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Geopolitical Risk, Climate Risk, and ESG Performance: Evidence from Energy Sector Companies Listed on the Indonesia Stock Exchange

Yohan Tristianto[1*], Dewi Hanggraeni[2], Indra Kusumawardhana[3]
Universitas Pertamina, Indonesia[1,3]
Universitas Indonesia, Indonesia [2]
Email: 203324213@student.universitaspertamina.ac.id[1*],
dewi_hanggraeni@yahoo.com[2], indra.kusumawardhana@universitaspertamina.ac.id[3]

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Abstract

Energy-sector companies increasingly face simultaneous geopolitical instability and climate-related pressures that may influence corporate sustainability strategies and Environmental, Social, and Governance (ESG) performance. This study aimed to examine the effects of geopolitical risk and climate risk on the ESG performance of energy-sector companies listed on the Indonesia Stock Exchange during 2020–2024. A quantitative explanatory design was employed using panel data from 60 companies, generating 300 firm-year observations selected through purposive sampling. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4, supported by bootstrapping, robustness testing, and Multi-Group Analysis. The results showed that geopolitical risk had a significant positive effect on ESG performance ($\beta = 0.082$; $p = 0.035$), while climate risk also had a significant positive effect ($\beta = 0.118$; $p = 0.001$). The model explained 49.7% of the variance in ESG performance, with firm size emerging as the strongest control variable. Multi-Group Analysis indicated that both effects were significant only among non-coal companies, suggesting heterogeneous sectoral responses within the Indonesian energy sector. These findings supported stakeholder and legitimacy perspectives, indicating that increasing external risks may encourage stronger ESG commitments through systematic organizational responses. The study concluded that geopolitical and climate risks should be integrated into corporate sustainability and risk-management strategies.

INTRODUCTION

Energy-sector companies operate at the intersection of two escalating systemic pressures: geopolitical instability and climate change. Geopolitical risk (GPR) has been identified as one of the major global business threats, manifesting through armed conflicts, trade restrictions, and sanctions that disrupt supply chains and increase financing costs (Cheng et al., 2025). At the same time, climate risk, consisting of physical hazards and transition pressures associated with decarbonization policies, is reshaping how energy firms manage resources, emissions, and stakeholder expectations (Yin et al., 2024). These two risks converge most directly in the energy sector, which supplies

essential commodities to the global economy while simultaneously facing substantial transition-risk exposure due to its greenhouse gas emission intensity.

In Indonesia, this convergence has become increasingly evident. The escalation of geopolitical tensions in the Middle East and disruptions in global energy routes have contributed to volatility in international oil prices, affecting the cost structures and cash flows of energy issuers on the Indonesia Stock Exchange (IDX), particularly those dependent on imported energy resources. At the same time, environmental concerns regarding Indonesia's continued reliance on fossil fuels, particularly coal, highlight challenges in achieving the country's Nationally Determined Contribution targets. ESG risk assessments published by Sustainalytics and reported through IDX also indicate significant variation within the energy sector, where coal-related issuers generally demonstrate higher ESG risks compared with renewable-energy companies. This pattern suggests that ESG performance heterogeneity within the energy sector is closely associated with differences in subsector exposure to transition risks (Alofaysan et al., 2026; Fliegel, 2025; Țăran et al., 2026).

Previous international studies have examined the relationship between geopolitical risk and ESG performance (Cheng et al., 2025; Lee & Wang, 2021) as well as the relationship between climate risk and ESG performance (Yin et al., 2024; Battiston et al., 2021), primarily as separate research streams and largely within the Chinese context. Studies that simultaneously examine both risks as interconnected systemic-risk factors, particularly using Indonesia-specific proxies such as national disaster-risk indicators for physical climate risk and greenhouse gas emission intensity for transition risk, remain limited, especially among IDX-listed energy companies. Furthermore, the direction of the geopolitical risk–ESG relationship remains theoretically ambiguous. Financing-constraint perspectives suggest that geopolitical uncertainty may negatively affect ESG investment due to increased financial pressure (Cheng et al., 2025). Conversely, stakeholder and legitimacy perspectives suggest that firms may strengthen ESG commitments as a strategic response to external pressure and the need to maintain legitimacy (Freeman, 1984; Suchman, 1995; Erzurumlu et al., 2025). This study addresses these gaps by examining the effects of geopolitical risk and climate risk on ESG performance among IDX energy companies during 2020–2024 using panel data comprising 300 firm-year observations. The study contributes by (1) jointly examining both risk dimensions within an integrated structural model, (2) incorporating Indonesian disaster-risk and emission-intensity indicators as climate-risk proxies, and (3) analyzing subsector heterogeneity through coal and non-coal Multi-Group Analysis.

