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Article

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Corporate ESG investments and Firm's value under the real-option framework: Evidence from two world-leading economies

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ABSTRACT

Under the UN sustainable development goals (SDGs), the United States (US) and China have ambitious environmental, social, and governance (ESG) investment plans. However, dichotomy is found in the literature about how rising ESG practices affect firm value (FV). This study examines the linear and nonlinear effect of ESG practices on FV and how growth-option value (GV) moderates this connection in the real-option framework. We use data on 5220 listed US and Chinese firms from 2018 to 2022 with a generalized method of moments model. The empirical results confirm that ESG practices nonlinearly affect FV, implying that ESG practices turn FV trajectory from positive to negative, and the degree of this effect varies across the sample but is more pronounced at Chinese firms than US firms. We also find that GV negatively moderates the nexus between ESG practices and FV across the sample. Our endogeneity-adjusted results pass robustness tests and have important policy implications.

1. Introduction

In the rapidly evolving global economic landscape, the integration of environmental, social, and governance practices (ESGP) into corporate decision-making and investment strategies, coupled with a heightened emphasis on ESG disclosures, has become more dominant. ESG standards were first introduced in the US in 2006 as principles of responsible investment. Sustainable investment strategies have surged in popularity since the outbreak of the COVID-19 pandemic in 2020. Since 2016, the global popularity of ESGP has exponentially surged, and the use of ESG filters has become common as they are integral to sustainable investing. Similarly, the United Nations' sustainable development goals (SDGs) for 2030, the Paris Agreement, the increasing complexity of businesses, sustainability compliance, media pressure, and heightened competition gave new impetus to this debate. Increasing ESG practices may create resilience to economic stress and downtime, which has attracted substantial attention among academics, legislators, and financial experts. ESG investing is vital, as it is an internal driving force in firms' growth. Firms are expected to contribute to mitigation of climate change risk and social welfare to build good relationship with stakeholders, among other

essential facets of financial investment.

From an investment perspective, ESG factors are critical drivers of portfolio risk and return and, ultimately, lead to profit maximization (Gillan et al., 2021; Naseer, Khan, et al., 2023). Sustainable investment integrates ESGP into fundamental investment analysis, in the belief that these factors affect a firm's performance and closely align it with socially responsible investment (Zhang & Zi, 2021). They eventually improve a firm's reputation and performance by prioritizing the well-being of future generations (Kim et al., 2015). However, a few companies are likely to internalize the externalities of environmental pollution, greenhouse gases, and fossil fuels (Liang & Renneboog, 2017).

Despite this favorable attention from investors, an ongoing academic debate revolves around the influence of a company's engagement in ESGP and its impact on firm value (FV). Recent papers emphasize the need for more sophisticated theoretical analysis to understand the insurance mechanisms in this corporate strategy and its connection to overall FV (Wang et al., 2020). Past studies predominantly examine the impact of ESGP on firm performance. Empirical evidence reveals diverse influences: some studies indicate a positive effect (Ademi & Klungseth, 2022; Al Amosh et al., 2023; Aydoğmuş et al., 2022), others a negative

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impact (Duque-Grisales & Aguilera-Caracuel, 2021; Semenova & Hassel, 2008), and still others find no significant relationship (Garcia-Castro et al., 2010). Few studies demonstrate a nonlinear relationship between ESGP and growth-option value (GV) (Fuente et al., 2022), but the existing literature lacks a comprehensive empirical analysis of the nonlinear link between ESGP and FV, failing to differentiate among current firm performance, FV, and GV. This diversity adds complexity to the ongoing debate (Wen et al., 2022).

The economic implications of additional ESGP is that if a firm continues to engage in ESG activity after a specific cut-off, FV will decline (Pu, 2022). Another strand of literature offers theoretical insights into the value of ESGP using a real-option framework (Alessandri et al., 2012). A few studies show that moderating factors can contribute to this relation across firms (Magrizos et al., 2021). Other papers show that FV is not determined solely by a straightforward comparison of direct costs and benefits; rather, it emerges from a complex interplay between ESGP and various other sources of value. Within this context, the real-option approach provides a comprehensive and cohesive framework, which considers the growth potential due to firms' ESGP in three distinct ways: first, by encouraging stakeholder-specific investment; second, by providing insurance protection; and, third, by fostering corporate flexibility in the face of uncertainty (Fuente et al., 2022; Godfrey, 2005; Godfrey et al., 2009). ESGP could raise FV for several potential reasons. ESGP could improve a firm's reputation, reduce risks, attract funding, and enhance operational efficiency, demonstrating a commitment to sustainability and compliance with regulations. However, the relationship between ESGP and FV can be complex and may not always follow a straightforward path, varying by industry, region, and practices (Fuente et al., 2022; Hart & Milstein, 2003). The backdrop and relevance prompted by worldwide facts, the most appropriate nonlinear modeling and development prospects on the ESGP-FV relationship needs to be presented. Drawing on real-option theory, this study has the following objectives. First, two opposite dynamics can become drivers of GV because of the insurance-like nature of ESGP. The development of social capital and trust encourages shareholders' firm-specific investment, so this course might favor GV (Shiu & Yang, 2017).

However, there is a possibility that an increase in the amount (e.g., a richer pool) of moral capital available because of ESGP and the subsequent reduction in business risk will have a negative effect on GV. A company's GV is likely to decline because of the risk-reducing impact of ESG practices. This impact corresponds to the negative effect of a risk reduction in the underlying asset of a call option on the value of this option (Kester, 1984). In consideration of these two opposing dynamics, our first objective in this article is to evaluate the nonlinear effect of ESGP on firms' GV. Our second objective is to examine the asymmetric effect of ESGP on FV. Third, moderating factors can contribute to this association differently across firms (Magrizos et al., 2021). Therefore, considering earlier objectives such as ESGP and GV suggests that the following channels may affect FV. The insurance effect of sustainable ESGP can be sub additive, and current and new stakeholders may have initiatives based on competing interests that can overlap with other insurance investments for companies with a larger GV, reducing their trust-enhancing effect (Jia & Li, 2020). These negative impacts of firms with more prosperous GV portfolios are likely to reduce the positive impact of ESGP on FV (Fuente et al., 2022). Therefore, our third objective is to examine how GV moderates the association between ESGP and FV in context of the US and Chinese listed firms.

This article focused on the US and China aims to enrich our understanding of the impact of ESGP on FV under a real-option framework. The US and China both have significant global economic importance, and each is implementing promising ESG investment strategies. The focus of our study enables us to capture a diverse range of corporate practices and behaviors, providing valuable insights into the implications of ESGP in different economic landscapes (Hossain & Masum, 2022). The unique institutional and regulatory frameworks in the US and China offer an opportunity to explore how variations in these

settings influence the relationship between ESGP and FV. Although we acknowledge the potential benefits of a cross-country setting, our focused approach enables a deeper exploration of the effect of ESGP in the context of these two leading economies.

The literature review indicates that ESGP are continually evolving in both China and the US, which have a common goal of promoting sustainable and responsible investment practices. Despite their differences, the shared commitment is evident, particularly in China, which is addressing significant environmental challenges and aims to achieve carbon neutrality by 2060 (Zhou & Wu, 2022). Globally, sustainable investment has grown substantially, and the US and China play a significant role. As highlighted by the US Sustainable Investment Foundation (SIF), the US expects a notable increase in sustainably invested assets (SIF, 2020). This aligns with the global trend, in which investors' capital allocation decisions appear to be positively influenced by ESG scores (Hartzmark & Sussman, 2019). President Xi Jinping's commitment to achieving carbon neutrality by 2060 highlights China's dedication to addressing environmental issues. This commitment aligns with the increasing global focus on ESGP and SDGs, with substantial implications for the global standing of both countries (Shahzad et al., 2023). As mentioned above, our focused approach contributes to a detailed examination of ESGP and FV in two major economic powerhouses. In addition, this exploration supports Michael Porter's assertion that international competition is driven by firms, emphasizing the centrality of ESGP in shaping policy decisions.

Based on the sample criteria, we calibrate our final sample of 5220 listed firms in the US and China from 2018 to 2022. To achieve our objectives, we apply feasible generalized least square (FGLS), and two-stage generalized method of moments (2 S-GMM), and our empirical results show that ESGP nonlinearly affects FV. ESGP turn the FV trajectory from positive to negative, and the degree of this effect varies across the sample but is higher at Chinese firms than US firms. GV negatively moderates the ESGP-FV nexus across the sample. *Overall, the results demonstrate a nonlinear effect of ESGP on firms' GV and FV.* Furthermore, the study shows that GV negatively moderates the nexus between ESGP and FV across the sample.

This article contributes to literature in a variety of ways. First, from the academic perspective, it provides a new cross-country perspective by investigating the nonlinear impact of ESGP on GV in the context of listed firms in two leading economies. Second, we investigate the nonlinear effect of ESGP on FV, as past studies provide plenty of anecdotal evidence but lacks cross-country evidence (Fuente et al., 2022; Velte, 2017; Xie et al., 2019). Third, we add to the literature by introducing GV into the same analytical framework as a moderating channel between ESGP and the FV in context of US and Chinese firms. Moreover, building on prior research (Anderson & Garcia-Feijóo, 2006; Cao et al., 2006; Trigeorgis & Lambertides, 2014), for a robustness check, we employ the ratio of capital expenditure to fixed assets in order to assess growth options using firms' financial metrics. Methodologically, we employ two sophisticated econometric models: FGLS to address concerns related to serial/autocorrelation, heteroskedasticity, cross-sectional dependence issues, and dynamic panel 2 S-GMM to account for endogeneity and reverse causality, Heckman's two-step and Driscoll and Kraay method. Further, we divide our sample into three panels and conduct country-level and overall analysis. We find that ESGP affects FV and GV nonlinearly, which has significant policy consequences for investors, managers, and regulators. Finally, we provide conceptual support for our claims by drawing on the real-option approach, which is the best way to detect the future of ESGP and unique wealth-creating drivers.

After this introduction, the paper is organized as follows. Section 2 reviews the existing research and formulates our hypotheses. Section 3 gives an overview of the data, variables, and methodology used in the study. The results are presented in Section 4, and Section 5 gives a conclusion and outlines the policy implications.

2. Literature review and hypothesis formulation

The ESG concept originated in a 2006 report on the United Nations Principles for Responsible Investment. ESG evaluates a company's performance in terms of specific environmental, social, and governance criteria, ensuring transparency and accountability for stakeholders and investors whereas corporate social responsibility encompasses wide-ranging social initiatives; corporate sustainability emphasizes long-term resilience with balanced economic, social, and environmental practices (Bansal & Song, 2017; Wai Kong Cheung, 2011). ESG investment is a practice followed by socially conscious investors to evaluate potential investment based on a company's behavior according to a set of standards related to environmental, social, and governance factors. ESGP allows investors to evaluate a firm's efforts to promote sustainable economic development and the extent to which the company lives up to its social responsibilities. Companies' environmental performance (e.g., in emissions, energy efficiency, renewable energy, biodiversity, pollution, greenhouse gases, fossil fuel, and biodiversity) is evaluated from the perspective of environmental (E) practices in corporate ESG investment (Liang & Renneboog, 2017). A wide range of governance-related characteristics, such as openness, management structure, corporate board, policies, information disclosures' compliance, audit-related issues, board diversity, company standards, and risk management, comprise what is known as governance (G) practices (Al-Qudah et al., 2022; Liang & Renneboog, 2021). However, a new strategy for improving sustainability in all countries is outlined by the United Nations' 2030 SDGs, which are to be implemented globally by 2030 (Mohieldin et al., 2022; Ndung'u, 2022). The sustainable development objectives set out to end poverty, increase equity, reduce the effects of climate change, and spur innovation that contributes to long-term economic growth (Cf, 2015; Mohieldin et al., 2022). In the upcoming section, we will introduce the pertinent discourse, articulate hypotheses, and outline the theoretical framework of the study.

