Sustainability and Capital Costs: The Impact of ESG Performance, Efficiency, and Firm Characteristics on WACC

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Abstract. ESG practices are widely promoted to increase sustainability transparency, demonstrate stronger performance, and reduce perceived risk. This study examines the relationship between ESG score and DEA with cost of capital as a key indicator of company performance, specifically financing effectiveness. A total of 32 IDX-listed companies reporting ESG data from 2016 to 2023 form the sample. ESG data were collected from the LSEG database, while DEA was derived through STATA 16 analysis. Fixed Effects and Random Effects panel data models are applied. The results show ESG has a positive impact, while DEA has a negative impact on the cost of capital proxied by WACC, implying ESG can significantly decrease cost of capital while enhancing company performance as reflected by DEA scores. These findings provide insight into what companies should prioritize in their operations to reduce cost of capital.

Keywords: Sustainability; ESG; DEA; Cost of Capital; WACC

1 Introduction

Global concerns about social equality and climate change are gaining more attention from the public. Pressure on companies towards their role in mitigating global warming is intensifying. Recent evidence indicates that global warming has peaked, with the Earth's average surface temperature now exceeding 1,5 degrees Celsius compared to pre-industrial levels [1]. The impact gets more prominent through extreme weather phenomena that trigger natural disasters such as wildfires, floods, and droughts in many areas around the world. By the year 2024, global losses due to floods are estimated to reach $550 billion with over 8.700 fatalities [2]. Early 2025, United States recorded the largest wildfire in Los Angeles's history, which caused material losses estimated between Rp2,200 trillion to Rp2,447 trillion [3].

Apar from environmental impacts, social challenges like economic disparity and gender inequality appears to be never-ending problems. Data from the World Inequality Database [4] in 2023 shows that out of the total wealth, over 50% is hold by the 10% wealthiest people, while the bottom 50% of the population owns less than 10% of global wealth. This gap is widened by low female participation in the economy, thereby creating gender inequality and hindering social development [5]. To address these problems, Environmental, Social, and

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Governance (ESG) based policies are being widely adopted in various countries. These policies aim to encourage companies to take a proactive role in addressing complex global issues. Through the ESG approach, it is expected to overcome social, environmental, and governance issues, thus creating a more inclusive and sustainable world for future generations.

The adoption of ESG has become a main strategy for firms in this sustainability-based economic era. The motivation for companies to adopt ESG are commonly due to an awareness to contribute socially, the government policies, and recognition that ESG is one of the determinants in enhancing company performance [6]. ESG practices also become a vital element for firms nowadays, due to its ability to drive stronger financial performance, generate competitive advantage, and comply with increasing demands from all stakeholders for transparency regarding sustainability [7]. firms tend to raise their commitment and disclose ESG related practices when it leads to better financial performance [8]. However, research by Fatemi et al [9] pointed out that empirical studies examining the impact of ESG adoption on corporate performance and financial value have not demonstrated a consistent relationship.

For companies, initiating ESG practices may require higher costs and decreased operational efficiency as companies have to spend big initial investment, consequently companies need to consciously balancing short-term challenges with long-term benefits when developing their ESG strategies since ESG practices support broader strategic decision-making and potentially reduce capital costs thereby reducing overall capital expenditures [10]. Based on capital market perspectives, companies with stronger ESG commitments should be able to get lower capital costs that will positively influence cash flow and company value. Several studies proved that higher ESG ratings can significantly reduce cost of capital, thereby mitigating operational and market risks as ESG practices do not incur any burden on companies, but bring additional advantage instead, including reduce financing costs and increasing investor confidence [11], [12]. In other words, ESG implementation can enhance company value through more efficient financing.

