ESG Risk Assessment : An Integrated Conceptual Model with a Multi-Analysis Approach in Indonesian Public Companies

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Abstract. The purpose of this research is to create comprehensive ESG risk assessment model by investigating the relation between carbon emissions, industry sectors, and SDG disclosure in Indonesian stock exchange. It is argued that ESG risk assessment should be sector-specific rather than 'one size fits all'. Businesses are encouraged to concentrate on the full range of SDG reporting and on sector-specific risk management, not simply carbon emission reductions. When crafting ESG frameworks, regulators should observe industry-specific nuances. This study develops a unified framework that integrates contingency theory with fsQCA to improve our understanding of ESG risks formation and propose the risk assessment model in emerging markets.

1 Introduction

Over the past ten years, ESG risk assessment has become a key tool for corporate analysis and investment decision-making. [10] In Indonesia, sustainability topics have become more relevant for the investors and it is already visible in the variation of ESG scores (score range from 7.11 to 53.10) on companies listed in Indonesia Stock Exchange. This difference brings out the difficulty of assessing ESG risks which calls for a nuanced analysis. Two other studies by [13] [14], also studied the link between carbon emissions and ESG performance, which showed a positive relationship between ESG disclosure and corporate financial performance. Nonetheless, [1] found that ESG risk quantification varies between sectors due to differences in the measurement of risk types and an overall lack of knowledge as to how industry sector characteristics moderate this relationship. Previous studies largely examined ESG analysis from a linear perspective and often ignored the potential complex combination of variable influencing ESG risk.

On the empirical side, firms with high emissions also display higher ESG scores, which is bringing back questions on how put to practice ESG risk assessment systems. This occurrence is confirmed by differences in SDG disclosure at level ($5.0 < X < 17.0$), and highly identical sector as reflected from Financial and Basic Materials sectors of companies

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listed on Indonesia Stock Exchange over the year of 2023. [4] highlight the critical need for industry context in ESG risk assessment, as every sector has its own set of challenges and normative standards.

Contingency Theory [7] is utilized in this study as theoretical basis to explain the ESG risk assessment complexity. This theory highlights that there is no one best way to organize organizations and the effectiveness of organizing depends on how well the desired organization fits in its environment. Contingency Theory is particularly useful in explaining how contextual factors (e.g., industry type and environmental impact) influence the relationship between carbon emissions, ESG risk. Moreover, the theory is conducive to the use of fuzzy-set Qualitative Comparative Analysis (fsQCA) technique based on respect that there will be many pathways leading to an outcome, as we also expect that favourable ESG risk factors configuration may be different across sectors and environments.

2 Methods

Four primary constructs are operationalized in this study. The dependent variable (ESG Value) represents Sustainalytics ESG risk score, indicating a company's sustainability level of risk. Low (0–10) scores are indicative of minimal risk, while high (>40) scores reflect systemic risk (IDX, 2023). The independent variable -TotalCarbonEmissions is a continuous variable that represents the total amount of carbon emissions (in tons) developed by company which defines the environmental impact of a company in operation. [2] The moderator, SDGs Disclosure, is developed using corporate disclosure scores and higher levels of firms' disclosure score imply a higher level of transparency and companies' commitment to sustainable practices. [8] The mediating variable, Industrial Sector, is measured with four indicators: sectoral average carbon emissions; sectoral average ESG score; a sectoral average SDG score; and the dominance of the sector. Normalized values of these indicators are combined to create a single score representing the ESG risk profile of each sector. [9]

There are several theoretical and empirical reasons why these four indicators should represent the Industrial Sector variable. The sectoral average carbon emissions are chosen since they characterize the operational conditions and environmental outcome of each industry sector, as for example a certain sector has its own emission profile caused by working processes. [5] We use the sectoral average ESG as a proxy for cohesion of ESG values in each antiharassment friendly sector, that is, the extent to which this sector faces similar risks and issues. [6]

Sectoral SDG disclosure is a critical measure as it reflects the extent of transparency and commitment of sectors towards interventionist practices, since sectors may have different degree of regulatory requirement or practice in order to disclose. [8] In the meantime, sectoral dominance is also used as a cue that enables us to take into consideration how well each sector of the sample population reflects relative representation and influence in interpreting findings of research. [3]

The all-around use of these four indicators enable the research to reflect multiple aspects of sector characteristics that might affect the linkage between carbon emissions and ESG value. The influence of ESG differs from one industry to another sector, and this difference may be known by the diverse sectoral pattern in which measured as an alternative. This multiple-indicator approach will also facilitate a more robust analysis of the industrial sector's role in relation to ESG risk.