2.1. Corporate ESG practices and firms' growth-option value

The origin of the concept of growth-option value can be traced back to the foundational contributions to financial economics by (Miller & Modigliani, 1961; Myers, 1977). Miller and Modigliani (1961) formalized the theory of corporate valuation, proposing that a firm's overall value comprises two fundamental components: the value of existing assets and the value associated with potential future growth opportunities. Myers (1977) extended this framework by suggesting that a firm's approaching growth opportunities can be conceptualized as growth options. These growth options grant the firm the right, without obligation, to make decisions regarding investment in these growth opportunities in future periods. Awaysheh et al. (2020) real-option theory, derived from financial options, provides a strategic framework applicable to ESG practices. It emphasizes flexibility in ESG strategies, allowing companies to adapt initiatives in response to changing conditions and uncertainty such as regulatory shifts or evolving industry standards. The timing of ESG practices' is crucial, with real-option theory guiding companies in strategically implementing initiatives when conditions are most favorable. The valuation of ESG opportunities by Lins et al. (2017) incorporates the theory's principles, assessing the long-term benefits and risks associated with specific ESG practices. Real-option theory helps in managing uncertainty tied to complex ESG challenges, helping companies make resilient and sustainable decisions (Lins et al., 2017). By using strategic decision trees, companies can visualize various paths for ESG initiatives, enhancing their ability to navigate uncertainty and create sustainable value over the long term. Many studies highlight the significance of integrating ESG practices from a strategic standpoint, recognizing their essential role in reinforcing core business functions and serving as a foundation for the growth of firms (Hart & Milstein, 2003). However, prior literature has predominantly focused on the impact of ESG performance on a firm's current

operations, neglecting explicit consideration of its influence on the firm's growth options (GO). Substantial evidence suggests that the value of many major strategies centers on this particular component (Alesandri et al., 2012; Estrada et al., 2010).

The real-option perspective is a pivotal conceptual link between strategic and financial analyses of corporate decisions, including ESG practices, enhancing understanding of the underlying mechanisms of value creation (Trigeorgis & Reuer, 2017). GO play a central role in the managerial decision-making process, as long-term value strategies typically comprise portfolios of options acquired and exercised sequentially in response to evolving uncertainty (Myers, 1977). Thus, the nature of a company's options portfolio over time determines the extent to which it can make flexible decisions in the face of uncertainty, with the value of such options depending on the company's managerial abilities and organizational mechanisms to develop, manage, exercise, and govern them (Klingebiel, 2012). For instance, several papers have offered theoretical insights into the real-option value of ESG practices (Kim et al., 2021). These procedures allow businesses more flexibility and reduce their risk profile in the face of uncertainty. For instance, Figge (2005) argues that a company's eco-efficiency initiatives might generate option value and insulate it against forthcoming social and environmental shocks. ESGP is viewed as a hedge against negative reputational risk and a tool for expanding the company's goodwill (Camilleri, 2018). Despite the apparent link between such practices and GV and its intriguing potential for better understanding the source of value from ESG policies, how this relationship works has not been thoroughly investigated.

To explain the mechanisms behind the link between ESGP and GV, we follow Haans et al. (2016) the two main opposing mechanisms determine value. The "trust-enhancing effect" of ESGP and the firm's stakeholder-specific investment are captured by the former. Growth platforms are only as valuable as the care and attention paid to them by people throughout their existence and use (Klingebiel, 2012). A company's ability to inspire legitimacy among its stakeholders is directly proportional to the quality of its ESG practices (Wang et al., 2003). ESG practices increase stakeholder trust by building social capital and increasing loyalty to the company (Godfrey, 2005; Henderson et al., 2015; Jia & Li, 2020). Therefore, a company's value will increase if its ESG performance improves (Fuente et al., 2022). Unlike the stakeholder-specific investment drive, this risk-reducing effect on GV increases marginally because of the well-known concave relationship between call option volatility and value. At lower risk levels, call options are more likely to be profitable. Given the negative relation between ESG performance and risk, we can assume that a one-percentage-point increase in ESG performance decreases GV at lower levels and more at higher levels (Godfrey, 2005; Henderson et al., 2015; Jia & Li, 2020). Limited empirical research has been conducted on the nonlinear effect of ESGP on GV. Fuente et al. (2022) explore this link using real-option theory at US publicly listed companies (2009–2018) and demonstrate an inverted U-shaped relationship. Our analysis extends to both US and Chinese firms, providing a cross-country perspective. Addressing the existing gaps, this article delves into the nonlinear relationship between ESGP and GV. To add a crucial dimension overlooked in prior studies, we employ dynamic modeling, more macroeconomic as well as more firm-level factors as control variables. In addition to including the GV ratio, we adopt the ratio of capital expenditure to fixed assets in order to enhance robustness, drawing on prior research (Anderson & Garcia-Feijóo, 2006; Cao et al., 2006; Trigeorgis & Lambertides, 2014). This gives a comprehensive assessment of growth options using firm financial metrics.

Methodologically, we depart from prior studies by avoiding two stage least square (2SLS) because of its sensitivity to outliers, potential distortion of results, and the inherent complexity of a two-stage process. Instead, we employ two advanced econometric models: FGLS to address concerns of serial and autocorrelation, heteroskedasticity, and cross-sectional dependence, and a two-stage dynamic panel GMM to

effectively account for endogeneity and reverse causality. We use ESG scores provided by the rating agency. These ESG scores are constructed based on strict standards, enabling a cross-regional or cross-country perspective as outlined by (Aerts et al., 2008). Establishing the backdrop for our hypotheses, we derive insights from the literature to posit our first hypothesis.

Hypothesis 1. ESG practices have a nonlinear influence on firms' growth-option value (GV).

This expectation arises from two contrasting dynamics driven by the strategic insurance-like nature of ESGP. The cultivation of social capital and trust, as endorsed by Shiu and Yang (2017) may stimulate shareholders' firm-specific investment, thereby favoring GV. However, the increase in moral capital resulting from ESGP, which reduces business risk, has the potential to have a negative impact on GV. The risk-reducing effect of ESG practices could reduce a company's GV, analogous to the negative influence of risk reduction in the underlying asset of a call option on its value, as noted by (Kester, 1984). Analyzing China, Khan et al. (2016) suggest that evolving institutional norms and strict regulatory pressures may initially drive firms to overinvest in ESG practices, aligning with social and regulatory expectations while reinforcing legitimacy. However, sustained overinvestment in ESG practices could yield diminishing returns and nonlinear, negative impacts on firms' performance, in line with Lueg and Pesheva (2021).

2.1.1. Corporate ESG practices and firm value

Existing research on the link between ESG practices and corporate performance falls into four main categories.

In the first strand, most studies support a positive correlation between ESG performance and financial performance. Ademi and Klungseth (2022) reveal a positive influence in a sample of 150 US firms for the period 2017–20. Velte (2017) examine the ESGP and financial performance (FP) rapport in Germany in 2010–14, finding that ESG performance affects the return on assets but not the Tobin's Q ratio and governance performance. In addition, Cormier and Magnan (2007) and Aerts et al. (2008) offer evidence of a positive relation. Aerts et al. (2008) find that a higher level of ESG disclosure in a sample of companies from countries in the European Union (including Belgium, France, Germany, and the Netherlands) and North America (Canada and the US) increases firm value by reducing information risk. Meanwhile, Cormier and Magnan (2007), analyzing data on Canadian, German, and French companies for the period 1992 to 1998, present evidence of a positive association, though it was not consistently observed across all countries. Other studies document a positive association between ESG investment practices at firms in other developed countries (Ameer & Othman, 2012; Aydoğmuş et al., 2022; Rahi et al., 2021; Weber, 2014; Xie et al., 2019). In the second strand, Schuler and Cording (2006) conduct empirical research showing a negative connection between corporate ESG practices and financial performance. Their findings suggest that managers actively involved in ESG activities might overlook the opportunity costs associated with these actions, potentially causing them to forgo more financially rewarding opportunities for the company. For instance, Semenova and Hassel (2008) contend that channeling resources into ESG activities might create additional expenses for companies that could jeopardize their overall value. Duque-Grisales and Aguilera-Caracuel (2021) reveal that ESG scores have a negative correlation with the financial performance of firms. Notably, in an examination of Canadian firms, Richardson and Welker (2001) find an unanticipated negative link between ESG disclosure and market value. In the third strand, some studies did not identify a statistically significant association between ESG practice and FV. For example, Garcia-Castro et al. (2010) did not find any substantial correlation, whereas Li

et al. (2018) suggest that financial underperformance is attributable to the costs incurred from socially responsible initiatives. This demonstrates some divergence in the findings in this strand of research. The fourth strand indicates a positive yet nonlinear connection, marked by significantly negative signs. This implies that the relationship between ESG practices and firm value is complex and nonlinear pattern. Studies that explore the nonlinear association, such as Lueg and Pesheva (2021), find a positive link between corporate sustainability and total shareholder returns by emphasizing the beneficial impact of disclosing governance practices. However, companies that overreport tend to experience declines in TSR. Teng et al. (2021) conduct a quantile regression analysis on 323 listed firms in Taiwan, showing that ESG risk has a negative impact on corporate sustainable growth in the upper quantiles of the growth rate but does not affect the lower and median quantiles, particularly at companies in environmentally sensitive industries. Pu (2022) analyze 232 Chinese listed firms and discover a positive association between ESG activities and firm performance, in an inverted U-shaped pattern, which suggests a positive impact up to a certain threshold, beyond which ESG activities have a negative effect. One reason could be spending more on social responsibility activities. This shows that continuation of a firm's ESG actions after a specific cut-off will reduce corporate performance. Adegbite et al. (2019) suggest that the effect of ESG investment on firm value may not be immediate and linear. ESG initiatives may take time to yield results and may have nonlinear patterns, as they influence a firm's performance, reputation, and risk management over time. In other words, the effect of ESGP on a FV may not be directly proportional.

Despite this extensive literature, a significant gap remains. Most studies are based on a single country and document linear associations using traditional accounting performance measures. Our study fills this gap by introducing a nonlinear regression model to explore the nonlinear relationship between ESG practices and FV in the context of two countries' listed firms. This approach addresses the insufficient empirical analysis of the nonlinear impact of ESGP on FV. Furthermore, it encourages a departure from traditional performance measures, highlighting the importance of established metrics for assessing FV. Based on insights from this prior literature, we posit our second hypothesis.

Hypothesis 2. ESGP has a nonlinear effect on firm value.