But research conducted by Ernst & Woithe [13] found there is no effect of ESG score on cost of capital proxied by WACC (Weighted Average Cost of Capital). Other previous studies also pointed to limited impact of ESG, as found the increased aspect could significantly reduces cost of capital is only corporate governance disclosure because it enables cheaper funding, while social and environmental disclosure does not show a significant impact [14]. These results are also inconsistent with other findings, whereby a one-point increase in ESG ratings reduces WACC by 0.1% gained through better environmental and social risk management [15]. In other side, study by Tanjung [16] discovered there is no significant differences in the cost of capital between ESG and non-ESG companies.

Considering the inconsistent results presented by previous studies, further research is needed to better understanding in relationship between ESG and cost of capital. Sustainability requires wise and efficient resource utilization, environmental preservation, equitable benefit distribution, and active community involvement in policy making [17]. To assess in-depth funding efficiency, this study will also use Data Envelopment Analysis (DEA), as it enables performance measurement based on company ability to convert inputs into ESG-relevant outputs. Data Envelopment Analysis (DEA) model has proven as an effective tool in evaluating capital allocation efficiency in ESG-related projects and organizations with high DEA efficiency scores often demonstrate more consistent and verifiable ESG disclosures [18], [19].

The gap in transparency and business ethics standards between developed and emerging economies may also explain how ESG performance affecting company performance being more pronounced in developed countries [10]. This study explores listed Indonesian companies as they operate in emerging market, which according to Indonesia Business Council

for Sustainable Development (IBCSD) data has less than 50% ESG disclosure and still ranks 36th out of 47 capital markets worldwide. Throughout this study, mainly aimed to provide empirical evidence regarding the adoption of ESG by companies as a strategic approach in designing policies by determining capital structure and optimizing the cost of capital.

2 Literature Review

Environmental, Social, and Governance (ESG) defined as a concept encompassing three core aspects that concerning companies in their operations and decision-making. The Environmental dimension focuses on the environmental impact of business practice including natural resource management, greenhouse gas emissions, and waste management. The Social dimension involves aspects of company responsibility towards employees, customers, and all stakeholders, covering matters of diversity, human rights, and community relations. While the Governance dimension relates to good corporate governance practices, involving transparency, accountability, and ownership structure [20].

The importance of ESG in modern business world is increasingly recognized, not only as a tool to raise corporate reputation, but also enable to strengthen competitiveness and long-term sustainability. By embracing ESG principles, companies are more able to respond regulatory changes, market demands, and social dynamics that emphasize sustainability [21]. Through ESG implementation, companies can enhance their financial performance by operating more efficiently while also maintaining better relationships with stakeholders, including investors, customers, and the public [22]. To ensure company's sustainability, focusing on long-term goals has to be a prior concern [23].

Research by Eccles et al. [24] reveals that companies with high levels of sustainability frequently adopt and disclose ESG data. The study also proposes that companies with high levels of sustainability have proven to achieve better performance in terms of returns, especially in companies with competitive branding and reputations. According to Cheng et al., [25] companies with better governance tend to more able to adopt ESG principles. The study also discovered companies with strong audit committees, independent boards of directors, and high managerial oversight are more proactive in integrating environmental, social, and governance factors into their business strategies. This indicates that companies prioritize good governance are more aware of ESG issues, eventually leading to long-term performance improvements.

In addition, research by Friede et al. [23] highlights how industrial sectors and pressure from institutional investors are crucial in driving corporate ESG adoption. Companies from sectors heavily influenced by environmental regulations or social issues, like energy and manufacturing, tend to be more immersed in ESG. Amidst the rapid emergence of ESG practices as crucial tool for corporate governance, companies conduct businesses while pursuing two objectives, social value and economic viability, for more sustainable growth [26]. At the same time, pressure from institutional investors, who increasingly concerned to corporate sustainability and social impact, also encourages ESG adoption as part of their investment strategy [23]. ESG disclosure able to helps companies reduce information asymmetry, enabling investors to evaluate company performance beyond financial parameters and gain a clearer insight into the company's ESG actions [27].

