a positive relationship.

H14. T ESG total score, green bonds, green economy, and firm value have a positive relationship.

H15. ESG scores, green bonds, green economy, and financial performance have a positive relationship.

H16. T ESG total score, green bonds, green economy, and financial performance have a positive relationship.

3. Research Design

This section is divided into three parts: the first part describes the research sample and data sources, the second part defines the variables used, and the third part details the empirical regression model. This study focused on Taiwanese listed companies. The data sources are divided into three main categories. The first category includes ESG and financial data from the Taiwan Economic Journal (hereinafter called TEJ) database. The second category includes data on companies listed on the TPEX that have issued green bonds under the sustainable development bond category. The third category includes data from the TEJ, which are matched with classifications from Stock Market, and other relevant databases. Further details are provided as follows:

3.1. Research Samples and Data Sources

This study utilizes data from the TESG, which is a sustainable development indicator, established in the TEJ for the period 2015 to 2021. Formulated for Taiwanese listed companies, the TESG indicator comprises various dimensions and is measured on the basis of comprehensive CSR reports, annual reports, and links to other external databases. It aligns with international standards, and data on the TESG are verified against the global reporting initiative (GRI) and sustainability accounting standards board (SASB) industry classifications. This study included 9,299 observations over a 7-year period after excluding 2329 observations that belonged to firms with missing data or firms in the financial and insurance sectors.

3.2. Description of Variables

Mediating and control variables are used in the analysis. The dependent variables are the two financial performance indicators of Tobin's Q (TQ) and return on Equity (ROE). The independent variables are scores on several ESG dimensions, specifically TESG score and scores on the environmental (denoted E), social (denoted S), and governance (denoted G) dimensions. The mediating variables pertain to green finance and the green economy. The control variables consist of five factors including company size, debt ratio, company age, the dual role of chairperson and CEO, and research and development expenditure ratio. Additionally, the study controls for year and industry fixed effects. Further details are provided as follows:

3.2.1. Dependent Variable

3.2.1.1 Tobin's Q

In this study, financial performance is indicated by debt repayment, operational status of corporate assets, development prospects, and profitability. In general, financial performance indicates the company's production, operation, and development status. Researchers have primarily used either market-based or accounting-based indicators of financial performance. TQ is a market-based indicator and is defined as the ratio of a company's market value to its book value (e.g., Kaplan & Zingales, 1997; Gompers et al., 2003; Bebchuk et al., 2009). It is a proxy variable for measuring stock

market value and is influenced by market efficiency. TQ is affected by a variety of market factors in a highly stochastic manner (Tampakoudis & Anagnostopoulou, 2020).

3.2.1.2 Return on Equity

A key financial indicator in accounting is ROE, which signifies the efficiency with which a company generates profits using its own capital. A higher ROE indicates greater profit generation for shareholders. ROE reflects the organization's efficiency in utilizing its assets (Pointer & Khoi, 2019). Studies have suggested that ROE is an effective measure of a company's long-term profitability (e.g., Staikouras & Wood, 2004; Athanasoglou et al., 2008).

3.2.2. Independent Variables

The independent variables in this study are ESG scores and total TESG score, primarily derived from the TEJ's "TESG Sustainable Development Index," which uses the GRI as the disclosure standard. The ESG score is based on the original ESG score (excluding the effects of negative news) and the ESG news threshold score. The original score is calculated based on a weighted calculation of aspects and disclosure items under the three pillars of ESG (quantitative weight of 75%; disclosure weight of 25%). The scores for aspects and disclosure items under each pillar are derived from variable scores, GRI information disclosure scores, and industry-weighted calculations. The scores range from 0 to 100, with higher scores indicating superior performance in the respective ESG-related indicators.

3.2.2.1 Environmental Score

The environmental pillar score from the TEJ ESG database is based on the weighted average of percentage scores for key measurable variables and disclosure levels within five aspects: emission of greenhouse gases, energy management, water and wastewater management, waste and toxic substance management, and ecological impact.

3.2.2.2 Social Score

The social pillar score from the TEJ ESG database is based on the weighted average of percentage scores for key measurable variables and disclosure levels in six aspects: human rights and community relations, data security, product quality and safety, employee information statistics, employee health and safety, and employee diversity.

3.2.2.3 Governance Score

The governance pillar score from the TEJ ESG database is based on the weighted average of percentage scores for key measurable variables and disclosure levels within five aspects: business models and innovation, management leadership, ownership and board representation, fair treatment for stakeholders, and corporate governance information transparency. The measurement variables and disclosure levels for each aspect are detailed in Table 1.

Table 1. TESG Sustainability Indicators as Independent Variables

Pillar	Issues and Disclosures	Independent Variables	
(3)	(16)	Main Quantifiable Measurable Variables	Information Disclosure Level
Environment (E)	Emission of Greenhouse Gases	-Carbon emissions per US\$1 million in revenue, -Improvement per carbon year (improved = -1, unchanged = 0, not improved = 1, annual accumulation)	Carbon Emissions Information
	Energy Management	-International certification related to carbon emissions -International advocacy groups joined -Issuance of green bonds and perpetual bonds as a percentage of assets (excluding the financial industry) -Certifications related to energy management	Energy Management Information
	Water and Wastewater Management	-Water consumption per million revenue -Water recovery rate -International water-related certifications -Annual improvement of unit water consumption (improvement, unchanged, no improvement, or annual accumulation)	Water Information
	Waste and Toxic Substance Management	-Environmental management-related certifications	Waste Management Information
Society (S)	Ecological Impact	—	Ecological Impact Information
	Human Rights and Community Relations	-Donations or revenue (Average of previous 3 years)	Human Rights and Community Relations Information
	Data Security	-Information security related certifications -Ratio of information security penalties to equity (average of the financial industry over the previous 3 years)	Information Security and Customer Privacy Information
	Product Quality and Safety	-Product quality related certifications (quality management and food safety) -Proportion of fines related to products as a percentage of equity (financial industry average in the previous 3 years)	Product Quality and Safety Information
	Employee Information Statistics	-Employee turnover -Salary level -Research & development capability	Employee Statistics

