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# ESG and cost of equity capital: Biophysical and ergonomic considerations from Chinese listed companies

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## CITATION

Xu B, Chen J, Cao C. ESG and cost of equity capital: Biophysical and ergonomic considerations from Chinese listed companies. *Molecular & Cellular Biomechanics*. 2025; 22(2): 829.  
<https://doi.org/10.62617/mcb829>

## ARTICLE INFO

Received: 19 November 2024  
Accepted: 25 November 2024  
Available online: 11 February 2025

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**Abstract:** The economic consequences of ESG have been debated between the “stakeholder hypothesis” and the “management self-interest hypothesis”. This study not only analyzes the impact of ESG behavior on the cost of equity capital using panel data and regression models but also delves into the biophysical and ergonomic aspects within the corporate context. ESG initiatives can lead to changes in the work environment and operational processes. For example, improvements in environmental sustainability might involve the installation of ergonomic equipment to reduce employees’ physical strain during work, which in turn could affect their productivity and overall well-being. Socially responsible initiatives may lead to a more harmonious workplace atmosphere, reducing stress levels among employees and potentially influencing their physiological states. The study uses panel data and regression models to analyze the impact of ESG behavior on the cost of equity capital. The findings reveal that corporate ESG behavior significantly reduces the cost of equity capital, supporting the stakeholder hypothesis. Further analysis indicates that this effect is more pronounced in highly market-oriented regions and non-state-owned enterprises, highlighting the roles of market efficiency and organizational flexibility. Additionally, the consideration of biophysical and ergonomic impacts on stakeholders provides a more comprehensive understanding of how ESG strategies can have far-reaching effects within and outside the organization. This research provides empirical evidence for enterprises to actively implement ESG strategies and offers actionable insights for governments to formulate policies that foster sustainable development.

**Keywords:** ESG performance; cost of equity capital; non efficient investment; biophysical factors; ergonomics

## 1. Introduction

China has prioritized high-quality development and sustainable development since the 14th Five-Year Plan [1]. The relevance of an organization’s internal corporate governance, social responsibility, and environmental responsibility has increased dramatically with the strengthening of global economic integration. China’s economy will be significantly impacted by whether businesses, which are the backbone of economic development, can innovate in sustainable development in order to attain high-quality development [2,3]. ESG is specifically a complete performance indicator that is analyzed in terms of the environment, social responsibility, and corporate governance. It stems from the principles and objectives of sustainable development that were proposed by the United Nations in 2016 [4]. The Listed Company Governance Guidelines, published by China’s Securities Regulatory Commission in June 2018, set the foundation for evaluating ESG data. Since then, ESG disclosure has grown in importance as a way for China’s capital market to execute the “dual-carbon”

aim and sustainable development of businesses, thanks to the strong push of Chinese policies. In an effort to advance the idea of ESG and, consequently, sustainable development, China published the “White Paper on China’s ESG Development” in December 2020. Comparatively speaking to other nations, domestic research on ESG began later, and the majority of it focuses only on how ESG affects business performance, financing limitations, investment efficiency, and stock price collapse [5–9]. Despite the fact that some articles highlight how ESG can lower capital costs, none of them thoroughly examine the connection between ESG and equity capital costs, and the mechanism underlying this effect is even more deficient [10].

In view of this, this paper selects China’s A-share listed companies from 2011 to 2020 as a sample, takes corporate ESG performance as the core explanatory variable, and explores the economic consequences of ESG behaviors from the perspective of the company’s cost of equity capital. The potential innovations of this paper are: first, the existing literature mostly examines the impact on the cost of equity capital from the perspective of social responsibility, and there are relatively few studies examining the overall impact of ESG on the cost of equity capital, and this paper enriches the relevant literature on the consequences of ESG behaviors from the perspective of ESG performance. Second, based on China’s national conditions, after clarifying the relationship between the two, this paper further investigates the mechanism of the two, puts forward targeted suggestions for Chinese enterprises to actively fulfill ESG, and provides evidence to support China’s sustainable development strategy.

## **2. Research design and variable description**

### **2.1. Sample selection and data sources**

In this paper, China’s A-share main board listed companies in Shanghai and Shenzhen are selected as the initial sample, and the sample period is chosen as 2011–2020. In order to ensure the accuracy of the data, the data are screened and processed as follows: (1) excluding the financial industry and other industries with fewer observations; (2) excluding companies with unpublished ESG scores in the Bloomberg database; (3) excluding companies that have been listed for less than one year, ST, or PT; and (4) shrinking the upper and lower 1% of all continuous variables. The ESG-related data of listed companies are from the Bloomberg database, and all other financial data are from the Cathay Pacific database.