Research demonstrates that companies with strong ESG performance often have better risk management frameworks, higher stakeholder trust, and greater reputation, enabling them to have better respond to crises [28]. In assessing corporate risk, it becomes very relevant to address its relationship with capital structure, considering the ratio between debt costs and

equity costs is critical. Companies risk could be measured through the cost of capital, which remains as primary concern in every investment decision made by both investors and companies [29]. Most of investors believe that a long-term ESG orientation will bring more sustainable businesses and minimize default risk, thereby result in equivalently low cost of capital [30].

Measuring company's cost of capital that takes into account both equity and debt could by utilizing Weighted Average Cost of Capital (WACC) [31]. WACC is calculated based on the proportion of each long-term funding source, specifically debt and equity, considering the differences in risk levels and costs of each capital component. Previous studies have discovered a negative relationship between ESG reporting and cost of capital, suggesting that ESG reporting reduces information asymmetry and uncertainty among investors. The findings align with framework of stakeholder theory, suggesting ESG disclosure able to enhance reputation, trust, and cooperation with all stakeholders, reduce information asymmetry, and decrease cost of capital [31], [32].

According to stakeholder theory, acting responsibly towards the environment allows companies to build stakeholder trust and in turn facilitates access to capital and reduces cost of capital. Environmental related performance proved have significant negative impacts to WACC [33], [34]. Similarly, company's social practice also found could significantly affect WACC in negative terms [33], providing evidence for stakeholder theory. ESG disclosure within annual reports represents an enhancement in company transparency, and is part of good corporate governance to mitigate conflicts between management and shareholders in accordance to agency theory. Improving corporate governance can reduce agency costs, assuring investors it protects their interests, and eventually lowering the WACC as shown in research by Ellili [35], Eliwa et al. [36], and Piechocka-Kałużna et al. [34].

3 Methods

The sample of this study includes of all firms listed in IDX which report their ESG activities from 2016-2023. ESG scores were taken from LSEG database. This results 256 firm-year observations with 32 firms. We obtained data envelopment analysis (DEA) data from analysing data using STATA.

We measure dependent variable using WACC. We logged WACC to address the normality of the data. WACC data were collected from LSEG database. We have two main independent variables, DEA and ESG. As mentioned before, ESG data is obtained from LSEG database. DEA data were obtained from analysing using STATA 16. We used DEA for our independent variable as we are interested in investigating the efficiency of ESG score in producing performance. Data envelopment analysis is able to analyse the effieciency of input variables in producing output variables. Our input variables were ESG and three aspects of ESG, which are social, environment, and governance. Our output variabels were net profit margin (NPM), revenue, and return on assets (ROA). We employed some control variables, consisting beta, der, size, capex, market value, tobins-q, and standar deviation of firm stock.

We estimated our model using fixed and random effect panel data estimation. We run these panel models to ensure the robustness of our results. This is our regression model:

$$WACC_{it} = \beta_1 + \beta_2 ESG_{it} + \beta_3 DEA_{it} + \beta Control_{it} + \mu_i + \varepsilon_{it}$$

In addtion, we also provide panel regression results with industry fixed effect to control the effect of industry in our estimation model.

4 Results

4.1 Descriptive Statistics

Descriptive statistics of variabels are presented in table 1. this data consist of 256 observations during 8 years. Some variables are reported in log natural. LNWACC has a mean of -2.294. The negative mean of lnwacc indicates that many firms have wacc less than 1, which is normal for firms to have such cost of capital. DEA has a mean of 0.729. DEA score range from 0 -1. the closer DEA score to 1, the more efficient firms in producing output. This indicates that most firms perform well to produce output. The mean ESG score is 48.7/100 with a wide cross-sectional distribution indicated by sd of 19.6, but its distribution is nearly symmetric, indicating substantial heterogeneity across firms. BETA, on average, is recorded above one (1.33), with a mild right skewness of 0.42, while financial leverage exhibits the most significant non-normality (average DER = 1.48, sd = 3.51; skew = 0.64; kurtosis = 33.2), consistent with the presence of highly leveraged firms commonly found in firm panels. Market size variables are reported in log terms (e.g., average ln MV = 31.36) to address scale and average logged Tobin's Q stands at 0.553 (≈1.74 in level), indicating that, in general, firms are traded above replacement value. Skewness for most log-transformed variables is moderate (|skew| < 0.35), supporting the usual log-normal assumption for firm-scale quantities and the use of linear models on logged data.