Addressing these research gaps is increasingly important because geopolitical and climate risks continue to influence corporate financial decisions, sustainability commitments, and stakeholder relationships. Energy companies affected by geopolitical disruptions may experience higher financing costs, supply-chain disruptions, technological restrictions, commodity-market uncertainty, and pressure to adjust energy strategies. Simultaneously, climate-related disasters may damage physical assets and operational networks, while transition policies may increase compliance requirements

and investment needs for cleaner technologies. These conditions create uncertainty regarding whether ESG investment and disclosure will decline due to resource constraints or increase as firms seek legitimacy, investor confidence, and long-term resilience. Understanding these mechanisms is essential for investors evaluating sustainability risks, corporate managers developing enterprise risk-management strategies, and policymakers designing energy-transition policies that balance sustainability objectives with energy security. This investigation is particularly relevant given that the research population includes IDX-listed energy companies from coal, oil and gas, gas distribution, geothermal, and energy-support subsectors, providing an appropriate setting for examining heterogeneous corporate responses (Bagiana et al., 2026; Putri & Rahayu, 2026; Sura & Hasibuan, 2025; Widianingsih & Felicia, 2026).

The novelty of this study lies in integrating geopolitical risk and climate risk within a single empirical framework for publicly listed Indonesian energy companies rather than examining them as independent external pressures. More specifically, the study combines Indonesia-specific geopolitical-risk measures with climate-risk indicators representing both physical and transition dimensions. Physical climate risk is measured using the Indonesia Disaster Risk Index, while transition risk incorporates energy-sector greenhouse gas emission intensity relative to a baseline, thereby grounding the analysis in official Indonesian data sources. Furthermore, the study extends previous research by comparing coal and non-coal energy companies through Multi-Group Analysis to identify whether firms operating under different transition-risk conditions respond differently to systemic pressures. These characteristics distinguish the study from previous research concentrated primarily on China and from studies relying predominantly on text-based climate-risk measures. Therefore, this research does not merely replicate existing geopolitical risk–ESG or climate risk–ESG models but develops a context-specific framework for explaining sustainability responses within an emerging-market energy sector characterized by regulatory complexity, environmental challenges, and energy-security concerns.

Based on these considerations, this study aimed to empirically examine how geopolitical risk and climate risk influenced ESG performance among energy-sector companies listed on the Indonesia Stock Exchange during 2020–2024. Specifically, the study sought to determine whether geopolitical risk significantly affected ESG performance, whether climate risk significantly affected ESG performance, and whether both systemic risks jointly explained variations in corporate ESG performance after controlling for relevant firm characteristics. The study incorporated firm age, leverage, profitability, and firm size as control variables and analyzed panel data consisting of 300 firm-year observations from 60 energy companies, as specified in the research design. In addition, the study examined whether these relationships differed between coal and non-coal companies. This approach enabled the research to evaluate not only whether systemic risks influenced ESG performance but also the sectoral conditions under which these effects became more pronounced.

This research is expected to provide theoretical and empirical contributions. Theoretically, the study connects stakeholder and legitimacy perspectives with resource-constraint mechanisms to explain why geopolitical and climate risks may generate different ESG responses. From a resource-constraint perspective, increasing risks may limit financing capacity and reduce resources available for sustainability initiatives. Conversely, stakeholder and legitimacy perspectives suggest that greater external pressure may encourage firms to strengthen ESG practices and disclosures. This study contributes by empirically testing these competing explanations within the Indonesian energy sector rather than assuming a predetermined relationship. Empirically, the research provides integrated evidence regarding geopolitical and climate risks, introduces Indonesia-specific measures of physical and transition climate exposure, and examines subsector heterogeneity between coal and non-coal companies. These contributions expand the geographical scope of ESG-risk literature beyond the markets that dominate previous studies.

Ultimately, this study is expected to provide benefits for academic, managerial, investment, and regulatory decision-making. Academically, the findings contribute to ESG-performance literature by demonstrating how multiple systemic external risks interact within an emerging-market energy context. For corporate managers, the results may provide an empirical basis for integrating geopolitical and climate risks into enterprise risk management, sustainability strategies, capital allocation decisions, and stakeholder communication. For investors and creditors, understanding whether firms strengthen or reduce ESG commitments under systemic pressure can improve sustainability-risk assessment and investment decisions. For policymakers and regulators, evidence of different responses between coal and non-coal companies can support more targeted sustainability disclosure requirements, transition incentives, and environmental policies rather than uniform approaches across diverse energy subsectors. Thus, the contribution of this research extends beyond identifying statistical relationships and provides evidence to support more resilient corporate strategies and context-sensitive energy-transition governance in Indonesia while contributing internationally relevant insights to the growing literature on geopolitical risk, climate risk, and ESG performance.