### **2.2. Main variable design**

- 1) Explanatory variables: cost of equity capital (PEG)
- 2) Explanatory variables: ESG performance (ESG)

This paper selects the ESG composite score in Bloomberg database as the core explanatory variable, which consists of three different dimensions of ESG indicators, namely, environmental (E), social (S) and corporate governance (G).

- 3) Control variables

Drawing on the existing literature, this paper selects the following control variables to be added to the model: gearing ratio, fixed asset ratio, firm size, current ratio, two-employee ratio, percentage of independent directors, return on assets, net

cash-to-asset ratio, and quick ratio [11,12]. The variable definitions and measures are shown in **Table 1**.

**Table 1.** Variable definitions and metrics.

Variable types	Variable names	Variable Codes	Variable metrics
Explanatory variable	Cost of equity capital	PEG	Calculated using the PEG model
Core explanatory variable	ESG score	ESG	Bloomberg Database ESG Composite Score
Control variables	Gearing Ratio	Lev	Total Liabilities/Total Assets
	Fixed Assets Ratio	Fixed	Fixed Assets/Total Assets
	Business Size	Size	Natural logarithm of total company assets
	Current Ratio	CR	Current Assets/Current Liabilities
	Combination of two positions	Duality	Takes the value of 1 if the chairman of the board and the managing director are the same person in the current year, otherwise 0
	Percentage of Independent Directors	Indep	Independent directors/Total number of board of directors
	Return on Assets Ratio	Roa	Net profit/total assets
	Cash to Net Assets Ratio	Cash	Cash/Net Assets
	Quick Ratio	QR	(Current Assets – Inventory Goods) ÷ Current Liabilities

### 2.3. Model setting

In order to test the empirical link between ESG performance and cost of equity capital, this paper sets up the following multiple regression model:

$$PEG_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \alpha_n \sum Controls + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (1)$$

If  $\varepsilon$  is a random disturbance term, the model accounts for vintage fixed effects and industry fixed effects,  $ESG$  is the primary explanatory variable, the Bloomberg database provides the  $ESG$  composite score, and  $PEG$  is the explanatory variable cost of equity capital.

## 3. Empirical testing and analysis of results

### 3.1. Descriptive statistics

The variables' descriptive statistics in **Table 2** show that the cost of equity capital ( $PEG$ ) varies significantly between its maximum value of 40.67 and its minimum value of 0. This is further supported by the standard deviation of 4.25, which further highlights the disparities in  $PEG$  costs across listed companies [13]. The average  $ESG$  score is 21.04, and according to Bloomberg's  $ESG$  grading system, the range is 0–100. This indicates that China's Listed firms' total  $ESG$  obligation fulfillment is poor, and corporate  $ESG$  fulfillment needs to be improved. In addition, the maximum value of 45.45 and the minimum value of 9.09 as well as the standard deviation of 7.13 can also be seen from the maximum value of  $ESG$  and the standard deviation of 7.13 also shows that there is a large gap in the fulfillment of  $ESG$  between different enterprises. In terms of the three different dimensions of E, S, and G, the fulfillment of

environment (E) by listed companies in China is worse compared to social responsibility (S) and corporate governance (G). The descriptive statistics of the other control variables are within reasonable limits and are roughly the same as the existing research results [14].

**Table 2.** Descriptive statistics for key variables.

Variables	Value	Mean	Standard deviation	Min	Max
PEG	7583	10.84	4.26	0	40.67
ESG	7583	21.04	7.13	9.09	45.45
E	7583	9.74	8.86	0	65.63
S	7583	23.55	10.68	0	77.19
G	7583	45.02	5.26	3.57	64.54
Lev	7583	0.47	0.20	0.07	0.85
Fixed	7583	0.23	0.18	0.00	0.73
Size	7583	23.27	1.35	20.64	27.15
CR	7583	2	1.84	0.26	12.41
Duality	7583	0.21	0.40	0	1
Indep	7583	37.60	5.64	31.25	57.14
Roa	7583	0.06	0.05	-0.05	0.24
Cash	7583	0.06	0.07	-0.13	0.25
QR	7583	1.54	1.68	0.17	11.21