Table 1. Descriptive statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max	(8) skewness	(9) kurtosis
LNWACC	256	-2.294	0.383	-3.337	-1.244	-0.134	2.731
DEA	256	0.729	0.238	0.141	1	-0.515	2.112
ESG	256	48.67	19.61	8.162	89.21	0.0161	2.095
BETA	256	1.331	0.639	-0.008	3.230	0.421	2.965
DER	256	1.479	3.512	-20.79	30.53	0.641	33.17
SIZE	256	31.37	0.910	29.20	33.54	0.0007	3.115
LNCAPEX	256	28.10	1.464	23.53	31.19	-0.288	3.076
LNMV	256	31.36	1.129	28.84	34.73	0.318	3.049
LTOBINS	256	0.553	0.696	-0.900	3.102	1.392	4.856
LNSD	256	5.875	1.349	1.921	9.462	-0.00727	2.873
Number of year	8	8	8	8	8	8	8

The Pearson correlation matrix shows varying relationships between the cost of capital (lnwacc) and other variables. A significant positive correlation is found between lnwacc and beta (0.648), indicating that firms with lower cost of capital tend to have higher market risk. Conversely, a significant negative relationship between lnwacc and lnposcape (−0.316) suggests that firms with lower cost of capital tend to operate in areas with less ESG diversity. Negative correlations are also observed between lnwacc with size and der (−0.263 and −0.264), indicating that larger and highly-leveraged firms have lower cost of capital. A significant positive correlation between lnmv and lnwacc (0.532) shows that companies with higher market

value tend to have lower cost of capital. Overall, these results illustrate the relationships among capital structure, market risk, and corporate ESG policies.

Table 2. Pearson Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) lnwacc	1.000									
(2) esg	0.061	1.000								
	(0.334)									
(3) dea	0.080	0.867	1.000							
	(0.201)	(0.000)								
(4) lnsd	0.031	0.109	-0.044	1.000						
	(0.616)	(0.083)	(0.484)							
(5) lnposcape	-0.316	0.061	-0.032	0.233	1.000					
	(0.000)	(0.331)	(0.607)	(0.000)						
(6) lnmv	-0.131	0.093	-0.088	0.298	0.532	1.000				
	(0.036)	(0.138)	(0.162)	(0.000)	(0.000)					
(7) size	-0.263	0.085	0.025	0.099	0.662	0.443	1.000			
	(0.000)	(0.178)	(0.694)	(0.113)	(0.000)	(0.000)				
(8) beta	0.648	-0.049	0.086	-0.238	-0.186	-0.342	-0.070	1.000		
	(0.000)	(0.437)	(0.172)	(0.000)	(0.000)	(0.000)	(0.266)			
(9) ltobins	-0.046	0.033	-0.051	0.039	-0.026	0.594	-0.351	-0.237	1.000	
	(0.465)	(0.604)	(0.419)	(0.535)	(0.675)	(0.000)	(0.000)	(0.000)		
(10) der	-0.264	-0.116	-0.050	-0.124	0.178	-0.014	0.114	0.192	0.101	1.000
	(0.000)	(0.065)	(0.424)	(0.048)	(0.004)	(0.819)	(0.068)	(0.002)	(0.107)	