METHOD

Research Design and Sample

This study applied a quantitative explanatory associative design using panel data. The population consisted of all energy-sector companies listed on the IDX under the IDX Industry Classification, including coal, oil and gas, gas distribution, geothermal, and energy-support subsectors (91 companies as of July 1, 2026). Purposive sampling was applied based on five inclusion criteria: continuous IDX listing before January 1, 2020; no permanent delisting during 2020–2024; availability of annual and/or sustainability reports for at least three of the five observation years; participation in the Ministry of Environment and Forestry's PROPER program in accordance with Ministerial Regulation No. 7/2025; and availability of audited financial statements. Based on these criteria, the

final sample consisted of 60 companies, generating 300 firm-year observations during 2020–2024.

Variable Measurement

Table 1 summarizes the operational definition, proxy, and data source of each construct.

Table 1. Operational definition of research variables

Construct	Symbol	Proxy / Measurement	Source
Geopolitical risk (X_1)	GPRC_IDN, GPR_ACTS, GPR_THREATS	Indonesia Geopolitical Risk index (Caldara & Iacoviello), annual mean, lagged t-2	matteoiacoviello.com/gpr
Climate risk (X_2)	CR_PHYS, CR_TRAN, CR_COMB	Physical risk: Indonesia Disaster Risk Index (IRBI); transition risk: energy-sector GHG emission intensity relative to a 2020 baseline; CR_COMB: combined indicator following Yin et al. (2024)	BNPB InaRISK; KLHK SIGNSMART; BPS
ESG performance (Y)	PROPER, GRI_IDX	PROPER environmental rating (1-5 ordinal) and GRI Standards 2021 disclosure index	KLHK PROPER; company sustainability reports; GRI
Control variables	AGE, LEV, ROA, SIZE	Years listed on IDX; total debt/total assets; net income/total assets; ln(total assets)	Audited financial statements

Model Specification

The three hypotheses are tested through the following structural equations, estimated jointly within a single PLS-SEM model:

$$ESG_{it} = \beta_0 + \beta_1 GPR_{i,t-2} + \beta_3 AGE_{it} + \beta_4 LEV_{it} + \beta_5 ROA_{it} + \beta_6 SIZE_{it} + \varepsilon_{it} \quad (1)$$

$$ESG_{it} = \beta_0 + \beta_2 CR_{it} + \beta_3 AGE_{it} + \beta_4 LEV_{it} + \beta_5 ROA_{it} + \beta_6 SIZE_{it} + \varepsilon_{it} \quad (2)$$

$$ESG_{it} = \beta_0 + \beta_1 GPR_{i,t-2} + \beta_2 CR_{it} + \beta_3 AGE_{it} + \beta_4 LEV_{it} + \beta_5 ROA_{it} + \beta_6 SIZE_{it} + \varepsilon_{it} \quad (3)$$

where ESG_{it} is the ESG performance of firm i in year t; $GPR_{i,t-2}$ is geopolitical risk lagged two years; CR_{it} is climate risk in year t; AGE, LEV, ROA, and SIZE are firm-level control variables; $\beta_0 ... \beta_6$ are structural path coefficients; and ε_{it} is the error term.

Data Analysis Technique

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 4, following the two-stage evaluation procedure of Hair et al. (2019): (1) measurement model (outer model) evaluation through convergent validity (outer loading, AVE), reliability (Cronbach's alpha, composite reliability), and discriminant validity (Fornell-Larcker criterion, HTMT); and (2) structural model (inner model) evaluation through the coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), model fit (SRMR), and hypothesis testing via one-tailed bootstrapping with 5,000 subsamples (95% confidence). Robustness was further examined through two-tailed bootstrapping, proxy substitution (an alternative historical GPR index), and Multi-Group Analysis (PLS-MGA) comparing coal and non-coal sub-sectors.