Pillar	Issues and Disclosures	Independent Variables	
(3)	(16)	Main Quantifiable Measurable Variables	Information Disclosure Level
Company Governance (G)	Employee Health and Safety	-Baby care stay statistics -Baby care reinstatement and retention statistics -Safety at work: risk of disability -Occupational health and safety management-related certifications	Employee Health and Safety Information
	Employee Diversity	—	Employee Diversity Information
	Business Models and Innovation	—	Supply Chain Management Information, Climate Change Impact Information
	Management Leadership	—	Business Ethics Information, Competitive Behavior Information, Legal Compliance Management Information, Key Event Risk Management
	Ownership and Board Representation	-Deviation of voting rights from cash flow rights, -Percentage difference between actual control and necessary control equity (considering the group's control structure) -Board and supervisory pledge ratio (considering the group's control structure) -A pyramidal shareholding structure -Cross-shareholding structure -Insufficient board and supervisory shareholding -Whether the chairperson also serves as the CEO -Control shareholding multiplier compared with before listing (since 2000, considering the group's control structure)	
	Treat Stakeholders Fairly	-Whether a change in accounting firms occurred within the previous 3 years (switching to a nonbig-four firm) -Whether a financial statement restatement has occurred due to changes in nonmaterial	

Pillar	Issues and Disclosures	Independent Variables	
(3)	(16)	Main Quantifiable Measurable Variables	Information Disclosure Level
	Corporate Governance Information Transparency	accounting policies within the past 3 years -Whether a difference of 50% or more exists between actual and announced share repurchases of treasury stock -Whether the remuneration of the board and supervisors is disproportionately high compared with profits -Corporate governance information transparency	

Note 1: Blanks in TEJ data indicate nondisclosure or inconsistent disclosure rules, preventing quantitative expression.
 Note 2: Certain measurable variables are industry-specific.
 Note 3: Future ESG disclosure content and quantitative evaluation items will evolve with legal and regulatory requirements.
 Note 4: Information disclosure degree refers to disclosure in sustainability reports (or annual meeting reports and company websites) in accordance with GRI regulations.
 Note 5: Data sources include sustainability reports, annual reports, official company websites, as well as relevant government websites.
 Source: TEJ.

3.2.3. Mediating Variables

In line with the methodology proposed by Baron and Kenny (1986), this study investigates involvement in green finance and the green economy as mediating variables.

3.2.3.1 Green Finance

In this study, green finance refers to the issuance of green bonds. The European Investment Bank initiated the public issuance of green bonds in 2007, aiming to raise funds specifically for environmentally sustainable projects. Green bonds have gained considerable attention and experienced rapid growth since 2013. In Taiwan, market for green bonds has increased from NT\$20.7 billion in 2017 to NT\$40.3 billion in 2021, with the number of issuances rising from 9 to 19. The evolution of green bond issuances in Taiwan over the years is provided in Table 2.

Green bonds are primarily issued to fund green projects. The World Bank suggests that investors can support green projects through green bond investments, thereby contributing to the funding of environmentally sustainable initiatives. The Organization for Economic Cooperation and Development considers green bonds as instruments for raising capital for low-carbon economies or environmental improvement projects. The climate bonds initiative defines green bonds as financial instruments that mobilize funds to enhance the quality of the ecological environment. The green bond principles stipulate that the proceeds from these bonds must be exclusively allocated to green projects, positioning them as vital financial tools for project financing.

In this study, “green bonds” refers to those issued by Taiwanese listed companies on the TPEX under the Sustainable Development Bonds category. Green bonds are treated as a dummy variable:

if a company has issued green bonds, it is assigned a value of 1; otherwise, the value is 0. Initially, the study identified 75 cases in the sample. After excluding samples from the financial, insurance, and securities industries, as well as eliminating missing data and outliers, the effective final sample size for green bonds was reduced to 36 observations.

Table 2. Number of green bonds issued in Taiwan over the years

Study Variables	Year	Number of Observations
Green Bonds Issued	2017	9
	2018	14
	2019	14
	2020	19
	2021	19
	Total	75

Source: TEJ, Taipei Exchange and this study.

3.2.3.2 Green Economy

In this study, “green economy” refers to companies involved in the development of green energy. Specifically, this study identifies companies involved in solar energy, wind power, 2050 net-zero carbon emission, and the development of energy storage system conceptual stocks from Taiwanese listed companies as green energy companies. Data for these companies were obtained from the TEJ database and then matched with stock market classifications. A company is considered a “Green energy company” (dummy variable = 1, 0 if otherwise) if it is involved in green energy development. The initial sample included 116 cases. After excluding companies in the financial, insurance, securities industries, and those with missing data, the final effective sample size comprised 79 cases. The classification of green energy development companies in Taiwan is detailed in Table 3.

Table 3. Classification of Green Energy Companies by Industry

Study Variables	Industry	Number of Observations
Green Energy Companies	Solar Energy	31
	Wind Power	31
	2050 Net Zero Carbon Emissions	43
	Develop Energy Storage System	11
	Total	116

Source: TEJ and this study

3.2.4. Control Variables

Drawing on previous studies (e.g., Di Tommaso & Thornton, 2020; Sharfman & Fernando, 2008), this study controlled for the following variables:

3.2.4.1 Company Size

Studies have indicated that the size of a company can influence its earnings ratio (e.g., McAlister et al., 2007; Rego et al., 2009; Tuli & Bharadwaj, 2009; Moeller et al., 2004). The literature suggests a positive relationship between ESG and company size (Stanwick & Stanwick, 1998), and numerous studies demonstrate that a company's total assets can reflect its financial operational performance. "Size" represents the natural logarithm of total assets (e.g., Bennouri et al., 2018; Jiang et al., 2022). Therefore, company size is considered a control variable.