The Industry Sector is measured using several integrated indicators. First, sectoral average carbon (SAC) emissions are calculated as the total sector's carbon emissions divided by the number of companies in that sector.

$$SAC = \frac{\sum TEi}{\sum Ni}$$

SAC = Sectoral Average Carbon Emissions; ∑TEi = Total Carbon Emissions in the Sector (the total sum of emissions from all companies within the sector); ∑Ni = Total number of companies in the sector. Standardization is then performed by subtracting the SAC value from its mean and dividing it by the standard deviation.

$$Z = \frac{X - \mu}{\sigma}$$

Z = Z-score; X = Individual value; μ = Mean (average); σ = Standard deviation. Next, the remaining three indicators are calculated using the same method. Once all four indicators are obtained, the next step is to calculate the Final Composite Score by applying an equal weighting of 0.25 to each indicator. This calculation results in a sector score, which is derived from the sum of the products of the weights and the Z-scores of each indicator.

$SS=(w_1 \times ZSAC)+(w_2 \times ZKES)+(w_3 \times ZIPS)+(w_4 \times ZDS)$

Where SS = Sector Score; w_1, w_2, w_3, w_4 = Weights of each variable; ZSAC = Z-score of Sectoral Carbon Index; ZKES = Z-score of Sectoral ESG Performance; ZIPS = Z-score of Sectoral Industry Dominance Index; ZDS = Z-score of Sectoral SDGs.

The last step is normalizing the final score by subtracting sector score from its minimum and dividing it by the maximum-minimum. This quantification yields a normalized score between 0 and 1, higher values indicating the sector to play a stronger "mediating effect" on the linkage of carbon emissions and ESG value.

$$SN = \frac{SS - SSMin}{SSMax - SSMin}$$

SN = Normalized Score; SS = Sector Score; SSmin = Minimum Sector Score in the dataset; SSmax = Maximum Sector Score in the dataset.

3 Results and Discussion

According to the statistical results of Table 1, and in both ESG models (1) and (2), Carbon Emissions have rather a negative impact on ESG, but not statistically significant at least based on coefficients that are -0.00023 and -0.00028 respectively. This relationship is also statistically significant (sig 10% for ESG model (1) and sig 5% for ESG model (2). The expected signs for Carbon Emissions, are to be negative since more emissions lead to a higher firm's level of risk but effect magnitude is very small. This result is consistent with the finding that other determinants could have moved this relationship, e.g., corporate risk reduction activities or sustainability guidelines practised by the company.

Table 1. The Impact of Carbon Emissions and Industrial Sector

Variabel	ESG (1)	ESG (2)
Carbon Emission (CE)	0.0871 *	0.0226 **
	-0.00023	-0.00028
Industrial Sector (SI)		0.0000 *
		16.7805
R2	0.0247	0.2128

***, 1%; **, 5%; *, 10% significance levels respectively

With the Sobel test as mediator, obtained t = 2.4468 for the Sobel test StringComparison with average age of participants way (t = 3.316) results suggest a mediation effect. This t-

value is higher than the critical t- value of 5% level of significance (1.990). These findings suggest that the Industrial Sector acts as a statistical intermediary on the associations between Total Carbon Emissions and an individual company's ESG risk at p-value of 5%.

Thus, it seems that the impact of Total Carbon Emissions on a firm's ESG risk is partially intermediated by the Industrial Sector as Total Carbon Emissions influence the Industrial Sector (0.00000000130) which in turn affects ESG risk (16.7805). that the Industrial Sector operates as a mediator of the link between Total Carbon Emissions and ESG risk. These results suggest that the effect of carbon emissions on ESG risk manifests not only directly but also via characteristics of the industrial sector in which the firm operates.

Table 2. SDGs Effect

Variabel	ESG (1)
Carbon_Emission (CE)	0.0268 **
	-0.000001260
SDGs_Disclosure (SD)	0.0492 **
	-0.7665
CE*SD	0.0288 **
	0.00000010
R2	0.0551

***, 1%; **, 5%; *, 10% significance levels respectively

Further to the results shown in Table 2, reporting that SDGs Disclosure plays a moderating role on the association between Total Carbon Emissions and corporate ESG risk, this relationship is empirically confirmed. This is consistent with a positive interaction coefficient (CE*SD) of 0.0000010, which is statistically significant at the 5 % level. The results show Carbon Emissions had adverse impact on ESG with coefficient value of -0.0000000126021 and statistically significant at 5% level, Also SDGs Disclosure also negatively affecting the ESG with coefficient value of -.76655 and its significance was observed at 5%. The significant positive interaction coefficient implies a reinforcing moderation effect, meaning that the effect of Carbon Emissions on ESG risk is amplified when companies exhibit higher levels of SDG disclosure. It means that firms are more likely to have a significant carbon-
-ESG risk relationship for those with higher level of SDG disclosures, which may state the greater transparency and responsibility in mitigating environmental impacts.