4.2 Regression Results

Tabel 3. Regression results

	(1)	(2)
VARIABLES	**lnwacc**	**lnwacc**
esg	0.003**	0.002

	(0.001)	(0.002)
dea (data envelopment analysis)	-0.207*	-0.044
	(0.088)	(0.131)
lnsd	0.016	0.019**
	(0.010)	(0.010)
lnposcape	-0.034**	-0.046***
	(0.013)	(0.017)
lnmv	0.242**	0.263***
	(0.088)	(0.095)
size	-0.257**	-0.255***
	(0.093)	(0.095)
beta	0.480***	0.468***
	(0.018)	(0.036)
ltobins	-0.258*	-0.287**
	(0.115)	(0.125)
der	-0.066***	-0.061***
	(0.013)	(0.013)
Constant	-1.354***	-1.770***
	(0.314)	(0.371)
Observations	256	256
R-squared	0.807	
Number of year	8	8

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 presents regression results. It includes two models: (1), which employs Fixed Effects (FE), and (2), which uses Random Effects (RE) to examine factors influencing wacc. Overall, both models show relatively consistent outcomes. In Model (1) with Fixed Effects, the ESG variable (0.003, $p < 0.01$) exhibits a significant positive impact on lnwacc, suggesting that an increase in ESG score tends to reduce the company's cost of capital. This finding aligns with the theory that companies with robust sustainability practices are often perceived as more stable by investors, thereby potentially securing financing at a lower cost. The DEA variable (−0.207, $p < 0.05$) demonstrates a significantly negative effect, indicating that firms with higher efficiency, as measured by data envelopment analysis, tend to have a lower cost of capital, possibly because efficient companies are more attractive to investors.

Some other variables also produce significant effects. lnmv and beta have significant positive effects on lnwacc at 1% level, indicating that companies with higher market value and greater market risk tend to have a higher cost of capital. Capex shows a significant negative effect at 5% level, suggesting that companies with higher capital investment tend to have a lower cost of capital. Size is also negatively associated with the cost of capital, indicating that larger companies are often charged with a lower cost of capital. In Model (2) with Random Effects, the results are largely similar to those of Model (1). However, the coefficients for some variables exhibit minor changes; for instance, DEA (−0.044, $p > 0.10$) is no longer significant, indicating a weaker relationship between efficiency and cost of capital when considering random effects. Similarly, capex and lnmv display a slightly stronger effect compared to Model (1). Size and beta continue to demonstrate significant effects on the cost of capital. Table 4 presents panel regression results with industry fixed effect. Overall the results are consistent even when we fixed industry category in our model

In summary, model FE, RE, and industry fixed models exhibit relatively consistent results, with several variables significantly influencing lnwacc. The application of three models provides a more comprehensive understanding of how various factors, including ESG, firm size, and market risk, affect the company's cost of capital in this sample. This should make our results more robust.

Table 4. Regression riesults with industry effect

VARIABLES	(1) lnwacc	(2) lnwacc
esg	0.003**	0.002
	(0.001)	(0.002)
dea	-0.269**	-0.058
	(0.083)	(0.161)
lnsd	0.021*	0.022**
	(0.010)	(0.010)
lnposcape	-0.017	-0.046
	(0.019)	(0.028)
lnmv	0.223**	0.260***
	(0.080)	(0.093)
size	-0.248**	-0.236***
	(0.087)	(0.091)
beta	0.459***	0.464***
	(0.024)	(0.049)
ltobins	-0.209*	-0.275**
	(0.105)	(0.126)
der	-0.073***	-0.068***
	(0.013)	(0.012)
Constant	-1.488**	-2.261***
	(0.561)	(0.708)
Observations	256	256
R-squared	0.822	
Number of year	8	8

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5 Discussion

The regression results presented in Table 3 offer insights into the determinants of a company's weighted average cost of capital (WACC). Using both the Fixed Effects (FE) and Random Effects (RE) models, some independent variables show a significant impact on lnwacc with minor variations in significance levels between the two models. Firstly, ESG exhibits a significantly positive influence on lnwacc in both models, with a coefficient of 0.003 ($p < 0.01$) for the FE model and 0.002 ($p < 0.01$) for the RE model. This finding suggests that companies

with superior ESG performance tend to incur a higher cost of capital. This aligns with previous research indicating that ESG has a limited effect on enhancing a company's performance. In this context, ESG does not positively affect the cost of capital by reducing its rate.