3.2.4.2 Debt Ratio

Studies have found that a company's debt can affect its operational performance. Companies with high levels of debt may face increased bankruptcy risk, restrictions on capital use, and poor operational performance (e.g., Hitt et al., 1998; Patton & Baker, 1987; Rego et al., 2009). Therefore, the debt ratio is employed as a control variable.

3.2.4.3 Company Age

As indicated by Zhang et al. (2018), established companies are more well-endowed and can thus better engage in business development than new companies. Thus, we controlled for company age.

3.2.4.4 Chairperson and CEO Dual Roles

In cases where the chairperson also serves as the CEO, they hold both managerial and supervisory responsibilities. Jensen & Meckling (1976) suggested that this dual role might sometimes lead to agency problems due to potential conflicts between the oversight and execution roles of the chairperson and CEO, potentially affecting a company's governance and operational performance. Agency problems are more likely when board oversight is weaker. Conversely, well-governed companies can mitigate the negative effects of the chairperson serving as the CEO on company performance. The chairperson, acting in self-interest as suggested by agency theory, might receive employee bonuses and stock options, regardless of the company's performance. This potential for conflict of interest underscores the importance of separating these roles to ensure effective governance and oversight. Kula (2005) found that separating these roles positively affects company performance. Fama (1980) discovered that separation of ownership and control can be an efficient organizational form. Therefore, the chairperson serving in dual roles (both as both chairperson and CEO) is considered as a control variable.

3.2.4.5 Research and Development Expense Rate

Research and development (R&D) are critical for a company's innovation capability (McWilliams & Siegel, 2000) and serves as a source of competitive advantage. Surroca et al. (2010) confirm that R&D intensity can influence a company's financial performance. Higher investment in R&D expenses and successful R&D projects make a company more competitive, unique, and knowledgeable. Therefore, the ratio of R&D expenditure is considered as a control variable.

3.2.5 Year and Industry Fixed Effects

To account for temporal and sectoral variations, this study controls for year and industry fixed effects, as follows:

3.2.5.1 Year Dummy Variable (YD)

As this study utilizes panel data format, time dummy variables are established to mitigate the effects of different years on the regression results (Barros et al., 2022). Different dummy variables are set for each year covered in this study.

3.2.5.2 Industry Dummy Variable (ID)

Industry differences can have varying effects on financial performance. The sample covers 32 industries, and 31 industry dummy variables are established to control their influence on financial performance, using industry as a control variable (Renneboog & Vansteenkiste, 2019). The detailed definitions of the variables in this study are provided in Table 4.

Table 4. Summary of the Definitions of the Variables

Variable	Constructs	Code Name	Definitions
Dependent Variable	Firm Value	TQ	TQ is used as a proxy variable. It is the ratio of market capitalization plus liabilities to total assets, calculated as (company market value + total liabilities) / total assets.
	ROE	ROE	Net profit after tax / total average shareholders' equity.
Independent Variable	Environmental Score	E score	(1) The original quantitative ESG score is a weighted score of the three pillars of environment, society, and corporate governance. The weight of each industry is calculated with reference to the SASB Industry Significance Map Index. (2) The original quantitative score of ESG can be obtained by multiplying the score of the topic and the score of the disclosure item of the pillar by 75% and 25% of the weight respectively, then summing up. (3) ESG original quantitative score plus ESG news threshold score yields E, S, G and TESG scores. (4) E, S, G and TESG scores range from 0 to 100, where 0 is the worst and 100 is the best.
	Social Score	S score	
	Governance score	G score	
	Environmental, Social and Governance total scores	TESG score	
Mediating Variable	Green Bonds	GB	GB is a dummy variable that indicates whether a company listed on the TPEX has issued green bonds. It is assigned a value of 1 if it issues such bonds and 0 otherwise.
	Green Energy Company	GEC	GEC is a dummy variable indicating involvement in green energy development. Assigned a value of 1 for involvement, 0 otherwise.
Control Variable	Company Size	SIZE	SIZE is the natural logarithm of the company's total assets.
	Debt Ratio	LEV	LEV is a ratio that measures a company's leverage, calculated as a percentage of total liabilities / total assets
	Company Age	AGE	AGE is the duration from the establishment of the company to the demonstration period.
	Chairperson and CEO Dual Roles	DUAL	DUAL is a dummy variable indicating whether the chairperson of the company also serves as the CEO. Assigned a value of 1 for dual roles, 0 otherwise.
	R&D Expense Rate (%)	RD	The ratio of R&D expenses to net operating income measures the company's future growth opportunities.

Data source: Compiled in this study.

3.3. Empirical Regression Model

3.3.1 ESG Scores and TESG Total Scores on Firm Value and Financial Performance

This study uses regression to investigate the influence of ESG scores and TESG total scores on firm value and financial performance. The main regression equations are as follows:

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{Escore}_{i,j,t} + \beta_2 \text{Sscore}_{i,j,t} + \beta_3 \text{Gscore}_{i,j,t} + \beta_4 X_{i,j,t} + \varepsilon_{i,j,t} \quad (1)$$

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{TESGscore}_{i,j,t} + \beta_2 X_{i,j,t} + \varepsilon_{i,j,t} \quad (2)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{Escore}_{i,j,t} + \beta_2 \text{Sscore}_{i,j,t} + \beta_3 \text{Gscore}_{i,j,t} + \beta_4 X_{i,j,t} + \varepsilon_{i,j,t} \quad (3)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{TESGscore}_{i,j,t} + \beta_2 X_{i,j,t} + \varepsilon_{i,j,t} \quad (4)$$