### 3.2. Analysis of regression results

**Table 3** presents the results of the benchmark regression of the effect of ESG performance on the cost of equity capital. The regression coefficient of ESG in column (1) is  $-0.035$  and is significantly negatively related to the cost of equity capital (PEG) at the 1% level, which leads to the result that the better the firm's ESG performance, the more it reduces the firm's cost of equity capital. Specifically, in terms of firms' environmental performance (E), the regression coefficient of E on PEG is negative and significant at the 1% level. This suggests that a company's cost of equity capital increases with its environmental performance and the amount of penalties it receives for environmental issues [15,16]. This outcome is in line with the practical intuition that environmental contamination exposes businesses to significant public pressure and raises associated environmental protection expenses in recent years due to increased environmental protection laws and enforcement. In terms of corporate social responsibility (S) and corporate governance (G), the regression coefficients of S and G on PEG are still negative and significant at least at the 5% level, suggesting that the more a firm fulfills its social responsibility and the higher its governance level, the lower the cost of equity capital will be.

**Table 3.** Benchmark regression results on the impact of ESG performance on PEG.

	PEG			
	(1)	(2)	(3)	(4)
ESG	−0.035*** (0.007)			
E		−0.026*** (0.006)		
S			−0.014** (0.004)	
G				−0.042*** (0.009)
Lev	3.671*** (0.398)	3.705*** (0.398)	3.729*** (0.398)	3.789*** (0.397)
Fixed	0.668 (0.377)	0.681 (0.377)	0.644 (0.378)	0.604 (0.377)
Size	0.424*** (0.049)	0.408*** (0.048)	0.373*** (0.047)	0.397*** (0.047)
CR	0.17 (0.128)	0.158 (0.128)	0.16 (0.128)	0.176 (0.128)
Duality	0.155 (0.109)	0.165 (0.109)	0.169 (0.109)	0.165 (0.109)
Indep	−0.004 (0.008)	−0.004 (0.008)	−0.005 (0.008)	−0.004 (0.008)
Roa	5.154*** (1.117)	5.220*** (1.117)	5.290*** (1.118)	5.193*** (1.117)
Cash	−3.437*** (0.799)	−3.449*** (0.799)	−3.555*** (0.799)	−3.435*** (0.799)
QR	−0.131 (0.138)	−0.115 (0.138)	−0.116 (0.138)	−0.132 (0.138)
C	2.904** (1.041)	2.782** (1.056)	3.637*** (1.027)	4.743*** (1.007)
Year/Industry	Y			
N	7583			
R <sup>2</sup>	0.287	0.286	0.285	0.286

Note: \*, \*\*, and \*\*\* indicate significant at the 10%, 5%, and 1% levels; respectively, with robust standard errors in parentheses; same below.

### 3.3. Mediating effect of inefficient investment test

For the measure of the level of inefficient investment, this paper draws on to build a model to calculate the firm's desired investment level, and the residuals estimated by the model are used to measure inefficient investment [17]. This paper draws on to construct model (2)–model (4) to examine whether the mediating effect of inefficient investment (Ineff) exists [18]. Model (2) is the model for the main test, and the coefficient  $\alpha_1$  measures the total effect of the independent variables on the impact of the dependent variable. Model (3) is used to test the effect of ESG performance on inefficiency investment, mainly observing the coefficient of ESG performance  $\beta_1$ . Model (4) is used to test the effect of ESG performance and inefficiency investment on firms' cost of equity capital, mainly examining the coefficients of ESG performance and analysts' attention  $\hat{\alpha}_1$ ,  $\hat{\alpha}_2$ . If  $\hat{\alpha}_1$  is not significant, but  $\hat{\alpha}_2$  is significant, it means

that inefficiency investment exerts a full mediation effect; if  $\hat{a}1$  and  $\hat{a}2$  are significant at the same time, it indicates that inefficient investment plays a partial mediation effect.

$$PEG_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \alpha_n \sum Controls + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (2)$$

$$Ineff_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_n \sum Controls + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (3)$$

$$PEG_{i,t} = \hat{\alpha}_0 + \hat{\alpha}_1 ESG_{i,t} + \hat{\alpha}_2 Ineff_{i,t} + \hat{\alpha}_n \sum Controls + \sum Year + \sum Industry + \varepsilon_{i,t} \quad (4)$$

The results of the first step of the mediation effect test are shown in column (1) of **Table 4** below, which is the result of the main regression of model (1), the regression coefficient of ESG performance on the cost of equity capital is negative and significant, which is in line with  $\alpha_1$  significant; the results of the second step are shown in column (2) of **Table 4** below, the regression coefficient of ESG performance on the inefficiency investment is negative and significant at 10% level, which indicates that ESG performance has a significant inhibitory effect on inefficient investment. Column (3) shows the results of the third step, and the coefficients of ESG performance and inefficient investment are significant at the 1% and 5% levels, respectively, indicating that the reduction of inefficient investment behavior caused by ESG performance is part of the reason for the reduction in the cost of equity capital of firms, and that inefficient investment plays a partly intermediary role.