RESULTS AND DISCUSSION

Measurement Model Evaluation

All reflective indicators exceeded the 0.70 outer-loading threshold except the physical climate risk indicator (CR_PHYS, loading = -0.858), which was removed from the model following Hair et al. (2019). The three geopolitical risk indicators loaded almost perfectly (0.996-0.999), consistent with the mathematical aggregation of the Caldara and Iacoviello (2022) index. Average Variance Extracted (AVE) for all constructs exceeded 0.50 (geopolitical risk = 0.996; climate risk = 0.917; ESG performance = 0.803), and composite reliability (rho_c) exceeded 0.70 for all constructs (0.999; 0.957; 0.891, respectively), confirming convergent validity and reliability. Discriminant validity was supported by the Fornell-Larcker criterion, with the square root of AVE on the diagonal (0.998; 0.958; 0.896) exceeding all inter-construct correlations, and by HTMT ratios (0.129-0.250), all well below the 0.90 threshold (Henseler et al., 2015).

Structural Model Evaluation

The structural model explains 49.7 percent of the variance in ESG performance (R^2 = 0.497; adjusted R^2 = 0.487), a moderate effect according to Hair et al. (2019). Effect sizes (f^2) show that firm size contributes the largest individual effect (f^2 = 0.550, large), followed by climate risk (f^2 = 0.025, medium) and geopolitical risk (f^2 = 0.013, small); despite their modest effect sizes, both risk constructs remain statistically significant. Predictive relevance is strong (Q^2 predict = 0.475 > 0.35), the overall Goodness-of-Fit is strong (GoF = 0.671), and the model shows an acceptable fit (SRMR = 0.074, below the 0.08-0.10 threshold) (Henseler et al., 2014).

Hypothesis Testing

Table 2 summarizes the bootstrapped path coefficients based on the primary one-tailed procedure (5,000 subsamples, 300 firm-year observations).

Table 2. Structural path coefficients and hypothesis testing results (one-tailed)

Path	β	t-stat.	p-value	Decision
Geopolitical risk (X1) → ESG performance (Y)	0.082	2.109	0.018	H1 supported
Climate risk (X2) → ESG performance (Y)	0.118	3.269	0.001	H2 supported
Firm size (SIZE) → ESG performance (Y)	0.555	15.982	0.000	significant
Firm age (AGE) → ESG performance (Y)	0.091	2.061	0.020	significant
Leverage (LEV) → ESG performance (Y)	-0.074	1.951	0.026	significant
Profitability (ROA) → ESG performance (Y)	0.204	4.216	0.000	significant

Both geopolitical risk and climate risk exert a significant positive effect on ESG performance, supporting H_1 and H_2, while jointly with the control variables they explain 49.7 percent of ESG performance variance (R^2 = 0.497), supporting H3. Firm size is the dominant determinant of ESG performance, consistent with legitimacy theory (Freeman,

1984; Suchman, 1995) and prior evidence that larger firms face greater stakeholder visibility and disclosure pressure (Drempetic et al., 2019). The stability of these estimates is examined further in the robustness tests below.

Robustness Tests

Two complementary robustness procedures were performed to verify that H1 and H2 do not depend on the choice of significance test or on the specific GPR proxy used. First, path coefficients were re-estimated using two-tailed bootstrapping (5,000 subsamples), a more conservative test that does not pre-specify the direction of the relationship. Second, the geopolitical risk proxy GPRC_IDN was substituted with GPRHC_IDN, the historical GPR index constructed from three newspapers (Caldara & Iacoviello, 2022), and the full model was re-estimated and re-bootstrapped under identical procedures. Table 3 compares one-tailed and two-tailed significance for every structural path.

Table 3. One-tailed versus two-tailed bootstrapping results

Path	p-value (1-tailed)	p-value (2-tailed)	Decision (2-tailed, α = 0.05)
Geopolitical risk (X1) → ESG performance (Y)	0.018	0.035	Significant
Climate risk (X2) → ESG performance (Y)	0.001	0.001	Significant
Firm age (AGE) → ESG performance (Y)	0.020	0.039	Significant
Leverage (LEV) → ESG performance (Y)	0.026	0.051	Not significant
Profitability (ROA) → ESG performance (Y)	0.000	0.000	Significant
Firm size (SIZE) → ESG performance (Y)	0.000	0.000	Significant

Both focal paths, geopolitical risk and climate risk, remain significant under the more conservative two-tailed test (p = 0.035 and p = 0.001, respectively), and these two-tailed estimates are the values reported alongside the path coefficients in the abstract. Among the control variables, only leverage is sensitive to test type: it is significant one-tailed (p = 0.026) but sits exactly at the conventional two-tailed threshold (p = 0.051), so its effect is read as marginal and is not part of the core H_1-H_3 conclusions.

Table 4 compares the main model (GPRC_IDN) with the proxy-substitution robustness model (GPRHC_IDN).