In equations (1), (2), (3), and (4), the subscripts i , j , and t represent company i in industry j during year t . The dependent variable $TQ_{i,j,t}$ represents firm value, whereas $ROE_{i,j,t}$ represents financial performance. C_0 is the intercept, α_j and α_t are industry and annual control effects, respectively, and $\beta_1, \beta_2, \beta_3$, and β_4 are the regression parameters. $\text{Escore}_{i,j,t}$, $\text{Sscore}_{i,j,t}$, and $\text{Gscore}_{i,j,t}$ represent the environmental, social, and governance dimension scores of the company, respectively, whereas $\text{TESGscore}_{i,j,t}$ is the total score of the three dimensions. $X_{i,j,t}$ includes control variables such as company size, debt ratio, company age, chairperson and CEO dual role, and R&D expense ratio. The company size is measured by the natural logarithm of the total assets of the company. $\varepsilon_{i,j,t}$ is the error term.

3.3.2 Mediating role of green bonds

The model includes an exploration of the influence of ESG scores and TESG total scores on firm value and financial performance, incorporating the issuance of green bonds as a factor in equations (5) to (8):

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{Escore}_{i,j,t} + \beta_2 \text{Sscore}_{i,j,t} + \beta_3 \text{Gscore}_{i,j,t} + \beta_4 \text{GB}_{i,j,t} + \beta_5 X_{i,j,t} + \varepsilon_{i,j,t} \quad (5)$$

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{TESGscore}_{i,j,t} + \beta_2 \text{GB}_{i,j,t} + \beta_3 X_{i,j,t} + \varepsilon_{i,j,t} \quad (6)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{Escore}_{i,j,t} + \beta_2 \text{Sscore}_{i,j,t} + \beta_3 \text{Gscore}_{i,j,t} + \beta_4 \text{GB}_{i,j,t} + \beta_5 X_{i,j,t} + \varepsilon_{i,j,t} \quad (7)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 \text{TESGscore}_{i,j,t} + \beta_2 \text{GB}_{i,j,t} + \beta_3 X_{i,j,t} + \varepsilon_{i,j,t} \quad (8)$$

In equations (5), (6), (7), and (8), the variable subscripts i , j and t represent company i in industry j during year t . The dependent variable $TQ_{i,j,t}$ represents the firm value. Dependent variable $ROE_{i,j,t}$ represents the financial performance of company. C_0 is the intercept item, α_j and α_t are industry and annual control effects respectively, and $\beta_1, \beta_2, \beta_3, \beta_4$, and β_5 are the regression parameters. $\text{Escore}_{i,j,t}$, $\text{Sscore}_{i,j,t}$, and $\text{Gscore}_{i,j,t}$ are the environmental, social, and governance dimension

scores of the company, respectively, whereas $TESGscore_{i,j,t}$ is the total score of the three dimensions. $GB_{i,j,t}$ is a dummy variable indicating whether the company listed on the TPEX have issued green bonds, assigned a value of 1 if so, and 0 otherwise. $X_{i,j,t}$ are control variables, including company size, debt ratio, company age, chairperson and CEO dual role, and the R&D expense ratio. The company size is quantified by the natural logarithm of the total assets of the company. $\varepsilon_{i,j,t}$ is the error term.

3.3.3 Mediating Role of Green Energy Companies

The exploration of the influence of ESG scores and TESG total scores, on firm value and financial performance is conducted. The model incorporates the factors of developing green energy companies for further analysis, as shown in equations (9) to (12):

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 Escore_{i,j,t} + \beta_2 Sscore_{i,j,t} + \beta_3 Gscore_{i,j,t} + \beta_4 GEC_{i,j,t} + \beta_5 X_{i,j,t} + \varepsilon_{i,j,t} \quad (9)$$

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 TESGscore_{i,j,t} + \beta_2 GEC_{i,j,t} + \beta_3 X_{i,j,t} + \varepsilon_{i,j,t} \quad (10)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 Escore_{i,j,t} + \beta_2 Sscore_{i,j,t} + \beta_3 Gscore_{i,j,t} + \beta_4 GEC_{i,j,t} + \beta_5 X_{i,j,t} + \varepsilon_{i,j,t} \quad (11)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 TESGscore_{i,j,t} + \beta_2 GEC_{i,j,t} + \beta_3 X_{i,j,t} + \varepsilon_{i,j,t} \quad (12)$$

In equations (9), (10), (11), and (12), the variable subscripts i , j and t represent company i in industry j during year t . The dependent variable $TQ_{i,j,t}$ represents the firm value. Dependent variable $ROE_{i,j,t}$ represents the financial performance of company. C_0 is the intercept item, α_j and α_t are industry and annual control effects respectively, and $\beta_1, \beta_2, \beta_3, \beta_4$, and β_5 are regression parameters. $Escore_{i,j,t}$, $Sscore_{i,j,t}$, and $Gscore_{i,j,t}$ are the environmental, social, and corporate governance dimension scores of company, respectively, whereas $TESGscore_{i,j,t}$ is the total score of the three dimensions. $GEC_{i,j,t}$ is a dummy variable for green energy development, assigned a value of 1 for involvement, 0 otherwise. $X_{i,j,t}$ are control variables, including company size, debt ratio, company age, chairperson and CEO dual role, and the R&D expense ratio. The company size is measured by the natural logarithm of the total assets of the company. $\varepsilon_{i,j,t}$ is the error term.