2.1.2. The moderating effect of GV on the association between ESG practices and firm value

According to the real-option theory, the value of a company is equal to the sum of its existing assets (assets-in-place) and its future operations (GO). Some studies offer a comprehensive evaluation of the potential impact of ESG practices on a company in three dimensions: encouragement of stakeholder-specific investment, provision of insurance protection, and corporate flexibility amid uncertainty Fuente et al. (2022); Godfrey (2005); Magrizos et al. (2021) highlight the varying influence of moderating factors on this relationship at different firms by encouraging investment specific to stakeholders, by offering insurance protection, and by cultivating corporate flexibility amid uncertainty. Theoretical work that links ESG performance and GV implies this may have an impact on a company's market value. Firm value could be affected by its ESG performance and GV value in a variety of ways. The interaction between ESG performance and GV influencing a firm's overall value may be intricate. Two mechanisms contribute to this complexity: (i) the potential subadditivity of the insurance impact associated with ESG performance. It is possible that the insurance effect of ESG performance is sub-additive, and that existing and potential stakeholders have divergent priorities. Jia and Li (2020) illustrate that

the insurance effect of sustainable ESG practices might be sub-additive. Additionally, competing interests of current and new stakeholders, which might overlap with other insurance investments, could diminish the trust-enhancing effect, especially at companies with higher GV. (ii) Conflicting interests between existing and new stakeholders. Galbreath (2011) anticipate a countervailing effect between ESGP and GV. Snoeren (2015) in the second channel, given that the goal of ESGP is to benefit existing stakeholders without jeopardizing the ability to create value for future stakeholders whereas GV usually incorporates new stakeholders, who may take away benefits at the cost of current stakeholders. GV threatens the interests of present stakeholders if it prioritizes new

is determined using a simplified approach. This involves estimating the replacement cost by considering the book value of total assets, a choice made due to the inherent difficulty in directly measuring the replacement cost, as highlighted by (Fafaliou et al., 2022; Flammer, 2015; Fuente et al., 2022; Ozkan et al., 2022).² The metric was developed by Brainard and Tobin in 1968 and further refined by Tobin in 1969. Chung and Pruitt (1994) developed a straightforward estimate for Tobin's Q following a methodology similar to that of Chung and Pruitt (1994); Naseer, Khan, et al. (2023), our analysis incorporates a similar measure as follows.

$$TQR_{i,t} = \frac{\text{Market value of common stock}_{i,t} + (\text{the market value of preferred stock}_{i,t} + \text{Total Liabilities}_{i,t})}{\text{Total Assets}_{i,t}} \quad (1)$$

stakeholders' interests. Thus, to achieve trust-enhancing results, organizations with higher GV must invest far more in ESG practices than those with lower GV. Fuente et al. (2022) further write that GV will raise questions about a firm's ESG performance and reduce its perceived legitimacy, and generating corporate value from ESG investing should consider current and long-term results. These detrimental impacts are likely to mitigate the positive influence of ESGP on FV. The debate suggests our third hypothesis.

Hypothesis 3. GV negatively moderates the connection between ESGP and FV.

This paper focuses on the effect of ESGP on firm value, and how the growth option moderates this association. It uses the most appropriate nonlinear regression model, filling a vacuum in the literature by providing a unique perspective on ESGP and FV under real options in two world-leading economies. The conceptual framework is presented in Fig. 1.

3. Data and methodology

3.1. Data and sample description

Based on a quantitative research strategy, this paper analyzes a sample of 5220 listed firms, including 2649 US publicly traded firms and 2571 firms listed in China over the period 2018–2022. We apply the following criteria to calculate and refine explained, explanatory, and control variables from raw data. (1) Companies without the requisite information were removed from consideration. (2) We accounted for dysfunctional firms to prevent survivorship bias. (3) All companies must make public their ESG score. (4) Any firm-year observations with total negative assets, equity, and financial or utility companies because these types of businesses have a unique capital structure and are overseen by a separate set of regulatory agencies. (5) We omit the outliers and companies with negative or no common equity. We collected annual data for analysis from various sources: Refinitiv's Eikon platform, the CompStat, Worldscope, & World Development Indicators.¹ To normalize for possible outliers in the data, the variables are winsorized at 1 percent and 99 percent.

3.2. Variable description

3.2.1. Measurement of firm value

The Tobin's Q ratio, a widely employed metric in academic literature to assess a firm's valuation (Awaysheh et al., 2020; Fafaliou et al., 2022)

3.2.2. Growth-option value under real-option framework

We calculate the growth-option value (GV) using the real-option framework (Fuente et al., 2022; Godfrey, 2005; Godfrey et al., 2009).³ The GV ratio (GV) is a financial metric that calculates the ratio of the GV due to equity divided by market capitalization. The assets-in-place value of a firm's equity in year t can be determined by calculating the present value of the firm's year- t earnings (net income), assuming that it will continue indefinitely, and discounted at the firm's cost of equity Ke (Alessandri et al., 2012; De Andrés-Alonso et al., 2006; Tong & Reuer, 2006).

In the initial phase of our analysis, we undertake the calculation of the value of assets in relation to equity.

$$\text{Value of assets in place}_{i,t} = \frac{\text{Net Income}_{i,t}}{ke_{i,t}} \quad (2)$$

In the subsequent stage of our analysis, we ascertain the Growth Option Value (GV) through the application of the following equation:

$$GV_{i,t} = \frac{\text{Market Capitalization}_{i,t} - \text{Value of assets in place}_{i,t}}{\text{Market Capitalization}_{i,t}} \quad (3)$$

The capital asset pricing model (CAPM) and the dividend capitalization model (DCM) are tools for assessing a company's cost of equity. Whereas the CAPM factors in the overall market risk linked to an investment, the DCM applies only to companies that pay dividends and assumes a consistent growth rate for dividends. However, the DCM does not account for investment risk to the same degree as the CAPM, as it omits beta requirements. Consequently, we use CAPM for a more comprehensive evaluation when calculating the cost of equity. In addition, various metrics for evaluating growth options are used in the literature, including the capital expenditure to fixed assets ratio and the growth in capital investment (Anderson & Garcia-Feijóo, 2006; Cao et al., 2006; Trigeorgis & Lambertides, 2014). Building on prior research, for a robustness check, we employ the capital expenditure to fixed assets ratio to assess growth options using firm financial data. The capital expenditure to fixed assets ratio is determined by scaling the annual change in capital expenditure by the total assets in the preceding year. Trigeorgis and Lambertides (2014) contend that capital asset growth, representing capital expenditure divided by fixed assets, offers a more direct approach for capturing growth options.

² We used TQR to measure firms' total value, and our measurement is in line with existing studies.

³ To measure the cost of equity, we use the capital asset pricing model to forecast market risk for investment because the dividend capitalization model only predicts dividend growth for dividend-paying companies and does not address investment risk.

¹ Data sources are listed in Appendix A.

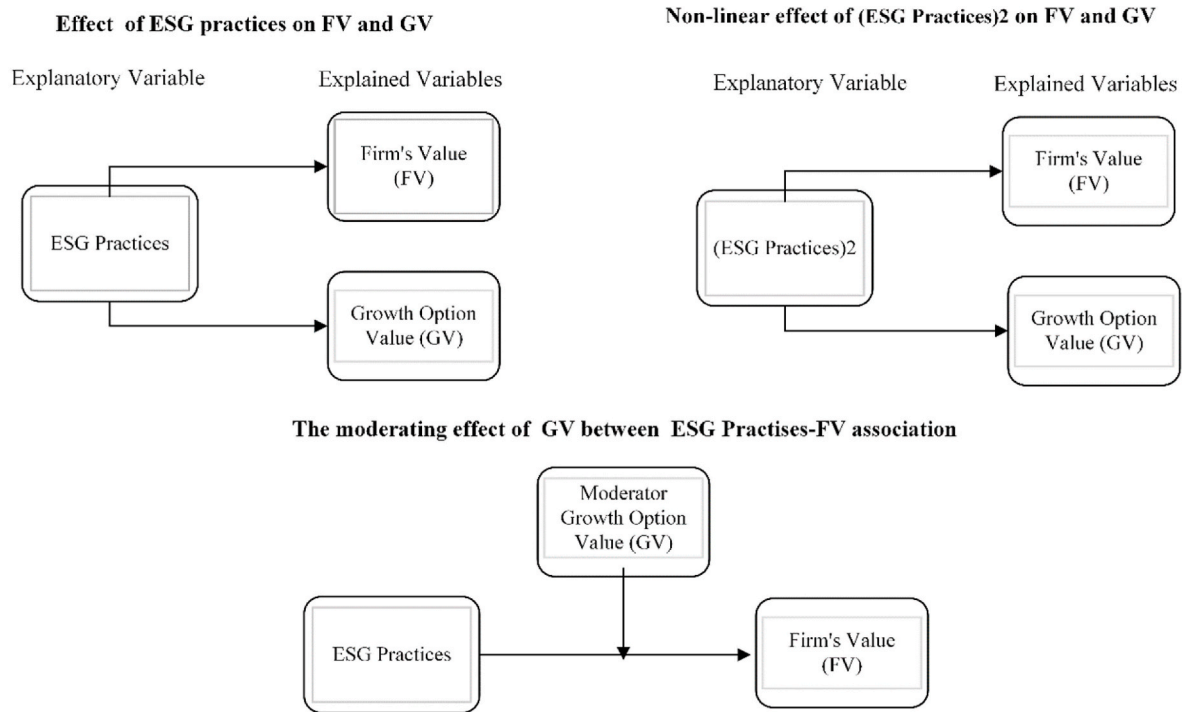


Fig. 1. Conceptual framework.

3.2.3. ESG practices

We use the overall ESG performance of a company by taking the average score of its three key pillars and weighting the components equally. (Fuente et al., 2022; Gillan et al., 2021; Kim et al., 2021).

We use the overall ESG score for US and Chinese firms from Refinitiv Eikon.⁴ Their scores are from 0 to 25, which indicate poor overall ESG performance and poor transparency in the public disclosure of key ESG information. Scores from 26 to 50 indicate a level of performance in the ESG domain that is considered satisfactory in comparison to peers and a moderate level of transparency in the public disclosure of ESG data that is important to the organization. Scores from 51 to 75 indicate a commendable level of ESGP in comparison to peers, as well as a higher-than-average level of transparency in publicly disclosing pertinent ESG data. Scores between 76 and 100 show excellent relative ESGP and strong openness in the public disclosure of relevant ESG data (Aydoğmuş et al., 2022). In addition, we follow earlier research and incorporate a set of control variables into our models, in which the factors at the business level are asset tangibility, operating cash flow, firm size, sales growth, and financial leverage, whereas the elements at the economy-wide level are the gross domestic product (GDP) and inflation. Table 1 Furnishes a detailed overview of all variables, offering a comprehensive presentation of their characteristics and specifications.

3.2.4. Econometrics model specification and empirical strategy

To conduct empirical testing, the study utilized the two-stage dynamic panel generalized method of moments (2 S-GMM), and the general equation (4) is presented below. To assess linear effects and equations (7) and (8) to examine non-linear effects. Additionally, we have formulated equations to evaluate moderating effects, specifically constructed to empirically assess the hypotheses outlined in the study.

$$Y_{i,t} = \alpha_0 + Y_{i,t-2} + \beta_1 X_{i,t} + \beta_2 X_{i,t} + \beta_3 X_{i,t} + \delta_1 X_{i,t} (\text{Controls}) + \dots + \delta_1 X_{i,t} (\text{dummy}) + \varepsilon_{i,t} \quad (4)$$

Direct effect:

$$GV_{i,t} = \alpha_0 + \beta_1 GV_{i,t-2} + \beta_2 ESGP + \delta_1 OCF_{i,t} + \delta_2 SAG_{i,t} + \delta_3 TANG_{i,t} + \delta_4 SIZE_{i,t} + \delta_5 LEV_{i,t} + \delta_6 GDP_t + \delta_7 INF_t + V_1 \text{dum year} + \eta_1 \text{dum industry} + \varepsilon_{i,t} \quad (5)$$

$$TQR_{i,t} = \alpha_0 + \beta_1 TQR_{i,t-2} + \beta_2 ESGP + \delta_1 OCF_{i,t} + \delta_2 SAG_{i,t} + \delta_3 TANG_{i,t} + \delta_4 SIZE_{i,t} + \delta_5 LEV_{i,t} + \delta_6 GDP_t + \delta_7 INF_t + V_1 \text{dum year} + \eta_1 \text{dum industry} + \varepsilon_{i,t} \quad (6)$$

No-linear Effect:

$$GV_{i,t} = \alpha_0 + \beta_1 GV_{i,t-2} + \beta_2 ESGP + \beta_2 (ESGP)_{i,t}^2 + \delta_1 OCF_{i,t} + \delta_2 SAG_{i,t} + \delta_3 TANG_{i,t} + \delta_4 SIZE_{i,t} + \delta_5 LEV_{i,t} + \delta_6 GDP_t + \delta_7 INF_t + V_1 \text{dum year} + \eta_1 \text{dum industry} + \varepsilon_{i,t} \quad (7)$$

$$TQR_{i,t} = \alpha_0 + \beta_1 TQR_{i,t-2} + \beta_2 ESGP + \beta_2 (ESGP)_{i,t}^2 + \delta_1 OCF_{i,t} + \delta_2 SAG_{i,t} + \delta_3 TANG_{i,t} + \delta_4 SIZE_{i,t} + \delta_5 LEV_{i,t} + \delta_6 GDP_t + \delta_7 INF_t + V_1 \text{dum year} + \eta_1 \text{dum industry} + \varepsilon_{i,t} \quad (8)$$

3.2.4.1. Moderating effect

$$TQR_{i,t} = \alpha_0 + \beta_1 TQR_{i,t-2} + \beta_2 ESGP + \beta_2 GV_{i,t} + (\beta_2 ESGP * GV_{i,t}) + \delta_1 OCF_{i,t} + \delta_2 SAG_{i,t} + \delta_3 TANG_{i,t} + \delta_4 SIZE_{i,t} + \delta_5 LEV_{i,t} + \delta_6 GDP_t + \delta_7 INF_t + V_1 \text{dum year} + \eta_1 \text{dum industry} + \varepsilon_{i,t} \quad (9)$$

Where ESGP is the environmental, social, and governance index, $(ESGP)^2$ is the squared term, term firm value is measured by the Tobin's Q ratio, GV is the growth-option value, $ESGP * GV$ is an interaction term, TANG is asset tangibility, OCF is operating cash flow; SIZE is firm size; SAG is sales growth; LEV is financial leverage; GDP is gross domestic product; and INF is inflation; i is a firm; t is the year; ε is an error term.