**Table 4.** Intermediation effects of inefficient investment.

	(1)	(2)	(3)
	PEG	Ineff	PEG
ESG	-0.035*** (0.007)	-0.017* (0.008)	-0.034*** (0.008)
Ineff			0.029** (0.011)
C	2.904** (1.041)	9.483*** (1.221)	2.694* (1.120)
Controls	Y		
Year/Industry	Y		
N	7583	7125	7125
R <sup>2</sup>	0.287	0.120	0.289

## 4. Further analysis

### 4.1. Robustness analyses

#### 4.1.1. Endogenous problems

The instrumental variables method comes first. This study uses the two-stage least squares method for instrumental variable regression to mitigate the potential bidirectional causation issue between ESG performance and cost of equity capital. The instrumental variable is chosen to be the arithmetic mean of ESG ratings (ESG\_IV) of

listed companies in the same industry and year as ours. The findings in **Table 5** below demonstrate that the second stage's ESG coefficient is negative and substantial, demonstrating the strength of the aforementioned findings.

**Table 5.** Instrumental variables approach.

	Phase I	Phase II
	ESG	PEG
ESG		-0.319*** (0.049)
ESG_IV	0.327*** (0.022)	
C	-41.615*** (1.460)	-10.590*** (2.275)
Controls	Y	
Year/Industry	Y	
N	7522	
R <sup>2</sup>	0.375	0.276

Second, propensity score matching.

In order to exclude the possible problems of selection bias between sample groups and the interference of confounding factors on the results, this paper chooses the propensity score matching (PSM) to control the impact of the differences between the two sample groups on the findings of the study will be divided into two groups with ESG performance divided into two groups by the mean value, higher than the mean value is good ESG performance (experimental group), and lower than the mean value is poor ESG performance (control group). This paper uses gearing ratio (Lev), fixed asset ratio (Fixed), firm size (Size), current ratio (CR), second job (Duality), percentage of independent directors (Indep), return on assets (Roa), and cash to net worth ratio (Cash) as matching variables for one-to-one matching of the sample. The regression results are shown in column 1 of **Table 6**, where the regression coefficient for ESG is negative and significant, indicating that the conclusion still holds.

**Table 6.** Robustness analysis.

	PEG	
	PSM	Replacement of ESG
ESG	-0.034*** (0.0072)	-0.167*** (0.028)
C	2.729** (1.053)	4.132*** (0.612)
Controls	Y	
Year/Industry	Y	
N	7503	18161
R <sup>2</sup>	0.287	0.255

#### 4.1.2. Substitution of explanatory variables

In this paper, ESG performance is analyzed using the CSI ESG ratings from the

wind database. The results are shown in Column 2 of **Table 6** above, and the coefficient of ESG\_new is negative and significant at the 1% level after changing the explanatory variables, which again proves the robustness of the previous results.

## **4.2. Heterogeneity test**

### **4.2.1. Nature of property**

First, state-owned enterprises (SOEs) are more likely to respond to the state's call to actively take on social responsibility and thus engage in ESG practices, while non-SOEs, as pure market participants, practice ESG more to meet the needs of various stakeholders and gain economic benefits from it. Second, SOEs are often politically connected to local governments, making it easier for them to obtain government subsidies and bank financing. In contrast, non-SOEs do not have this advantage and need to gain the trust of the government and external investors through ESG [19]. Finally, SOEs have a more complete management and supervision system, and receive much more media attention and supervision than non-SOEs. In summary, we expect that the ESG performance of non-SOEs reduces the cost of equity capital more than that of SOEs. The regression results are shown in columns (1) and (2) of **Table 7**, and the absolute values are larger than those of SOEs in the non-SOE sector, and are significant at the 1% level of significance, which is consistent with the expectation.

### **4.2.2. Marketability**

The level of marketization and the effective distribution of resources vary by region in China. When a business is located in an area with less marketization, information communication efficiency, as well as the level of transparency and informatization in the area, are all lower than in areas with more marketization [20]. ESG behaviors of managers are likely to be opportunistic behaviors to increase their own interests against shareholders, which results in the role of ESG on the cost of equity capital becoming smaller. In regions with a higher degree of marketization, the public has a stronger awareness of environmental protection and social responsibility, and the government regulates firms more strictly, which causes firms in regions with a high degree of marketization to face more regulation. Therefore, we hypothesize that the effect of ESG behaviors on equity capital is more pronounced in cities with a higher degree of marketization. Accordingly, this paper refers to and treats the samples from Shanghai, Guangzhou, Zhejiang, and Jiangsu as the high marketization group and vice versa as the low marketization group [21]. The experimental results in columns (3) and (4) of **Table 7** show that the absolute values in the high marketization group are larger than those in the low marketization group, and all of them are significant above the 1% level.