3.3.4 Mediating Role of Green Bonds and Green Energy Companies

The influence of ESG scores and TESG total scores, on firm value and financial performance is analyzed. The model incorporates the factors of issuing green bonds and developing green energy companies for further analysis, as shown in equations (13) to (16):

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 Escore_{i,j,t} + \beta_2 Sscore_{i,j,t} + \beta_3 Gscore_{i,j,t} + \beta_4 GB_{i,j,t} + \beta_5 GEC_{i,j,t} + \beta_6 X_{i,j,t} + \varepsilon_{i,j,t} \quad (13)$$

$$TQ_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 TESGscore_{i,j,t} + \beta_2 GB_{i,j,t} + \beta_3 GEC_{i,j,t} + \beta_4 X_{i,j,t} + \varepsilon_{i,j,t} \quad (14)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 Escore_{i,j,t} + \beta_2 Sscore_{i,j,t} + \beta_3 Gscore_{i,j,t} + \beta_4 GB_{i,j,t} + \beta_5 GEC_{i,j,t} + \beta_6 X_{i,j,t} + \varepsilon_{i,j,t} \quad (15)$$

$$ROE_{i,j,t} = C_0 + \alpha_j + \alpha_t + \beta_1 TESGscore_{i,j,t} + \beta_2 GB_{i,j,t} + \beta_3 GEC_{i,j,t} + \beta_4 X_{i,j,t} + \varepsilon_{i,j,t} \quad (16)$$

In equations (13), (14), (15), and (16), the variable subscripts i , j and t represent company i in industry j during year t . The dependent variable $TQ_{i,j,t}$ represents the firm value. Dependent variable $ROE_{i,j,t}$ represents the financial performance of company. C_0 is the intercept item, α_j and α_t are industry and annual control effects respectively, and $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$, and β_6 are regression parameters. $Escore_{i,j,t}$, $Sscore_{i,j,t}$, and $Gscore_{i,j,t}$ are the environmental, social, and governance dimension scores of company, respectively, whereas $TESGscore_{i,j,t}$ is the total score of the three dimensions. $GB_{i,j,t}$ is a dummy variable indicating whether the company listed on the TPEX has issued green bonds, assigned a value of 1 if so, and 0 otherwise. $GEC_{i,j,t}$ is a dummy variable representing involvement in green energy development: 1 if involved, 0 otherwise. $X_{i,j,t}$ are control variables, including company size, debt ratio, company age, chairperson and CEO dual role, and the R&D expense ratio. The company size is measured by the natural logarithm of the total assets of the company. $\varepsilon_{i,j,t}$ is the error term.

4. Data Analysis and Results

Parameter estimation is used to evaluate the explanatory power of green finance and the green economy on firm value and financial performance in terms of ESG scores and TESG total scores.

4.1. Descriptive Statistics

Table 5 presents descriptive statistics for the variables. The mean (median) TQ is 1.2737 (0.9600) with a standard deviation of 1.1189. The mean (median) ROE is 6.1309 (6.9900) with a standard deviation of 15.3773. The mean (median) GB is 0.0056 (0.0000) with a standard deviation of 0.0746. The mean (median) GEC is 0.0472 (0.0000) with a standard deviation of 0.2121. These statistics highlight significant variability in profitability among different companies and underscore the importance of green finance as a financing method. The scale of the green economy in Taiwan is relatively small. The mean E, S, and G scores, and TESG total scores are 54.7279, 55.1239, 53.9383, and 54.5688, respectively. These scores, all exceeding 50 points, indicate that Taiwanese companies are actively engaged in ESG practices, with governance scores being the lowest. The standard deviations are 10.7106, 10.1179, 10.7049, and 7.6306, respectively, with the standard deviation for the total TESG scores being smaller than that of the individual ESG scores. This suggests that different effects will arise from environmental conservation, social welfare, and corporate governance, indicating substantial differences in ESG performance among various companies, with a generally favorable average ESG performance.

Table 5. Descriptive Statistics

Variable	Mean	Median	Std.	Maximum	Minimum
TQ	1.2737	0.9600	1.1189	20.9400	0.0300
ROE	6.1309	6.9900	15.3773	149.9800	-96.6700
E Score	54.7279	52.5100	10.7106	90.3500	25.3500
S Score	55.1239	54.3000	10.1179	91.0000	26.9800
G Score	53.9383	54.4000	10.7049	84.4100	19.6500
TESG Score	54.5688	53.9500	7.6306	83.7300	32.9300
GB	0.0056	0.0000	0.0746	1.0000	0.0000
GEC	0.0472	0.0000	0.2121	1.0000	0.0000
SIZE	15.3128	15.1171	1.4752	22.0246	10.0850
LEV	41.2960	41.4900	18.1335	97.5200	0.3800
AGE	34.9045	33.0000	13.3912	76.0000	2.0000
DUAL	0.3652	0.0000	0.4815	1.0000	0.0000
RD	6.5642	1.9400	33.1914	929.9500	0.0000
Observations	9299				

Data source: Compiled in this study.

4.2. Correlation Analysis

Table 6 displays the correlation coefficients for this study. The relation coefficients between independent variables in the regression are all below 0.5, indicating no multicollinearity problems. A significant positive correlation emerges at the 5% level between firm value and corporate governance performance and TESG total scores. This correlation suggests that higher governance and TESG total scores are associated with increased firm values. Financial performance indicates a significant positive correlation at the 5% level with ESG scores and TESG total scores, which implies that higher ESG scores and TESG total scores are associated with higher financial performance. This result provides initial verification of the hypotheses. The strong correlation between TQ, ROE, and the control variables indicates the appropriateness of the selected control variables. Finally, the correlation coefficients among all other control variables are below 0.5, confirming that the model does not suffer from serious multicollinearity problems.