⁴ ESG scores from Refinitiv, May 2022.

Table 1
Descriptions and measurement of variables.

Variables	Measurement	Data Sources
Firms' Value = Tobin's Q Ratio (TQR)	Equation (1).	CompStat; Eikon, winds, CSMAR
Environmental Social and Governance Index (ESGP)	ESG (score) is an explanatory Variables. Refinitiv Eikon (Asset4, a database of Thomson Reuters). We used the overall environmental, social, and governance performance of a company by taking the average score of its three key pillars and weighting it equally	Refinitiv Eikon
Growth Option Value (GV)	GV is calculated by taking the difference between a company's market capitalization and the value of its assets-in-place attributable to equity and multiplying that number by one hundred.	CompStat, CSMR, and wind database.
Control Variables		
Firm financial fundamentals		
Firm Leverage (LEV)	Debt to equity ratio	Refinitiv Eikon, CSMR, and wind database
Firm size (SIZE)	Natural logarithm of sales	
Cash flow (OCF)	CF=Net Cash flows	
Assets Tangibility (TANG)	TANG = tangible Assets/Total Assets	
Sales Growth (SAG)	SAG = % change in annual sales	
Macroeconomics Fundamentals		
GDP Growth	GDP = gross domestic product	World Bank Database
Inflation	INF = Annual Inflation	
Robustness Check		
GV dummy, alternative measure	Predicted values, alternative estimators, and additional control (capital expenditure to fixed assets ratio to assess growth options using firm financial data)	

Notes: Table 1 includes variable definitions. Firm value is determined by Tobin's Q ratio (TQR)Growth option value, ESG practices (ESGP), tangibility of assets (TANG), operating cash flow (OCF), firm size (SIZE), sales growth (SAG), leverage (LEV), gross domestic product (GDP), and inflation (INF) are all metrics used to assess a firm's value. Building on prior research, for robustness, we add alternative proxy of growth-option (capital expenditure to fixed assets ratio to assess growth options using firm financial data). Data variables are winsorized to remove the lowest and highest one percent of values in case of an outlier.

Table 2
Descriptive statistics.

Panel (A) US firms										
Variable	TQR	GV	ESGP	OCF	SAG	TANG	SIZE	LEV	INF	GDP
Obs	13,245	13,245	13,245	13,245	13,245	13,245	13,245	13,245	13,245	13,245
Mean	2.9011	0.8625	0.4909	0.0987	1.4105	13.5402	9.0801	0.2605	3.1	−0.043
Std. Dev.	1.3072	0.7081	0.3031	0.0812	1.0057	1.0954	7.0947	0.1403	2.511	3.1276
Min	0.6190	0.1053	0.0000	0.0916	0.8303	8.1019	6.1029	0.0000	1.4	2.08
Max	8.2010	9.3401	0.9874	0.4063	7.0109	19.0350	24.3031	0.7107	7.5	5.9
Panel (B) Chinese listed firms										
Obs	12,855	12,855	12,855	12,855	12,855	12,855	12,855	12,855	12,855	12,855
Mean	2.081	0.7903	0.3103	0.0749	1.0189	11.3079	7.0829	0.3208	2.068	−0.043
Std. Dev.	0.5991	1.7011	0.2901	0.0998	0.9431	2.9039	5.2095	0.4037	0.709	0.422
Min	0.1209	0.0113	0.0000	0.6785	0.0681	7.5024	5.0259	0.0000	0.98	5.28
Max	7.803	7.4041	0.9536	0.0393	6.7013	17.7607	17.5034	0.6299	2.9	8.4
Panel (C) Full sample										
Obs	26,100	26,100	26,100	26,100	26,100	26,100	26,100	26,100	26,100	26,100
Mean	2.2303	0.6076	0.5140	0.7659	1.0091	14.0011	6.7299	0.2908	2.584	3.7666
Std. Dev.	0.0573	0.8071	0.3090	0.5195	0.318	3.9058	2.3601	0.2072	1.822	3.3782
Min	1.0312	0.0113	0.0000	0.6785	0.0681	7.5024	5.0259	0.0000	0.98	2.10
Max	8.2010	9.3401	0.9874	0.4063	7.0109	19.0350	24.3031	0.7107	7.5	8.40

Notes: Table 2 Reports summary statics of US, Chinese, and a full sample firm, for the variables outlined in Table 1 of the appendix, ESGP refers to environmental, social, and governance practices, and firms' value is measured by Tobin Q ratio = TQR, growth option value = GV, Assets Tangibility = TANG, Operating cash flow = ; OCF, =Firm Size = SIZE. sales Growth = SAG; financial leverage = LEV; gross domestic product = GDP and inflation = INF respectively for the period of 2018–2022.

The model includes industry and year fixed-effect dummy variables. TQR and firms' GV are lagged dependent variables.

In the first step, we apply fixed effect robust to deal with serial and autocorrelation and heteroskedasticity. In next step, to deal with further statistical challenges we generalized models that consider serial and autocorrelation, heteroskedasticity concerns, and cross-sectional dependence, therefore, we apply a more suitable estimator, that is, FGLS (Shen et al., 2016). In addition, to deal with the endogeneity issue, we employ two-step two-stage generalized method of moments (2 S-GMM) (Arellano & Bond, 1991) in our main assessment. Finally, we perform a robustness check to confirm our results (Driscoll & Kraay, 1998; Fuente et al., 2022; Kong et al., 2022; Shen et al., 2016).⁵

⁵ Alternative estimators fixed-effect and Driscoll-Kraay standard error and two-step Heckman regression estimates and with introducing dummy and additional control to validate our estimations under various econometric estimations.

4. Empirical results

In this section, we present our empirical results. First, we offer descriptive statistics of the empirical variables and preliminary tests such as correlation analysis, VIF, and second-generation panel unit-root tests (Khan et al., 2022). Second, we use a range of regression estimations, namely, baseline linear and nonlinear estimations for fundamental understanding, and FGLS regression to address serial and autocorrelation, heteroskedasticity issues, and cross-sectional dependence issues. Then, we test our hypotheses on the linear and nonlinear effects of ESG practices on firms' GV and its total value and moderating effect of GV in the relationship between ESGP and firm value. Third, following Arellano and Bond (1991), we employ dynamic panel 2 S-GMM to deal with endogeneity concerns, because it automatically constructs instrumental variables to eliminate endogeneity and produces more reliable results. Fourth, we apply Driscoll-Kraay's fixed-effect standard error and other robustness checks, including a test that rules out alternative estimators such as the Heckman estimations, following (Kong et al., 2022; Shen

Table 3
Benchmark regression estimated results.

Variables	Linear effect			Non-linear effect		
	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)
	GV	GV	GV	GV	GV	GV
ESGP	0.0444** (0.0222)	0.0301*** (0.0119)	0.0431*** (0.0136)	0.0303*** (0.0099)	0.0208*** (0.0101)	0.0308** (0.0154)
(ESGP) ²				−0.0301*** (0.0119)	−0.039*** (0.0111)	−0.0326*** (0.0125)
OCF	0.0031 (0.0021)	0.0041 (0.0055)	0.0022*** (0.0009)	0.0109 (0.0348)	0.0601** (0.0301)	0.0005*** (0.0000)
SAG	0.0352*** (0.0302)	0.0019*** (0.0005)	0.0902*** (0.0154)	0.0170*** (0.0004)	0.0025 (0.0017)	0.0205 (0.0200)
TANG	−0.0931 (0.0647)	−0.0129 (0.0125)	−0.0559*** (0.0019)	−0.123*** (0.0027)	−0.0181 (0.0103)	−0.0029* (0.0016)
SIZE	0.0037*** (0.0007)	0.0132*** (0.0001)	0.0056*** (0.0015)	0.0301*** (0.0076)	0.0597*** (0.0107)	0.0092*** (0.0017)
LEV	−0.0040*** (0.0006)	−0.0304** (0.0152)	−0.0115*** (0.0031)	−0.0213*** (0.0001)	−0.0130*** (0.0080)	−0.0065*** (0.0023)
INF	−0.0415 (0.0305)	−0.0204*** (0.0001)	−0.0021*** (0.0004)	−0.0403*** (0.0006)	−0.0602*** (0.0019)	−0.0481*** (0.0048)
GDP	0.0326 (0.0580)	0.0822** (0.0411)	0.0222** (0.0111)	0.0319 (0.0303)	0.1033*** (0.0119)	0.4106*** (0.0348)
CONS_	3.4007*** (0.0599)	−3.0712*** (0.0014)	4.6504*** (0.0129)	7.0303*** (1.3037)	0.3094 (1.3076)	1.1107*** (0.9044)
No. of obs.	13,245	12,855	26,100	13,245	12,855	26,100
adj. R ²	0.2814	0.3021	0.2231	0.2309	0.2013	0.2601
IM test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
F-statistic	34.32***	45.39***	29.39***	23.41***	79.07***	62.12***

Notes. Table (3) contains a benchmark regression estimate using the variables specified in [Appendix A Table 1](#). GV denotes the growth option value. Columns (1–3) show the baseline linear models for US enterprises, Chinese firms, and the entire sample (overall panel). Columns (4–6) present baseline linear models with Quadratic terms for US enterprises, Chinese firms, and the entire sample (overall panel). The asterisks represent the degrees of significance ***—0.01, **—0.05, and *—0.10, respectively.

[et al., 2020](#)).

4.1. Summary statistics

[Table 2](#) summarizes the descriptive statistics of our sample (2018–2022). We include three primary and seven control variables for our analysis. TQR, which is an important metric for assessing firm value, has a mean of 2.9011 for US firms and 2.081 for Chinese firms. These values are relatively low compared to all US firms. The overall mean value of TQR for the full sample is 2.2303. The range of TQR values is higher for US enterprises than Chinese firms. Furthermore, the average GV for US firms is 0.8625, which is higher than that of Chinese companies, a trend repeated in the US having the highest and lowest GV. On average, US companies tend to derive greater value (TQR and GV) than Chinese companies. The mean value of ESGP measured by the overall ESG index is 0.4909 for US firms and 0.3103 for Chinese firms. The maximum value of ESGP measured with the overall ESG index is 0.9874 for US firms and 0.9536 for Chinese firms. The mean, standard deviation, minimum, and maximum values of seven control variables are also presented.