Table 3. Truth Table Algorithm Results in fsQCA

Condition	Raw Coverage	Unique Coverage	Consistency
Score_CE*~Score_SDGs	0.00489362	0.002127660	0.359375
Score_CE*~Score_SecInd	0.00297872	0.000212766	0.318182

Solution Coverage : 0.00510638
Solution Consistency : 0.369231

This is consistent with the fsQCA results in table 3, illustrated by two main configurations found: (1) a constellation of high Total Carbon Emissions facilitates low SDG-transparency, with raw coverage of 0.00489362 (not even a full percent) and consistency of 0.359375 then (2) combination for high Total Carbon Emissions between sectors with high-enough ESG yields, where in this specification the configuration has raw coverage of 0.00297872 again not quite one per cent and con- sistency to 0.318182. Such combination of two factors has the worst solution coverage value with very low level (0.00510638 or 0.51%)

as well as solution consistency (0.369231), indicating that it is not meaningful with respect to explaining a FFC's ESG risk position.

Table 4. Analysis of Necessary Conditions for ESG Score

Condition Tested	Consistency	Coverage
Score_CE	0.005106	0.181818
Score_SecInd	0.651277	0.654060
Score_SDGs	0.808298	0.578234

In turn, both the necessary condition results in Table 4 show that Total Carbon Emissions is not a necessary condition (consistency 0.005106), followed by SDG Disclosure being more critical also as a necessary condition (consistency 0.808298) after the Industrial Sector (consistency 0.651277). Accordingly, we may infer that the selected combinations have little effect in explaining a company's ESG risk level and that untested factors might matter more.

Table 5. ANOVA test

ESG	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3567.341	9	396.371	6.518	0.000
Within Groups	4256.983	70	60.814		
Total	7824.323	79			

According to the data analysis results in Table 5 (ANOVA Test), ESG risk profiles differ among industrial sectors of companies. This is further verified by the ANOVA test in which p-value of 0.000 is found ($p < 0.10$), implying a variation in ESG values across industries. The Post-Hoc Bonferroni test analysis results (Table 6) offer a deeper understanding of these sectoral differences. The magnitude of the mean difference value in ESG values between Technology and the Industrial (20.62667) sector is bigger than that observed between Technology and Energy (19.07500) sectors. The Financial sector is significantly different with respect to the Energy sector (with a mean difference -12.96397). The Consumer Discretionary sector is particularly different from on the mean four other sectors: Consumer Staples (difference in means -15.48044), Industrials (difference in means -20.35933), Basic Materials (difference in means -10.80600) and Energy (difference in means -18.80767).

Table 6. Bonferroni Post-Hoc Test

(I) SecInd	(J) SecInd	Mean Difference (I-J)	Sig.
Technology	Industrial	-20.62667*	0.082
	Energy	-19.07500*	0.014
Finance	Energy	-12.96397*	0.004
Consumer Discretionary	Consumer Staples	-15.48044*	0.002
	Industrial	-20.35933*	0.008
	Basic Materials	-10.80600*	0.070
	Energy	-18.80767*	0.000
Consumer Staples	Consumer Discretionary	15.48044*	0.002
	Infrastructure	13.54819*	0.029
Industrial	Technology	20.62667*	0.082
	Consumer Discretionary	20.35933*	0.008
	Infrastructure	18.42708*	0.038
Infrastructure	Consumer Staples	-13.54819*	0.029
	Industrial	-18.42708*	0.038
	Energy	-16.87542*	0.000

(I) SecInd	(J) SecInd	Mean Difference (I-J)	Sig.
Basic Materials	Consumer Discretionary	10.80600*	0.070
Energy	Technology	19.07500*	0.014
	Finance	12.96397*	0.004
	Consumer Discretionary	18.80767*	0.000
	Infrastructure	16.87542*	0.000

According to Table 6, the infrastructure sector differs significantly different from both the Consumer Staples sector (mean difference -13.54819), the Industrials sector (mean difference -18.42708) and the Energy one (mean difference -16.87542). Across the four comparisons made in this piece, the Energy sector exhibits the greatest difference with Technology, Finance, Consumer Discretionary, and Infrastructure sectors; suggesting that its ESG risk profile is radically different from other sectors. All of these differences are at least significant at 90% ($\alpha = 0.10$) confidence level based on the Post-Hoc Bonferroni test results reported in Table 6.

4 Conclusions

ESG risk are sector-specific and needs a targeted mitigation strategy and the scope of such strategy as applied to specific sector; carbon emissions are not the sole driver of risk, but a mitigating role by industrial sectors within emission-risk relationship while SDG disclosure could enhance firm's ESG performance; and fsQCA indicates that simple configuration falls short but our integrated framework based on Contingency Theory with multi-analysis approach provides better explanation for emerging market situation.

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