Table 6. Pearson Correlation Coefficient

Variable	TQ	ROE	E Score	S Score	G Score	TESG Score	GB	GEC	SIZE	LEV	AGE	DU AL	RD
TQ	1												
ROE	0.184**	1											
E Score	-0.006	0.131**	1										
S Score	0.019	0.159**	0.476**	1									
G Score	0.063**	0.161**	0.215**	0.206**	1								
TESG Score	0.043**	0.210**	0.705**	0.757**	0.704**	1							
GB	0.080**	0.004	0.020	0.074**	0.002	0.041**	1						
GEC	-0.035**	-0.034**	0.133**	0.106**	0.020	0.108**	-0.017	1					
SIZE	-0.168**	0.196**	0.399**	0.475**	0.133**	0.429**	0.096**	0.140**	1				
LEV	-0.240**	-0.099**	0.103**	0.061**	-0.028**	0.045**	0.013	0.089**	0.343**	1			
AGE	-0.247**	-0.034**	0.116**	0.139**	-0.058**	0.072**	0.017	0.067**	0.306**	0.118**	1		
DUAL	0.002	-0.036**	-0.071**	-0.097**	-0.294**	-0.225**	-0.021*	-0.031**	-0.140**	-0.027**	-0.064**	1	
RD	0.162**	-0.126**	-0.048**	0.000	-0.006	-0.015	-0.010	-0.028**	-0.089**	-0.156**	-0.140**	0.014	1

1. *, **, and *** represents the level of significance at 10%, 5%, and 1%, respectively.

2. N=9299.

Data source: Compiled in this study.

4.3. Results of Empirical Analysis

Table 7 presents the regression results examining the relationship between corporate ESG scores and TESG total scores with firm value and corporate financial performance. The analysis of Models 1 and 2 in Table 7 indicate that the coefficients for ESG scores and TESG total scores are 0.004, 0.005, 0.003 and 0.011, with standardized coefficients of 0.043, 0.041, 0.027, and 0.075, respectively. These coefficients are statistically significant at the 1%, 1%, 5% and 1% levels, respectively. Notably, the TESG total score exhibits the most significant effect. The research findings support hypotheses 1 and 2, indicating that higher ESG scores are associated with greater firm value. The analysis for Models 3 and 4 in Table 7 reveal that the coefficients for ESG scores and TESG total scores are 0.042, 0.035, 0.151 and 0.244, with standardized coefficients of 0.029, 0.023, 0.105, and 0.121, respectively. These are statistically significant at the 5%, 10%, 1%, and 1% levels, respectively. The TESG total score again presents the highest coefficient and demonstrates the most substantial effect. The research findings support hypotheses 3 and 4, suggesting that higher ESG scores are associated with improved corporate financial performance.

Table 7. Effect of ESG Scores on Firm Value and Financial Performance

Variable	TQ		ROE	
	Model 1	Model 2	Model 3	Model 4
Constant	2.187*** (16.263)	2.131*** (16.380)	-35.970*** (-19.105)	-33.815*** (-18.556)
E Score	0.004*** (3.725)		0.042** (2.495)	
S Score	0.005*** (3.350)		0.035* (1.871)	
G Score	0.003** (2.558)		0.151*** (9.957)	
TESG Score		0.011*** (6.723)		0.244*** (10.645)
SIZE	- 0.053*** (-5.409)	- 0.047*** (-5.024)	2.761*** (20.225)	2.587*** (19.793)
LEV	- 0.010*** (-14.468)	- 0.010*** (-14.437)	- 0.184*** (-19.566)	- 0.184*** (-19.644)
AGE	- 0.017*** (-16.884)	- 0.016*** (-16.797)	- 0.149*** (-10.869)	- 0.155*** (-11.348)
DUAL	- 0.008 (-0.325)	0.000 (-0.012)	0.921*** (2.783)	0.585* (1.807)
RD	0.003*** (7.762)	0.003*** (7.728)	-0.067*** (-14.401)	-0.068*** (-14.516)
The Industry Effect Is Fixed	yes	yes	yes	yes
The Annual Effect Is Fixed	yes	yes	yes	yes
Observations	9,299			

1. *, **, and *** represents the level of significance at 10%, 5%, and 1% respectively.

2. () denotes t-values.

Data source: Compiled in this study.

Table 8 presents the regression analysis results evaluating the influence of corporate ESG scores and TESG total scores on firm value and financial performance after incorporating the factor of green bond issuance. In the analysis of Models 5 and 6, as illustrated in Table 8, the coefficients for ESG scores and TESG total scores are 0.005, 0.004, 0.003 and 0.011, with standardized coefficients of 0.045, 0.036, 0.028, and 0.075, respectively. These coefficients are statistically significant at the 1% level. The analysis suggests that issuing green bonds enhances social benefits, as indicated by the decrease in the standardized coefficient for the social dimension from 0.041 to 0.036, and an increase in its significance from 0.001 to 0.003, demonstrating partial mediating effects. The research results support hypotheses 5 and 6, indicating a correlation between higher ESG scores and increased firm value. The analysis of Model 7 and Model 8 in Table 8 indicate that the coefficients for ESG scores and TESG total scores are 0.041, 0.037, 0.151 and 0.244, with standardized

coefficients of 0.028, 0.024, 0.105, and 0.121, respectively. The results are significant at the 5%, 10%, 1% and 1% levels, respectively. This suggests that higher T ESG scores are associated with stronger financial performance, endorsing hypotheses 7 and 8. The issuance of green bonds appears to enhance environmental benefits, as evidenced by the reduction in the standardized coefficient for the environmental dimension from 0.029 to 0.028, and an increase in significance from 0.013 to 0.015, indicating partial mediating effects.