4.2. Correlation matrix and VIF

[Appendix Table A1](#) Presents the Pearson correlation matrix to test the correlation among the explanatory variables. The initial approach concerns pairwise correlation, in which each explanatory variable is individually correlated to another. As indicated in the pairwise correlation coefficients fall within an acceptable range in our all specifications. In [Appendix Table A2](#), the VIF of the independent variables have average values below 2, and the reciprocal of the VIF is below the threshold value of 1. Collectively, this shows the absence of multicollinearity in all panels, whether the US, Chinese, or full panel firms. In

addition, the panel unit-root framework is used to assess the stationarity in regression analysis. [Appendix Table A3](#) provides the detail of the Levin-Lin-Chu test, a first-generation unit-root test designed for symmetrical panel data, operates under the assumption of cross-sectional independence, and the obtained results are presented in table. In addressing the issue of cross-sectional dependence, the second-generation PCIPS test provides unit-root results for both US and Chinese firms, as well as the entire sample. Our findings indicate that the variables exhibit significance and stationarity at the level (integrated of order 0).

4.3. Benchmark regression estimated results

Columns (1)–(3) in [Table 3](#) list the findings of the baseline linear models for firms in the US, China, and the full sample. The findings indicate a positive relationship between ESGP and GV. The coefficient is 0.0444 for US firms and 0.0301 for Chinese firms. The baseline linear models indicate a positive and statistically significant relationship between ESGP and GV for the full sample. This means that an increase of 1 percent in ESG practices leads to an increase in the GV of firms by 0.0444 percent for US firms, 0.0301 percent for Chinese firms, and 0.0431 for the full sample, therefore, ESGP enhances the value of a firm's growth option portfolio. Columns (4)–(6) use baseline linear models with quadratic terms for, respectively, US enterprises, Chinese firms, and the full sample. The (ESGP)² coefficient for US firms, Chinese firms, and the full sample are −0.0301, −0.0389, and −0.0326 (negative and significant), respectively. The initial figures show that (ESGP)² has a negative connection with firms' GV only up to a point and then starts to decrease. However, the magnitude varies across the sample. For the sake of brevity, we omit the results on the control variables. The significance of the *F*-statistics suggests that our fixed-effect models are adequately specified, and the OLS estimates provide a basic understanding but

Table 4
Estimated Feasible generalized least squares (FGLS) Results.

FGLS models	Linear effect			Non-linear effect		
	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	GV	GV	GV	GV	GV	GV
ESGP	0.0495*** (0.0159)	0.0351*** (0.0112)	0.0413*** (0.0187)	0.0401*** (0.0101)	0.0374*** (0.0126)	0.0342*** (0.0123)
(ESGP) ²				−0.0415*** (0.0135)	−0.0425*** (0.0144)	−0.0351*** (0.0114)
OCF	0.0109*** (0.0030)	0.0006*** (0.0001)	0.0820*** (0.0042)	0.0055*** (0.0021)	0.0023*** (0.0007)	0.0623*** (0.0219)
SAG	0.0305 (0.0224)	0.00321*** (0.0203)	0.0226** (0.0113)	0.0301*** (0.0120)	0.0091*** (0.0003)	0.0009 (0.0209)
TANG	−0.0191*** (0.0033)	−0.00259*** (0.0044)	−0.0305*** (0.0005)	−0.0182*** (0.0064)	−0.0301*** (0.0104)	−0.0501*** (0.0117)
SIZE	0.0034*** (0.0019)	0.0064** (0.0032)	0.0049*** (0.0024)	0.0045*** (0.0015)	0.0066*** (0.00031)	0.0176*** (0.0004)
LEV	−0.0640** (0.0320)	−0.0574*** (0.0029)	−0.0507 (0.0323)	−0.0427*** (0.0024)	−0.0773*** (0.00301)	−0.0073*** (0.0033)
INF	−0.0529*** (0.0040)	−0.0536*** (0.0046)	−0.0503*** (0.0021)	−0.0504*** (0.0042)	−0.0301*** (0.0066)	−0.0371*** (0.0066)
GDP	0.0146*** (0.0007)	0.0062** (0.0031)	0.0290*** (0.0098)	0.0311*** (0.0070)	0.0361*** (0.0128)	0.0222** (0.0111)
CONS_	−5.0205*** (0.0922)	5.0171*** (0.0721)	2.0072*** (0.0128)	−0.0067*** (0.0029)	4.00891*** (0.0965)	1.0091* (0.0155)
Industry/year fixed.	Yes	Yes	Yes	Yes		Yes
No. of obs.	13,245	12,855	26,100	13,245	12,855	26,100
Hausman test	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$
Wooldridge test	F = 53.07***	F = 33.93***	F = 93.07***	F = 89.01***	F = 56.27***	F = 73.97***
Breusch–Pagan	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
F-statistic	51.04***	54.09***	79.92***	74.02***	94.07***	74.09***
Wald test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Table (4) Dependent variable GV = growth option value. We give the FGLS models without the quadric term in columns (1) through (3). We also present the FGLS models in columns 5 and 6, including the quadric terms (ESGP)² for US, and Chinese firms, and the complete sample (overall-panel). Standard error (.) * Significant at *p.1, ** Significant at *p.05, and *** Significant at *p.01.

suffer from unobserved heterogeneity issues.

4.4. FGLS regression estimated results

After fulfilling all conditions, we conduct panel unit-root tests in Appendix Table A2.⁶ Then we perform the Breusch and Pagan LM test for RE or OLS tests for panel data estimation to select the proper model. Our LM and IM tests show that our models suffer from heteroskedasticity. Thus, we ruled out OLS estimation and conducted panel data estimation. The Hausman (1978) test determines the choice between a fixed- or random-effects model, and, after estimation, it confirms that our fixed-effects model is suitable. We used fixed effects with a robust option to deal with serial and autocorrelation and with heteroskedasticity in the fixed effects (Shen et al., 2016). Our models have serial and autocorrelation and heteroskedasticity problems as shown by the fact that the modified Wald and Wooldridge tests are statistically significant. To deal with two statistical challenges first, we employ Fixed effects with a robust function as it accounts for serial and autocorrelation or heteroskedasticity. Second, we employ generalized models as they consider serial and autocorrelation, heteroskedasticity concerns, and cross-sectional dependence and a better estimator, FGLS.

⁶ The panel unit-root framework checks stationarity in regression analysis. The Levin-Lin-Chu test, a first-generation unit-root test for symmetrical panel data, assumes that cross sections are independent, and the results are in the table. The second-generation PCIPS test addresses the problem of cross-sectional independence allowing for cross-sectional reliance unit-root results on US and Chinese firms and the full sample. We find that the variables are significant and stationary at level (integrated of order 0).

We report the FGLS models in Table 4 without the quadric term in columns (1)–(3) and including the squared terms for ESGP for US and Chinese firms with the full sample in columns (5) and (6). The FGLS findings also indicate that firms' GV is positive and significantly influenced by ESGP. Specifically, an increase of 1 percent in ESGP raises the TQR of firms by 0.0495 percent for US firms, 0.0351 percent for Chinese firms, and 0.0413 for overall sample.

In Table 5, we report the findings of the linear effect of ESGP on TQR. The FGLS results indicate that ESGP has a positive and significant effect on TQR. Next, we test the moderating effect of GV on the relationship between ESGP and FV. The FGLS results in columns (4)–(6) suggest that GV negatively moderates the association between ESGP and TQR in all cases. The moderating effect of GV is more negative for Chinese firms than US firms. In the next step, we demonstrate the nonlinear effect of (ESGP)² on TQR, and the results imply that the coefficient of the squared term for the US, Chinese, and full sample firms are, respectively, −0.0394, −0.0471, and −0.0372 (negative and significant), signifying that as ESGP initially increase its effect on TQR but this effect is flips from positive to negative and is more pronounced at Chinese firms than US firms.

4.5. Dynamic panel two-stage generalized method of moments: endogeneity issues

We used a dynamic panel 2 S-GMM estimation model to address endogeneity. This method is a robust approach that employs lagged values as instruments in both levels and differences to address endogeneity and potential reverse causality in dynamic panel data models. It leverages the orthogonality conditions in the GMM framework to ensure the validity of the instruments used (Cui et al., 2023; Windmeijer, 2005).

Table 5

Estimated Feasible generalized least squares (FGLS) Results (Moderating effect & including a quadratic term).

FGLS models	Direct Effect			Moderating effect			Non-linear effect		
	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(4)	(5)	(6)
Variables	TQR	TQR	TQR	TQR	TQR	TQR	TQR	TQR	TQR
ESGP	0.0601*** (0.0199)	0.0411*** (0.0133)	0.0549*** (0.0207)	0.0737*** (0.0345)	0.0408** (0.0204)	0.0581*** (0.0196)	0.0449** (0.0259)	0.0399** (0.0250)	0.0336** (0.0168)
(ESGP) ²							−0.0394*** (0.0216)	−0.0421*** (0.0191)	−0.0372** (0.0186)
GV	−0.0594*** (0.0116)	−0.0728*** (0.0198)	−0.0471*** (0.0144)	−0.0104*** (0.0069)	−0.0309*** (0.130)	−0.0211*** (0.0078)			
(ESGP *GV)				−0.0118*** (0.0059)	−0.0182** (0.0091)	−0.0106*** (0.0031)			
OCF	0.0141 (0.0111)	0.0040** (0.0020)	0.0094 (0.0077)	0.0201*** (0.0002)	2.0080*** (0.0040)	0.0104** (0.0052)	0.0111*** (0.0012)	1.0080*** (0.0940)	0.0101 (0.0131)
SAG	0.0018** (0.0009)	0.0406*** (0.0103)	0.0050** (0.0025)	0.0004*** (0.0001)	0.0303*** (0.0029)	0.0303*** (0.0103)	0.0014** (0.0007)	0.0103*** (0.0033)	0.0198** (0.0099)
TANG	−0.0020** (0.0010)	−0.2017*** (0.0071)	−0.0038** (0.0019)	−0.0307*** (0.0105)	−0.0101*** (0.0011)	−0.0207*** (0.0072)	−0.0107*** (0.0045)	−0.0301*** (0.0111)	−0.0022** (0.0011)
SIZE	0.0014*** (0.0002)	0.0010*** (0.0003)	0.1100*** (0.0032)	0.0114*** (0.061)	0.0008** (0.0004)	0.0208*** (0.0053)	0.0104*** (0.0071)	0.0018** (0.0009)	0.0011 (0.0032)
LEV	−0.0606*** (0.0107)	−0.0226** (0.0113)	−0.0056*** (0.0004)	−0.0504*** (0.0104)	−0.0040** (0.0020)	−0.0224*** (0.0112)	−0.0504*** (0.0100)	−2.0340** (0.0320)	−0.0106*** (0.007)
INF	−0.0204** (0.0102)	−0.0203*** (0.0104)	−0.0268** (0.0134)	−0.0104*** (0.0069)	−0.0409*** (0.0200)	−0.0201*** (0.0058)	−0.0100*** (0.0029)	−0.0009*** (0.0000)	−0.0004** (0.0002)
GDP	0.0096*** (0.0012)	0.0218** (0.0109)	0.0517*** (0.0039)	0.0007*** (0.0000)	0.0226** (0.0123)	0.0103*** (0.0009)	0.0117*** (0.0010)	0.0205** (0.0102)	0.0204*** (0.0019)
CONS_	7.0707*** (0.0041)	5.0011*** (1.0309)	0.0031*** (0.0006)	9.0009*** (4.0031)	5.0083*** (3.0041)	11.0002*** (0.0929)	3.0109*** (0.0491)	7.0084*** (3.0091)	1.0092*** (0.0029)
Year & Industry	Yes	Yes	Yes	Yes		Yes	Yes		Yes
No. of obs.	13,245	12,855	26,100	13,245	12,855	26,100	13,245	12,855	26,100
R-squared	0.231	0.131	0.247	0.105	0.219	0.108	0.119	0.193	0.221
Hausman Test	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$	$\chi^2 = 0.0000$
Wooldridge test	F = 73.75***	F = 53.07***	F = 109.09***	F = 89.41***	F = 76.59***	F = 103.07***	F = 89.41***	F66.52***	F = 119.09***
Breusch–Pagan	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
F-statistic	91.09***	84.81***	69.01***	70.89***	69.97***	104.95***	51.84***	39.93***	114.05***
Wald test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Table (5) shows the FGLS estimates. The dependent variable TQR, which stands for Tobin's Q ratio, is a measure of the firm's total market value. The impact of ESG practices (ESG INVS) on the TQR Effects that are linear, moderating (ESG INVS*GV), as well as non-linear (ESG P)² that include the quadratic term. Errors in robustness are enclosed in parentheses; *** denotes a significance level of p 0.01, **p 0.05, and p 0.1.