Subsequently, DEA (Data Envelopment Analysis) demonstrates a significantly negative effect on lnwacc in the FE model (-0.207, $p < 0.05$), but is not significant in the RE model (-0.044, $p > 0.10$). This result implies that companies with efficiency in producing output from ESG tend to have a lower cost of capital. It is associated with investors' perception of a company's internal efficiency as a risk-mitigating factor. These results suggest that the positive effect of ESG emerges when ESG effectively enhances company performance, as evidenced by a high DEA score.

The negative effect of CAPEX indicates that companies with higher capital investments tend to have a lower cost of capital. Companies with substantial investment levels are perceived as more aggressive in their expansion and innovation strategies, leading to a reduced risk perception among investors [37]. The positive effect of LNMV on WACC indicates that companies with larger market values tend to incur a lower cost of capital. This observation aligns with the theoretical perspective that larger companies are perceived by investors as more stable and less risky, thereby enabling them to secure financing at reduced interest rates [38]. Conversely, both size and beta exhibit negative relationships with the cost of capital across both models. This suggests that larger companies and those with higher market risk levels tend to experience a lower cost of capital, attributable to the stability associated with size and the potential for enhanced risk diversification.

Overall, these regression results provide compeling evidence that factors such as environmental, social, and governance (ESG) performance, operational efficiency, capital investment, and company size significantly influence a company's cost of capital. As a practical implication, these results suggest that companies seeking to reduce their cost of capital should prioritize enhancing ESG performance which are able to create operational efficiency and making strategic investments that can mitigate investors' risk perceptions.

6. Conclusion and Suggestion

This research examines the impact between ESG practice and the cost of capital for companies listed on Indonesia Stock Exchange (IDX) that report their ESG activities from 2016-2023 according to LSEG database. Regression analysis shows that ESG has positive and significant effect on cost of capital, measured by WACC, indicating companies with strong ESG performance lead to higher cost of capital rather reducing it as discovered in most studies. Since ESG reporting unable to reduce information asymmetry and uncertainty among stakeholders, further analysis of efficiency assesed by Data Envelopment Analysis (DEA). DEA enables performance measurement based on company ability to convert inputs (ESG) into outputs (NPM, revenue, ROA). Through analysis, DEA found have negative significant effect into cost of capital, implies greater company efficiency tend to have a lower cost of capital. These results suggest that ESG effects in decreasing the cost of capital occurs when ESG effectively improving company performance, as demonstrated by high DEA score.

Other variables also observed in this study, demonstrate significant positive effects from market value and beta, shows higher market value and risk tend to have higher WACC, and conversely, negative significant result found in capital expenditure, company size, DER, and standard deviation of firm stock. The incapability of ESG scores to reduce WACC reflects stakeholders perception that ESG spending is not generating worthwhile value, and even potentially increases risk due to uncertainty. This research provides empirical evidence that all stakeholders place more trust in ESG ratings once companies have proven to be operationally effective.

This finding also provide practical insight for companies to improve ESG performance, operational efficiency, and acquire strategic investments to reduce investor risk perception and cost of capital. Therefore, further studies suggest to explore the relationship between ESG and cost of capital in more depth by utilizing detailed ESG item score, resulting in more specific conclusion and ensuring development of more data-driven policies in encouraging ESG adoption. Additionally, in supporting more effective ESG implementation, it becomes important to standardize ESG disclosure for providing more relevant and reliable data to all stakeholders in evaluating company's ESG performance.

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