Table 8. Mediating Role of Green Bonds in the Relationship Between ESG Scores on Firm Value and Financial Performance

Variable	TQ		ROE	
	Model 5	Model 6	Model 7	Model 8
Constant	2.277*** (16.954)	2.229*** (17.152)	-36.219*** (-19.187)	-34.109*** (-18.654)
E Score	0.005*** (3.995)		0.041** (2.443)	
S Score	0.004*** (3.009)		0.037* (1.940)	
G Score	0.003*** (2.735)		0.151*** (9.924)	
TESG Score		0.011*** (6.796)		0.244*** (10.637)
GB	1.294*** (9.026)	1.292*** (9.025)	-3.594* (-1.784)	-3.849* (-1.911)
SIZE	-0.059*** (-6.086)	-0.054*** (-5.806)	2.779*** (20.303)	2.609*** (19.887)
LEV	-0.010*** (-14.450)	-0.010*** (-14.400)	-0.184*** (-19.583)	-0.185*** (-19.666)
AGE	-0.017*** (-16.972)	-0.016*** (-16.898)	-0.149*** (-10.867)	-0.155*** (-11.344)
DUAL	-0.006 (-0.254)	0.001 (0.025)	0.917*** (2.769)	0.582* (1.800)
RD	0.003*** (7.864)	0.003*** (7.813)	-0.067*** (-14.415)	-0.068*** (-14.529)
The Industry Effect Is Fixed	yes	yes	yes	yes
The Annual Effect Is Fixed	yes	yes	yes	yes
Observations	9,299			

1. *, **, and *** represents the level of significance at 10%, 5%, and 1% respectively.

2. () denotes t-values.

Data source: Compiled in this study.

Table 9 presents the regression results for corporate ESG scores and total T ESG scores on firm value and financial performance after incorporating factors related to green energy companies. The analysis of Models 9 and 10, as illustrated in Table 9, indicate coefficients for ESG scores and total

ESG scores are 0.004, 0.004, 0.003 and 0.011, with standardized coefficients of 0.042, 0.041, 0.027, and 0.075, respectively. These coefficients are statistically significant at the 1% level, with the ESG total score having the strongest effect. This indicates that involvement in green energy enhances environmental benefits, as indicated by the decrease in the standardized coefficient for the environmental dimension from 0.043 to 0.042, providing partial mediating effects. The research results support hypotheses 9 and 10, indicating that higher ESG scores are associated with greater firm value. In the analysis of Models 11 and 12, as illustrated in Table 9, the coefficients for ESG scores and total ESG scores are 0.047, 0.037, 0.150 and 0.250, with standardized coefficients of 0.033, 0.024, 0.105, and 0.124, respectively. The results are significant and positive at the 1%, 5%, 1%, and 1% levels, respectively. These findings support hypotheses 9 and 10, suggesting that higher ESG scores correspond to improved financial performance.

Table 9. Mediating Role of Green Energy Companies in the Relationship between ESG Scores on Firm Value and Financial Performance

Variable	TQ		ROE	
	Model 9	Model 10	Model 11	Model 12
Constant	2.191*** (16.222)	2.137*** (16.333)	-36.816*** (-19.497)	-34.814*** (-19.022)
E Score	0.004*** (3.696)		0.047*** (2.827)	
S Score	0.004*** (3.343)		0.037** (1.976)	
G Score	0.003*** (2.562)		0.150*** (9.898)	
TESG Score		0.011*** (6.691)		0.250*** (10.913)
GEC	0.016 (0.306)	0.023 (0.440)	-3.583*** (-4.914)	-3.741*** (-5.137)
SIZE	- 0.053*** (-5.417)	- 0.047*** (-5.042)	2.792*** (20.457)	2.629*** (20.099)
LEV	- 0.010*** (-14.452)	- 0.010*** (-14.429)	-0.181*** (-19.191)	-0.181*** (-19.234)
AGE	- 0.017*** (-16.885)	-0.016*** (-16.802)	-0.147*** (-10.739)	-0.153*** (-11.185)
DUAL	-0.008 (-0.321)	0.000 (-0.013)	0.903*** (2.730)	0.585* (1.810)
RD	0.003*** (7.762)	0.003*** (7.728)	-0.067*** (-14.417)	-0.068*** (-14.538)
The Industry Effect Is Fixed	yes	yes	yes	yes
The Annual Effect Is Fixed	yes	yes	yes	yes
Observations	9,299			

1. *, **, and *** represents the level of significance at 10%, 5%, and 1% respectively.

2. () denotes t-values.

Data source: Compiled in this study.

Table 10 provides regression results examining the influence of corporate ESG scores and TESG total scores on firm value and corporate financial performance after incorporating factors related to green bonds and green energy companies. The regression results for Models 13 and 14, as illustrated in Table 10, reveal that the coefficients for ESG scores and TESG total scores are 0.005, 0.004, 0.003 and 0.011, with standardized coefficients of 0.045, 0.036, 0.028, and 0.075, respectively. These coefficients are statistically significant at the 1% level. Notably, the TESG total score demonstrates the most substantial influence and the strongest relationship. The research results support hypotheses 13 and 14, suggesting that higher TESG scores lead to superior firm value. The integration of green bonds and green energy development leads to better scores on the social dimension, as evidenced by the decrease in the standardized coefficient for the social dimension from 0.041 to 0.036, and an increase in its significance from 0.001 to 0.003, indicating the presence of partial mediating effects. The analysis of Models 15 and 16, as illustrated in Table 10, indicate that the coefficients for ESG scores and TESG total scores are 0.046, 0.039, 0.150 and 0.250, with standardized coefficients of 0.032, 0.025, 0.104, and 0.124, respectively. The results are significantly positive at the 1%, 5%, 1%, and 1% levels. The research results support hypotheses 15 and 16, indicating that higher TESG scores correlate with stronger financial performance. The combination of issuing green bonds and developing a green economy seems to enhance governance benefits. This is indicated by the decrease in the standardized coefficient for the governance dimension from 0.105 to 0.104, which also suggests partial mediating effects.