In Table 6 we report the GMM results in columns (1)–(3) after controlling for endogeneity, showing a positive and significant effect of ESGP across GV, based on the coefficient values of 0.0541, 0.0338, and 0.0338, respectively. Our expanded method of moments models shows that ESGP has a larger effect on US firms than Chinese firms. Specifically, a 1 percent increase in ESG practices boosts the value of growth options by 0.0541 percent for US companies, 0.0301 percent for Chinese businesses, and 0.0338 percent for all companies. Next, we introduce the quadratic term in the dynamic GMM models, and the results indicate that a nonlinear association of (ESGP) with firms' GV, and our results are in line with (Fuente et al., 2022).

Table 7 presents GMM estimates, encompassing the direct effect of ESGP on GV, the moderating effect of GV, and the nonlinear effect of (ESGP)² on TQR. Our main analytical models, FGLS and dynamic panel two-stage GMM, consistently maintain their reliability. This holds true even after addressing challenges like cross-sectional dependence, endogeneity, and incorporating controls for various firms and macro-economic variables. The AR (1) p-value, AR (2), and Sargan and Hansen test override are negligible, indicating that GMM is adequately stated. The test confirms not only the functionality but also the instruments used in GGM estimations. The fact that the p-value is small lends credence to the null hypothesis, which is that the instruments are reliable.

4.6. Robustness check and methodological strength

Table 8 gives the robustness check estimate using alternative estimators. Static models may have autocorrelation, cross-sectional dependence, and serial correlation (Driscoll & Kraay, 1998). To address these concerns, we use the Driscoll-Kraay model (Sun & Govind, 2022).⁷ The study findings are consistent across all estimations, and the models are well specified, as the F-statistics obtained are significant.⁸

Because the Driscoll-Kraay test and robust OLS estimations potentially bias the sample selection, we use Heckman's two-step estimation to support our findings (Shen et al., 2016), starting with the probit model (Kong et al., 2022). Table 9 shows that the results remain consistent, even after correcting for endogeneity. As an additional regressor, we use the inverse Mills ratio to mitigate the issue of self-selection bias in the study sample. The null hypothesis of no joint significance of the research variables is rejected by the Wald's test at the significance levels of 1%, 5%, and 10%. Heckman's two-step estimation also supports this rejection.

⁷ Heteroskedasticity, also known as cross-sectional or "spatial" dependence, is a real issue, thus we use the Driscoll and Kraay method to account for it (Driscoll & Kraay, 1998).

⁸ Most of the results are significant at 1%, 5%, and 10%, but some control variables lose their significance.

Table 6

Dynamic panel two-stage generalized method of moments (GMM) Estimated Results.

GMM estimate	With ESGP			Including (ESGP) ²		
	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	GV	GV	GV	GV	GV	GV
L2. GV	0.0307*** (0.0103)	0.0026*** (0.0018)	0.0149*** (0.0063)	0.0181*** (0.0012)	0.0062*** (0.0028)	0.0030** (0.0015)
ESGP	0.0541*** (0.0118)	0.0338*** (0.0109)	0.0254** (0.0127)	0.0459** (0.0225)	0.0365*** (0.0132)	0.00307*** (0.0110)
(ESGP) ²				−0.0227*** (0.0106)	−0.0314** (0.0157)	−0.0319*** (0.0116)
OCF	0.0041 (0.0025)	−0.0010 (0.0011)	0.0020*** (0.0002)	0.0041*** (0.0011)	0.0022** (0.0011)	0.0030** (0.015)
SAG	0.0103*** (0.0008)	0.0050** (0.0025)	0.0206** (0.0103)	0.0101*** (0.0001)	0.0002*** (0.0002)	0.0228** (0.0114)
TANG	−0.0401** (0.0040)	−0.0204** (0.0102)	−0.0005*** (0.0000)	−0.0011*** (0.0004)	−0.0006*** (0.0002)	−0.0418** (0.0209)
SIZE	0.0004*** (0.0000)	0.0940*** (0.0345)	0.0009*** (0.0004)	0.0204*** (0.0020)	−0.0100*** (0.0007)	−0.0238** (0.0119)
LEV	−0.0906*** (0.0139)	−0.0174 (0.0118)	−0.0610** (0.0305)	−0.0004** (0.0002)	−0.0014*** (0.0001)	−0.0003*** (0.0001)
INF	−0.0302*** (0.0138)	−0.0504*** (0.0117)	−0.0070*** (0.0009)	−0.0002*** (0.0000)	−0.0304** (0.0152)	−0.0108*** (0.0033)
GDP	0.0409*** (0.0203)	0.0026*** (0.0018)	0.0169*** (0.0073)	0.0281*** (0.0112)	0.0152*** (0.0008)	0.0131*** (0.0013)
CONS_	−1.0302*** (0.0138)	−5.0504*** (0.0927)	7.0270*** (0.0929)	−11.002*** (0.0608)	−4.0074*** (0.0805)	−4.0008*** (0.0333)
Industry/year fixed.	Yes	Yes	Yes	Yes	Yes	Yes
No. of IDs.	2649	2571	5220	2649	2571	5220
Wu Hausman test	20.3051***	38.3148***	29.3000***	32.3014***	9.3001***	18.9059***
AR (1)	0.000	0.000	0.000	0.000	0.000	0.000
AR (2)	0.201	0.144	0.321	0.151	0.203	0.151
Sargan test of overdid (p-value)	0.170	0.071	0.090	0.053	0.061	0.104
Hansen test p-value	0.164	0.231	0.344	0.252	0.311	0.104

Notes. Table (6) shows dynamic panel two Steps generalized method of moments (GMM) estimated results estimation for US, Chinese, and full sample firms using “year” and “id” variables. The explained variable is GV denotes the growth option value. In each model, “L2.” represents a two-step GMM model lagged value. The first model tests the direct influence of ESGP on GV for US enterprises, Chinese firms, and the entire sample. We examined the effect of (ESGP)² on GV. Standard errors in parentheses are robust. This table also shows stability tests among estimate methodologies. The first and second rows of each variable give coefficients and standard errors an asterisk (***) denotes $p < 0.01$; two (**) indicate $p < 0.05$; and one (*) indicates $p < 0.10$.

4.7. Discussion

This article explores the following the nonlinear impact of ESGP on GV for US and Chinese listed firms and the nonlinear effect of ESGP on FV for listed firms in these two economies, addressing the lack of cross-country evidence in previous studies (Adegbite et al., 2019; Elsayed & Paton, 2005; Fuente et al., 2022; Qiu et al., 2016). It contributes to the literature by incorporating GV into the same analytical framework as a moderating factor between ESGP and FV. In summary, our empirical examination of US and Chinese listed firms reveals a significant nonlinear relationship between ESGP and both FV and GV, but this effect shifts from being positively linear to nonlinear, with a negatively significant coefficient.

Several factors contribute to these outcomes. The strategic insurance-like nature of ESGP introduces two opposing dynamics that might drive GV. The development of social capital and trust, as shown by (Shiu & Yang, 2017), may encourage firm-specific investment by shareholders, favoring GV. However, the increase in moral capital due to ESGP and the consequent reduction in business risk might have a negative impact on GV, leading to a likely decline. This negative effect is analogous to the impact of risk reduction in the underlying asset of a call option on its value (Kester, 1984). Variations across firms are influenced by stakeholder demands, institutional pressure, and resource disparity. Stakeholder theory, which holds at Chinese companies, emphasizes heightened negative repercussions (Aksom & Tymchenko, 2020; Khan et al., 2016). Institutional pressure, in accordance with evolving norms,

contributes to nonlinear effects in ESG adoption, with stronger regulatory pressure in China as compared to US, resulting in a more significant negative impact in case of China (Boulhaga et al., 2023; He et al., 2023; Rahi et al., 2021). Differences in firms’ ESG-related resources could lead to nonlinear impacts on FV, and unequal resource availability contributes to more pronounced negative effects at Chinese firms than US firms.

Our findings indicate that firms are rewarded for efforts to improve ESG factors, which leads them to embrace the stakeholder approach. ESG can raise a company’s value in different ways. For instance, if people have more confidence in a firm’s policies, they may be more willing to provide financial support if it engages in more ESG activities (Zhang & Zi, 2021). Furthermore, engaging in ESG activities not only boosts brand awareness but also enhances the brand image. As a result, the firm gains a competitive advantage, which ultimately boosts sales and company value (Fuente et al., 2022; Tahmid et al., 2022). In addition, our findings suggest that the relationship between ESGP and the firm’s GV and FV is nonlinear based on an examination of the significant and negative terms. The impact of ESGP on the GV of US and Chinese firms varies in terms of magnitude but has the same direction albeit more pronounced in the case of Chinese firms. This study presents empirical evidence of negative nonlinear relationship between a firm’s ESGP and its value in all panel specifications. These investments are vital for effectively managing a firm’s governance objectives. Nevertheless, the positive impact of ESG performance on firm value reverses when it exceeds a certain threshold. This reversal occurs due to the risk-mitigating influence of ESG performance (Galbreath, 2011). ESG

Table 7

Main regression dynamic panel two steps GMM estimated results.