### **4.2.3. Degree of pollution**

Businesses that emit a lot of pollutants are subject to more stringent regulations under the sustainable development policy. In order to lower environmental hazards and the expenses associated with environmental regulation, polluting enterprises should be under regulatory pressure to focus more on their environmental protection practices and actively assume responsibility for environmental protection. ESG practices are a reflection of the legitimacy and social responsibility of highly polluting



industries. Because of the industry's unique characteristics, polluting companies are more ready to use ESG practices to send green signals to the outside world. This is done to improve their own reputation and get public acceptability, which lowers the cost of their stock capital. Therefore, we expect the ESG performance of polluting firms to be more pronounced on the reduction of the cost of equity capital. The regression results are summarized in columns (5) and (6) of **Table 7**, where the coefficients are negative but the correlation is not significant in heavily polluting industries, while they are significantly negative in non-heavily polluting industries. This is contrary to the expected results. This suggests that ESG behaviors of polluting firms are difficult to be recognized in the capital market. The reason may be that ESG as a kind of invisible investment of enterprises, due to the pollution problems faced by heavy pollution industry itself is difficult to convert enterprise ESG behavior into enterprise value in a short time, so compared with non-pollution industry may not be able to get the support of the capital market in a short period of time.

**Table 7.** Subgroup regression results.

	Nature of Property		Marketability		Degree of pollution	
	State enterprise	Non-state enterprise	High degree of marketization	Low degree of marketization	Heavily polluted industries	Non-heavily polluted industries
	(1)	(2)	(3)	(4)	(5)	(6)
ESG	-0.022* (0.010)	-0.035*** (0.010)	-0.039*** (0.011)	-0.035*** (0.010)	-0.011 (0.012)	-0.053*** (0.009)
C	0.614 (1.426)	1.295 (1.672)	2.965 (1.798)	2.192 (1.329)	6.656*** (1.853)	0.738 (1.274)
Controls	Y					
Year/Industry	Y					
N	3786	3797	2926	4657	2525	5058
R <sup>2</sup>	0.309	0.298	0.317	0.277	0.198	0.329

## 5. Conclusions and recommendations

This paper examines whether ESG behavior of listed companies can provide useful information to decision makers from the perspective of cost of equity capital. It is found that ESG behaviors of listed companies can significantly reduce the cost of equity capital of firms, which provides incremental information for investors to judge the future development of firms, and at the same time increases the transparency of information and optimizes the information environment of China's capital market. Further research shows that ESG behaviors of non-state-owned firms and firms in highly marketized regions have more significant effects in reducing the cost of equity capital. The mechanism test shows that the inefficient investment behavior of enterprises is an important mechanism for ESG performance to reduce the cost of equity capital, which is consistent with the theory of reputational mechanism.

Based on the above results, this paper puts forward the following suggestions: First, enterprises should not only see the high cost of fulfilling their social responsibility and actively engaging in environmental protection behaviors, but also make efforts to improve their own awareness of environmental protection and social

responsibility from the perspective of sustainable development. Second, regulators and the government should improve ESG disclosure requirements as well as the reward and punishment system, establish a sound ESG disclosure system, give full play to the market mechanism, encourage enterprises to actively disclose ESG-related matters, and at the same time, increase the supervision of environmental protection, and adhere to the implementation of sustainable development strategies. Third, enterprises should coordinate the relationship between various stakeholders, strengthen internal supervision, and actively safeguard the interests of various stakeholders. Fourth, enterprises should pay attention to the monitoring role played by media analysts and the role played in alleviating information asymmetry, through media communication means to increase investors' understanding of the enterprise, improve corporate visibility and establish a good corporate image.

**Author contributions:** Conceptualization, JC and CC; methodology, JC; software, CC; validation, JC and CC; formal analysis, CC; investigation, BX; resources, CC; data curation, JC; writing—original draft preparation, JC; writing—review and editing, CC; visualization, JC; supervision, BX; project administration, BX; funding acquisition, BX. All authors have read and agreed to the published version of the manuscript.

**Ethical approval:** Not applicable.

**Conflict of interest:** The authors declare no conflict of interest.

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