Table 10. Mediating Role of Green Bonds and Green Energy Companies in the Relationship between ESG Scores on Firm Value and Financial Performance

Variable	TQ		ROE	
	Model 13	Model 14	Model 15	Model 16
Constant	2.284*** (16.936)	2.240*** (17.130)	-37.098*** (-19.592)	-35.147*** (-19.135)
E Score	0.005*** (3.946)		0.046*** (2.775)	
S Score	0.004*** (2.994)		0.039** (2.053)	
G Score	0.003*** (2.744)		0.150*** (9.861)	
TESG Score		0.011*** (6.748)		0.250*** (10.908)
GB	1.296*** (9.041)	1.296*** (9.044)	-3.992* (-1.948)	-4.193** (-2.083)
GEC	0.031 (0.603)	0.038 (0.738)	-3.630*** (-4.976)	-3.791*** (-5.204)
SIZE	-0.060*** (-6.108)	-0.055*** (-5.841)	2.812*** (20.549)	2.653*** (20.208)
LEV	-0.010*** (-14.456)	-0.010*** (-14.415)	-0.181*** (-19.206)	-0.181*** (-19.255)
AGE	-0.017*** (-16.981)	-0.016*** (-16.912)	-0.147*** (-10.736)	-0.153*** (-11.178)
DUAL	-0.006 (-0.247)	0.001 (0.025)	0.897*** (2.714)	0.582** (1.802)
RD	0.003*** (7.863)	0.003*** (7.814)	-0.067*** (-14.433)	-0.068*** (-14.553)
The Industry Effect Is Fixed	yes	yes	yes	yes
The Annual Effect Is Fixed	yes	yes	yes	yes
Observations	9,299			

1. *, **, and *** represents the level of significance at 10%, 5%, and 1% respectively.

2. () denotes t-values.

Data source: Compiled in this study.

4.4 Results for Hypothesis

This study investigates the relationship between ESG scores and firm value and corporate financial performance. Additionally, it explores the mediating influence of issuing green bonds and developing green energy companies on this relationship. The empirical results are comprehensively summarized in Table 11.

Table 11. Results of Hypothesis Testing

Hypothesis	Independent/ Mediator Variable	Dependent Variable	Positive (+)/ Negative (-) impact	Significance	Results
H 1	E	TQ	+	***	Support hypothesis
	S		+	***	
	G		+	**	
H 2	TESG	TQ	+	***	Support hypothesis
H 3	E	ROE	+	**	Support hypothesis
	S		+	*	
	G		+	***	
H 4	TESG	ROE	+	***	Support hypothesis
H 5	E	TQ	+	***	Support hypothesis
	S		+	***	
	G		+	***	
	GB		+	***	
H 6	TESG	TQ	+	***	Support hypothesis
	GB		+	***	
H 7	E	ROE	+	**	Support hypothesis
	S		+	*	
	G		+	***	
	GB		-	*	
H 8	TESG	ROE	+	***	Support hypothesis
	GB		-	*	
H 9	E	TQ	+	***	Support hypothesis
	S		+	***	
	G		+	***	
	GEC		+	***	
H 10	TESG	TQ	+	***	Support hypothesis
H 11	GEC	ROE	+	***	Support hypothesis
	E		+	**	
	S		+	***	
	G		+	***	
H 12	TESG	ROE	+	***	Support hypothesis
	GEC		-	***	

H 13	E	TQ	+	***	Support hypothesis
	S		+	***	
	G		+	***	
	GB		+	***	
	GEC		+		
H 14	TESG	TQ	+	***	Support hypothesis
	GB		+	***	
	GEC		+		
H 15	E	R OE	+	***	Support hypothesis
	S		+	**	
	G		+	***	
	GB		-	*	
	GEC		-	***	
H 16	TESG	ROE	+	***	Support hypothesis
	GB		-	**	
	GEC		-	***	

Note: + means a positive relationship exists (the coefficient is positive), - means a negative relationship exist (the coefficient is negative)

***, ** and * represent the significance level of 1%, 5% and 10% respectively.

Data source: Compiled in this study.

5. Conclusions

This study conducted an analysis of ESG scores at both individual and aggregate levels, with green finance and green economy playing intermediary roles. The results indicate that ESG scores significantly and positively influence firm value and financial performance across all dimensions—environmental, social, and corporate governance. Furthermore, the aggregate TESG total scores also significantly and positively influence firm value, corroborating the stakeholder theory.

When the factor of issuing green bonds is included in the analysis, both individual ESG scores and the overall TESG score exhibit a positive and significant influence on firm value and financial performance. The issuance of green bonds acts as a partial mediator, particularly in the environmental and social dimensions. Similarly, incorporating the factor of developing a green economy reveals that both individual ESG scores and the overall TESG score maintain a positive and significant influence on firm value and financial performance, with partial mediating effects observed in the environmental dimension. Furthermore, when both green bonds and green economy development are considered, partial mediating effects are observed in the social and governance dimensions.

The implications of this study aid the promotion of efforts to balance profitability with ethics and sustainability. The study advocates for the use of green bonds to address funding gaps in green development. It also recommends for governmental and regulatory bodies to establish

comprehensive supervisory norms for information disclosure to prevent listed companies from superficially and deceptively adopting ESG concepts.

Environmentally-friendly enterprises do not emerge spontaneously. The habitualization of ESG practices, as opposed to mere awareness, is required heavy industry especially, which is characterized by pollution and high energy consumption. Advances in energy conservation and pollution control are also necessary in these highly polluting industry.

This study has some limitations. First, the sample size is small. This lack of data is due to the novelty and small scale of green finance and the green economy. Second, this study did not account for green innovation, which is a key factor.

Third, the ESG ratings chosen for this study encompass dimensions at both individual and aggregate levels. However, due to the relatively novel data source of TEJ, future analyses could benefit from incorporating additional data sources to investigate the influence across different dimensions more comprehensively.

Moreover, this study utilizes data from Taiwan's listed over-the-counter companies. Future research could encompass cross-country and cross-industry studies, offering a broader perspective on the green effects of enterprises from different countries and sectors.

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