Variables	Direct effect			Moderating effect			Including (ESGP) ²		
	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TQR	TQR	TQR	TQR	TQR	TQR	TQR	TQR	TQR
L2.TQR	0.0102*** (0.0017)	0.0104*** (0.0002)	0.0401*** (0.0118)	0.0286*** (0.0110)	0.0119*** (0.0043)	0.0241*** (0.0102)	0.0064*** (0.0010)	0.0023*** (0.0010)	0.0241*** (0.0102)
ESGP	0.0497*** (0.0105)	0.0404*** (0.0194)	0.0511*** (0.0128)	0.0419*** (0.0145)	0.0326*** (0.0117)	0.0441** (0.0225)	0.0439*** (0.0025)	0.0329*** (0.0017)	0.0551** (0.0225)
(ESGP) ²							−0.0334** (0.0117)	−0.0349*** (0.0121)	−0.0363*** (0.0131)
GV	−0.0302** (0.0151)	−0.0424*** (0.0157)	−0.0410** (0.0205)	−0.0208*** (0.0101)	−0.0321*** (0.0107)	−0.0310** (0.0205)			
(ESGP*GV)				−0.0124** (0.0012)	−0.0249*** (0.0110)	−0.0238** (0.0119)			
OCF	0.0291*** (0.0025)	0.0408*** (0.0201)	0.0105*** (0.0029)	0.0237*** (0.0035)	0.0530*** (0.0089)	0.0609*** (0.0365)	1.0206*** (0.0901)	0.0600*** (0.0027)	0.0406*** (0.0095)
SAG	0.0601** (0.0112)	0.0015*** (0.0006)	0.0038** (0.0019)	0.0012*** (0.0004)	0.0140*** (0.0031)	0.0062*** (0.0009)	0.0031 (0.0019)	0.0010*** (0.0006)	0.0032 (0.0023)
TANG	−0.0224** (0.0112)	−0.0300*** (0.0009)	−0.0102** (0.0510)	−0.0098*** (0.0019)	−0.0306*** (0.0101)	−0.0003*** (0.0000)	−0.0345*** (0.0045)	−0.0403*** (0.0121)	−0.0183*** (0.0041)
SIZE	0.0154*** (0.0041)	−0.0202** (0.0101)	−0.0008** (0.0004)	0.0079*** (0.0004)	0.0052 (0.0033)	0.0144** (0.0078)	0.0006*** (0.0001)	0.0100*** (0.0036)	0.0309** (0.0043)
LEV	−0.0120*** (0.0097)	−0.0061*** (0.0009)	−0.0100*** (0.0011)	−0.0254** (0.0127)	−0.0209 (0.0109)	−0.0509*** (0.0174)	−0.0105*** (0.0007)	−0.0208*** (0.0092)	−0.0601*** (0.0009)
INF	−0.0404** (0.0202)	−0.0501*** (0.0101)	−0.0028*** (0.0012)	−0.00113*** (0.0038)	0.0095*** (0.0023)	0.0301*** (0.0097)	−0.0036*** (0.0018)	0.0104*** (0.0034)	0.0800*** (0.0123)
GDP	0.0111*** (0.0057)	0.0107*** (0.0092)	0.0201*** (0.0006)	0.0074*** (0.0010)	0.0043*** (0.0015)	0.0201*** (0.0103)	0.0369*** (0.0110)	0.0303*** (0.0109)	0.0001*** (0.0000)
CONS_	1.0608*** (0.0304)	0.0727*** (0.0094)	1.0647*** (0.0803)	−0.0109*** (0.0024)	−0.0282*** (0.0045)	0.0095*** (0.0481)	−1.0054*** (0.0322)	−0.0222*** (0.0045)	5.0505*** (0.0401)
Year/Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of IDs.	2649	2571	5220	2649	2571	5220	2649	2571	5220
AR (1)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (2)	0.130	0.503	0.271	0.151	0.611	0.170	0.531	0.531	0.181
Sargan test (P-value)	0.100	0.090	0.050	0.063	0.060	0.102	0.050	0.071	0.090
Hansen test P-value	0.261	0.151	0.481	0.251	0.101	0.103	0.171	0.102	0.113

Notes: Table (7) reports GMM models estimated Results estimation for US, Chinese, and complete sample firms. The explained variable is TQR denotes the firm value. In each model, “L2.” represents a two-step GMM model lagged value. First, we analyze the impact of ESG practices on TQR. Second, we examine whether GV (ESGP*GV) acts as a moderator between ESG practices and TQR. The next variable we analyze is how the square root term (ESGP)² influences TQR. Asterisks (***) $p < 0.01$; two (**), $p < 0.05$; and (*) $p < 0.10$.

practices strive to meet the needs of existing stakeholders without jeopardizing the ability to generate value for future stakeholders, as indicated by (Galbreath, 2011). On the contrary, GO typically involve the inclusion of new stakeholders, as suggested by (Snoeren, 2015), potentially leading to a division of benefits at the cost of current stakeholders (Fuente et al., 2022).

Hence, a firm's ESGP can affect its value in different ways. For example, firms with more robust ESGP can enhance their reputation and brand value, which can attract more customers, investors, and talent (Koller et al., 2019); harm their reputation, profitability, and valuation (Aouadi & Marsat, 2018); foster innovation and efficiency, which can improve their productivity, competitiveness, and profitability (Koller et al., 2019); and improve their relationship with various stakeholders, such as employees, customers, suppliers, regulators, and communities, which can enhance their trust, loyalty, and cooperation (Koller et al., 2019). However, the impact of ESG performance on firm value may also depend on other factors, such as the materiality of ESG issues in the firm's and the COVID-19 pandemic, which affected ESG performance amid financial crises (Broadstock et al., 2021). Therefore, the effect of ESGP on firm value may vary across different firms and contexts (Cohen, 2023). In summary, this study lays a foundation for future research through expanding the analysis to include additional countries, thus contributing to a more comprehensive understanding of the global implications of corporate ESGP. This study calls for further research, as the variations observed across firms could be shaped by factors such as

institutional norms, cultural contexts, regulatory environments, stakeholder demands, institutional pressures, and resource disparity.

5. Conclusion

This study examines the nonlinear effect of ESG practices (ESGP), firm value (FV), and growth-option value (GV), with a specific focus on the moderating role of growth-option value in the real-option framework. Using a sample comprising 5220 listed firms in the United States and China from 2018 to 2022, we employ FGLS, and dynamic two-stage system generalized method of moments approaches. Our empirical findings reveal a positive and significant yet nonlinear impact of ESGP on both FV and GV. The higher-order term (ESGP)² shifts the trajectory of firm value from positive to negative, demonstrating variability across the sample, with a more pronounced effect at Chinese firms than their US counterparts. Significantly, GV emerged as a negative moderator in the relationship between ESGP and FV, with a greater impact on Chinese firms. These results contribute complex insights on the nonlinear nexus between ESGP, GV, and FV, shedding light on the moderating effect of GV on the ESGP and FV relationship.

The study results remain robust to potential endogeneity concerns and have important policy implications. First, policy makers should consider the nonlinear nature of ESGP impacts, encouraging the adoption of nuanced and sustainable strategies. ESGP boosts social capital and stakeholder trust, encouraging firm-specific investment for

Table 8

Robustness check with alternative estimators.

Variables	Direct effect			Moderating effect			Including (ESGP) ²		
	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TQR	TQR	TQR	TQR	TQR	TQR	GV	GV	GV
ESGP	0.0517*** (0.0118)	0.0407*** (0.0201)	0.0356* (0.2113)	0.0621*** (0.0215)	0.0314*** (0.0316)	−0.0534*** (0.0103)	0.0349*** (0.0108)	0.0219*** (0.0098)	0.0309*** (0.0113)
(ESGP) ²							−0.0507*** (0.0161)	−0.0707** (0.0181)	−0.0305** (0.0040)
GV	−0.0594*** (0.0116)	−0.0623*** (0.0198)	−0.0471* (0.0279)	−0.0491*** (0.0212)	−0.0531*** (0.0144)	−0.0460*** (0.0223)			
(ESGP*GV)				−0.0118*** (0.0015)	−0.0141*** (0.0019)	−0.0056* (0.0033)			
OCF	0.0005 (0.0012)	0.0367*** (0.0127)	0.0439*** (0.0017)	0.0501*** (0.0112)	0.0025*** (0.0001)	0.0124*** (0.0102)	2.0501*** (0.0112)	0.0888** (0.0444)	0.0460** (0.0230)
SAG	0.0053*** (0.014)	0.0342*** (0.0122)	0.0101*** (0.0103)	0.0501*** (0.0101)	0.0403*** (0.0124)	0.0362*** (0.0152)	0.0501*** (0.0101)	0.0903*** (0.0129)	0.0693*** (0.0333)
TANG	−1.0332*** (0.0101)	−0.0006*** (0.0001)	−0.0401*** (0.0063)	−0.0301*** (0.0105)	0.0603*** (0.0025)	−0.0706*** (0.0152)	−1.0301*** (0.0105)	−0.0917*** (0.0104)	−0.0207 (0.0172)
SIZE	0.0124*** (0.0102)	0.0170 (0.0111)	0.0102*** (0.0000)	0.0114*** (0.011)	0.0106*** (0.0343)	0.0101*** (0.0209)	0.0114 (0.0111)	0.0523*** (0.0116)	0.0019*** (0.0003)
LEV	−0.0203*** (0.0101)	−0.0104*** (0.0033)	−0.3507*** (0.0033)	−0.1301*** (0.0204)	−0.0820*** (0.0091)	−0.0170*** (0.0133)	−0.1301*** (0.0204)	−0.0391*** (0.0108)	−0.0236** (0.0168)
INF	−0.0139*** (0.0110)	−0.0781*** (0.0114)	−0.0529*** (0.0099)	−0.0577*** (0.0106)	−0.0328** (0.0115)	−0.0513*** (0.0102)	−0.0577*** (0.0106)	−0.0301** (0.0115)	−0.0643*** (0.0308)
GDP	0.0009*** (0.0003)	0.0333*** (0.0111)	0.0106*** (0.0343)	0.0307*** (0.0055)	0.0302*** (0.0107)	0.0329*** (0.0113)	0.0307*** (0.0055)	0.0424** (0.0103)	0.0233*** (0.0018)
CONS_	7.0363*** (0.3137)	9.0094*** (0.6056)	11.0047*** (0.8047)	2.0409*** (1.1105)	0.0494** (0.0247)	3.0097** (0.0155)	19.0400*** (1.0180)	10.0024** (5.0012)	12.1000*** (0.5000)
No. of obs.	13,245	12,855	26,100	13,245	12,855	26,100	13,245	12,855	26,100
adj. R ²	0.221	0.259	0.279	0.185	0.192	0.234	0.091	0.116	0.153
F-statistic	35.01***	45.01***	65.19***	37.98***	68.27***	72.11***	42.06***	51.25***	74.17***

Notes: Table 8 presents the results of the robustness check using alternative estimators. We apply the fixed effect Driscoll-Kraay method with standard error for firms in the United States, China, and the complete sample. The dependent variable TQR represents the firm value. First, we analyze the impact of ESG practices on firm value (TQR). This study investigates the potential moderating role of GV (ESGP*GV) in the relationship between ESG practices and TQR. Next, we examine the impact of the square root term (ESGP)² on TQR. Building on prior research, for robustness check we employ capital expenditure to fixed assets ratio to assess growth options using firm financial data as an alternative proxy of GV. The use of asterisks to indicate statistical significance is a common practice in academic research. In this convention, three asterisks (***) are typically used to denote a p-value less than 0.01, two (**) indicate a p-value less than 0.05, and a single (*) signifies a p-value less than 0.10.

optimizing GV. Moreover, the findings indicate the positive effects of ESGP on firm value. ESG considerations can increase the value of a firm in a variety of ways. Boosting ESG operations has the potential to strengthen public support for a company's policies. As a result, when a business can distinguish itself from rivals, sales rise and so does the value of the company. However, beyond a certain level, stakeholders view ESG operations as redundant and prefer to invest in innovation, leading to a decline in corporate value. Second, firms should embrace well-balanced, enduring ESG strategies to steer clear of excessive investment and declining returns. Third, investors should factor in the nonlinear impacts of ESG in making decisions.

This research adds to understanding of the changing regulatory and institutional dynamics that influence the effects of ESG. Moreover, firms' GV negatively moderates the ESGP-value relation, resulting in various strategies to manage downside risk and enhance GV, such as internationalization, equity partnerships, and diversification. The compatibility issue between ESGP and GV arises from the differing interests of current and prospective stakeholders. Managers should pay more attention to ESG performance for two reasons: its strategic insurance-like characteristics and its potential to boost future GV for their companies. ESGP as a driver of GV value has been marginalized thus far. In this context, managers have struggled with the issue of allocating investment resources most effectively across the three ESG pillars to increase stakeholder confidence in the firm. If their ESGP is persuasive, businesses are unlikely to use GV. Third, encouraging stakeholders to move toward long-term sustainability through integrated ESG investment can be a practical policy direction for firms.

Specifically, our results provide support for the idea that sustainable investment not only affects a company's overall value and GV but also

contributes to the betterment of the world. Sustainable investment is consistent with the goals of sustainable development as it helps to reduce global poverty and enhance productivity. The ultimate objective of the SDGs, known as "Partnership for the Goals," highlights the interconnectedness between ESGP outcomes and the SDGs. According to the SDGs:

Strengthen the means of implementation and revitalize the global partnership for sustainable development. Increasing international cooperation is seen as vital to achieving each of the 16 previous goals. Developing multi-stakeholder partnerships to share knowledge, expertise, technology, and financial support is seen as critical to the overall success of the SDGs. The goal encompasses improving North and South-South cooperation, and public-private partnerships which involve civil societies are specifically mentioned.

Our results based on the cross-country evidence from the world's two most dominant economies (the US and China) must be carefully interpreted. The study does not capture the individual effect of ESG components and COVID-19. Future research on ESG dynamics could go in several directions, such as diversification strategy, institutional quality, green innovation, investor behavior (specifically, investor sentiment), financial flexibility, and the role of the top management team. The relationship between ESG practices and firm value varies between US and China listed firms, influenced by institutional norms, cultural contexts, and regulatory environments. This research calls for separate investigations into the dynamics of the nonlinear relationship and its impact on GV. Finally, deep learning models, such as neural networks, can capture highly complex and nonlinear relationships. These models are highly flexible but might require more data and computational resources.

Table 9
Heckman two-step estimates.

Heckman two-step	Estimates-Direct effect			Moderating effect.			Moderating effect Including dumGV		
	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample	US firms	Chinese Firms	Full Sample
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	TQR	TQR	TQR	TQR	TQR	TQR	TQR	TQR	TQR
ESGP	0.0382*** (0.0119)	0.0221** (0.0111)	0.0202*** (0.0100)	0.0402*** (0.0115)	0.0318*** (0.0102)	0.0288*** (0.0101)	0.0416** (0.0208)	0.0394*** (0.0126)	0.0281*** (0.0088)
GV				−0.0231*** (0.0012)	−0.0261*** (0.0024)	−0.0243*** (0.0093)			
(ESGP*GV)				−0.0058*** (0.0015)	−0.0061*** (0.0019)	−0.0060*** (0.0030)			
DUMGV							−0.0194*** (0.0005)	−0.0230** (0.0115)	−0.0203*** (0.0089)
ESGP*DUMGV							−0.0041*** (0.0010)	−0.0113** (0.0017)	−0.0104** (0.0052)
OCF	1.0601** (0.0302)	0.0080** (0.0040)	0.0440** (0.0220)	0.0079*** (0.0022)	2.0367*** (0.0127)	0.0109*** (0.0019)	1.6005*** (0.0073)	0.6023*** (0.0601)	0.4611*** (0.1049)
SAG	0.9501** (0.5101)	0.0303*** (0.0029)	0.0403*** (0.0133)	0.3101*** (0.0191)	0.0342*** (0.0122)	0.0121*** (0.3103)	0.0501*** (0.0106)	0.0423*** (0.0124)	0.1433*** (0.0739)
FIN_SLK	−0.2307*** (0.0145)	−0.0917*** (0.0184)	−0.3207*** (0.0272)	−0.0029** (0.0016)	−0.3706*** (0.1052)	0.0401*** (0.0063)	−0.0172*** (0.0046)	0.0903*** (0.0024)	−0.4201*** (0.1017)
SIZE	0.0004*** (0.001)	0.0023*** (0.0006)	0.0309*** (0.0103)	0.0502*** (0.0130)	0.0180*** (0.0109)	0.0102*** (0.0000)	0.0084*** (0.0022)	0.0176*** (0.0041)	0.0670*** (0.0104)
LEV	−0.0509*** (0.0134)	−0.0374*** (0.0128)	−0.1123*** (0.0113)	−0.1173*** (0.0307)	−0.3174*** (0.0033)	−0.3507*** (0.0033)	−0.0413*** (0.0193)	−0.1830*** (0.0091)	−0.4030*** (0.1093)
INF	−0.0377*** (0.0116)	−0.0209** (0.0105)	−0.0243*** (0.0108)	−0.0307*** (0.0135)	−0.0711*** (0.0104)	−0.0907*** (0.0372)	−0.0261*** (0.0141)	−0.0329** (0.0016)	−0.0709*** (0.0341)
GDP	0.0404*** (0.0155)	0.0224** (0.0113)	0.0133* (0.0119)	0.0302*** (0.1073)	0.0023*** (0.0011)	0.0011*** (0.0009)	0.0301*** (0.0015)	0.0364*** (0.0128)	0.0304*** (0.0103)
CONS_	11.0309*** (5.0338)	8.0681*** (3.0844)	4.0052*** (1.0321)	7.5021*** (3.1004)	0.0094** (0.0058)	1.0048*** (0.0947)	0.0366*** (0.0139)	0.0090* (0.0046)	7.0214*** (0.9106)
Industry/year fixed	Yes		Yes	Yes		Yes	Yes		Yes
Inverse Mills Ratio (λ_i)	0.0131*** (0.0008)	1.0584*** (0.1112)	0.0517*** (0.0131)	0.0278*** (0.0017)	0.0593*** (0.0136)	0.0491*** (0.0234)	0.0364*** (0.0129)	0.0163*** (0.0110)	1.0680*** (0.0945)
No. of obs.	13,245	12,855	26,100	13,245	12,855	26,100	13,245	12,855	26,100
Censored Obs.	12,032	10,149	22,191	12,042	10,449	23,051	12,142	10,539	22,953
Uncensored Obs.	1213	2706	3909	1203	2436	3049	1103	2316	3147
Wald chi2	1521.19***	1721.72***	2921.34***	1501.14***	1701.02***	2091.21***	1301.91***	1701.53***	2701.75***

Notes: Table 9 reports Heckman's two-step estimation method was employed in our study. The analysis begins with the Probit model. The findings remain consistent and valid even after accounting for endogeneity, as indicated by Tables 6 and 7. The inverse Mills ratio is used as an additional regressor to address the problem of self-selection bias in the study sample. Wald's test rejects the null hypothesis of no joint significance of the research variables at the significance levels of 1%, 5%, and 10%. Furthermore, Heckman's two-step estimation method also provides support for this rejection.

Declaration of competing interest

None.

Data availability

Data will be available on request.

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Appendix

Table A1
Correlations Matrix

Panel (A) US firms										
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) TQR	1.0000									

(continued on next page)

Table A1 (continued)

Panel (A) US firms										
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(2) GV	−0.0712***	1.0000								
(3) ESGP	0.0394***	0.939	1.0000							
(4) OCF	0.0540***	0.027***	0.0509***	1.0000						
(5) SAG	0.05010***	0.726***	0.0308***	0.0542***	1.0000					
(6) TANG	−0.0322***	−0.018	−0.0375***	−0.005	0.017***	1.0000				
(7) SIZ	0.0916***	0.0611***	0.3209***	0.0367***	0.248***	0.069***	1.0000			
(8) LEV	−0.0301***	0.0532***	−0.0020	−0.0265***	0.033***	0.007***	−0.0025***	1.0000		
(9) INF	−0.0021	0.023***	0.0017***	−0.002	0.016	−0.028***	−0.0701***	0.0021	1.0000	
(10) GDP	0.0322***	0.239***	0.0359***	0.0033***	0.0665***	0.0150***	0.0105***	0.0815***	0.0741***	1.0000
Panel (B) Chinese listed firms										
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) TQR	1.0000									
(2) GV	−0.0351***	1.0000								
(3) ESGP	0.030***	0.0303***	1.0000							
(4) OCF	0.004***	0.0237***	0.0039***	1.0000						
(5) SAG	0.0100	0.0106	0.6339***	0.0042	1.0000					
(6) TANG	−0.0402***	−0.0088***	0.0453***	0.0451***	0.0167***	1.0000				
(7) SIZ	0.006***	−0.3671***	−0.3239***	−0.037***	−0.2048***	0.0579***	1.0000			
(8) LEV	−0.0727***	0.0562***	−0.0503***	−0.0325	0.0331***	0.0007***	−0.005	1.0000		
(9) INF	−0.0331***	0.0225***	0.0347***	−0.0402***	0.016***	−0.0208***	−0.0891***	0.011***	1.0000	
(10) GDP	0.0137***	−0.2019***	−0.239***	0.0023***	−0.0306***	0.0740***	0.0315***	0.0205***	−0.082***	1.0000
Panel (C) Full sample										
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) TQR	1.0000									
(2) GV	−0.0501***	1.0000								
(3) ESGP	0.0540***	0.0309***	1.0000							
(4) OCF	0.0314***	0.0200	0.0332***	1.0000						
(5) SAG	0.0103	0.0736***	0.7308***	0.0032***	1.0000					
(6) TANG	−0.0023***	0.0138	0.0145	0.0405***	0.017***	1.0000				
(7) SIZE	0.0062***	0.3601***	−0.3029***	0.0357	0.2408***	0.0069***	1.0000			
(8) LEV	−0.0015	0.0152***	−0.0501***	0.0225***	0.0433***	0.0307***	−0.2055***	1.0000		
(9) INF	−0.0041***	0.0303	0.01807	−0.0702	0.0576***	−0.0228***	−0.0181	0.0031	1.0000	
(10) GDP	0.0125***	0.0309***	0.3309***	0.0353***	0.0436***	0.2093***	0.0714***	0.0245***	0.0931***	1.0000

Notes: By using the variables that are specified in Table 1 Appendix Table A1 provides the correlation for US, Chinese, and full sample firms.

Table A2

Variance Inflation factor-VIF Estimations

Variables	US firms'		Chinese listed firms		Chinese listed firms	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
ESGP	1.91	0.52	1.11	0.90	1.99	0.50
OCF	1.30	0.77	0.90	1.11	1.71	0.58
SAG	1.09	0.91	1.09	0.92	1.70	0.59
TNAG	1.27	0.79	1.20	0.83	1.9	0.53
SIZE	1.91	0.52	1.02	0.98	1.28	0.78
LEV	1.11	0.90	1.14	0.88	1.15	0.87
INF	0.99	1.01	1.00	1.00	1.09	0.92
GDP	1.10	0.91	2.02	0.50	1.02	0.98
Mean VIF	1.21		1.18		1.48	

Appendix Table A2 shows explanatory variables with a VIF threshold value of less than ten and no multi-collinearity.

Table A3

Cross-Sectional Dependence & Independence- Panel Unit Root Results

Variables	US firms'		Chinese listed firms		Full Sample	
	LLC-test	PCIPS test	LLC-test	PCIPS test	LLC-test	PCIPS test
TQR	−3.202***	−8.211***	−21.222***	−18.105***	−4.101***	−19.231***
GV	−13.111***	−22.119***	−12.003***	−4.021***	−11.403***	−22.201***
ESGP	−5.011***	−12.444***	−1002.73***	−22.701***	−9.449***	−9.101***
OCF	−23.102***	−10.001***	−284.232***	−10.805***	−25.302***	−10.032***
SAG	−7.111***	−5.007***	−5.8713***	−30.409***	−7.804***	−31.401***
TANG	−3.001***	−16.001***	−20.004***	−16.501***	−21.004***	−6.001***
SIZE	−9.103***	−17.003***	−11.911***	−17.509***	−19.001***	−14.009***
LEV	−7.103***	−13.004***	−8.003***	13.004***	−18.903***	−12.013***
INF	−11.101***	56.001***	−36.101***	−51.001***	−16.103***	−15.001***
GDP	−12.011***	−3.601***	−21.191***	−8.609***	−12.105***	−3.602***

Appendix A3 Table. provides the Levin-Lin-Chu first-generation unit root test for symmetrical panel data. It assumes cross-section units are cross-sectionally independent and displays its results in the table. The second-generation PCIPS test addresses the cross-sectionally problem by allowing for cross-sectional reliance unit root results.

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