Table 4. Main model versus proxy-substitution robustness model (two-tailed)

Aspect	Main model (GPRC_IDN)	Robustness model (GPRHC_IDN)
β geopolitical risk → ESG (p)	0.082 (p = 0.035)	0.082 (p = 0.037)
H_1 status	Supported	Supported
β climate risk → ESG (p)	0.118 (p = 0.001)	0.117 (p = 0.001)
H_2 status	Supported	Supported
R^2 (adjusted)	0.497 (0.487)	0.497 (0.487)
SRMR	0.074	0.075

The path coefficients, significance status, R^2, and SRMR are virtually unchanged across the two GPR proxies (coefficient differences below 0.001 for both focal paths),

indicating that H1 and H2 do not depend on the specific geopolitical risk index used and confirming the internal validity of the structural model.

The positive effect of geopolitical risk on ESG performance (H_1) diverges from Cheng et al. (2025), who report a negative effect in the Chinese A-share market driven by financing-constraint pressure, but is consistent with Erzurumlu et al. (2025), who find a positive GPR-ESG relationship across 37 countries, and with Alsagr and van Hemmen (2021), who show that geopolitical risk can accelerate renewable-energy adoption in emerging markets through diversification urgency. The Indonesian result supports the stakeholder and legitimacy based mechanism: as geopolitical uncertainty intensifies scrutiny from investors and creditors, energy companies, several of which operate under regulated pricing schemes and government-linked ownership, tend to strengthen ESG disclosure to preserve reputational standing and access to international financing. The two-year lag structure used for geopolitical risk also captures the delayed nature of corporate ESG responses documented by Lee and Wang (2021). At the same time, the effect size of geopolitical risk remains small ($f^2 = 0.013$) relative to firm size ($f^2 = 0.550$), indicating that geopolitical risk is a statistically relevant but secondary determinant of ESG performance among IDX energy companies, one that should inform rather than dominate corporate sustainability strategy.

The positive effect of climate risk on ESG performance (H_2) is consistent with Yin et al. (2024), who report the same direction in the Chinese market through financing-constraint and social-attention channels. This convergence across two emerging-market energy contexts strengthens the external validity of the legitimacy-based explanation: companies with higher physical and transition risk exposure operate under greater stakeholder pressure and are more likely to have adopted mature climate-risk disclosure frameworks, such as TCFD (2017), that reinforce broader sustainability reporting practices.

Multi-Group Analysis comparing coal and non-coal sub-sectors reveals a contrasting pattern: both geopolitical risk ($\beta = 0.143$, $p = 0.019$) and climate risk ($\beta = 0.212$, $p = 0.000$) are significant only among non-coal energy companies, while neither effect is significant among coal companies ($p = 0.907$ and $p = 0.392$, respectively); the structural model also fits better among non-coal firms ($R^2 = 0.595$, SRMR = 0.052) than among coal firms ($R^2 = 0.471$, SRMR = 0.075).

This pattern, initially counter-intuitive given coal's higher transition-risk exposure, is consistent with a saturation effect: large Indonesian coal issuers have long operated under mining-license schemes (PKP2B/IUPK) that mandate reclamation guarantees and PROPER compliance from the outset, leaving limited headroom for year-to-year ESG variation, whereas the more heterogeneous non-coal sub-sector, with its mix of upstream production-sharing contracts, trading and distribution entities, and recently listed issuers, shows greater responsiveness to rising risk exposure. Leverage is also negatively associated with ESG performance among coal companies ($\beta = -0.129$, $p = 0.012$) but not among non-coal companies ($\beta = 0.000$, $p = 0.998$), consistent with the capital-intensive, debt-financed nature of coal mining leaving less headroom for ESG investment beyond

minimum compliance. This saturation effect does not imply uniformly weaker ESG performance among coal issuers: notably, PT Alamtri Resources Indonesia Tbk (formerly PT Adaro Energy Indonesia Tbk) achieved consecutive PROPER Gold ratings from 2020 to 2024, a beyond-compliance outcome that illustrates how firm-level financial capacity and management commitment can still differentiate ESG performance within an already-mature regulatory baseline.

CONCLUSION

This study provides empirical evidence that geopolitical risk and climate risk both exerted significant positive effects on the ESG performance of energy companies listed on the IDX during 2020–2024, jointly explaining 49.7% of the variance in ESG performance. Unlike previous evidence from the Chinese market, Indonesian energy companies appeared to respond to increasing geopolitical and climate risks by strengthening rather than reducing their ESG commitments, consistent with stakeholder and legitimacy theories. However, this effect was concentrated among non-coal energy companies and remained relatively modest in magnitude compared with the influence of firm size, indicating that subsector transition-risk maturity and firm characteristics may jointly shape the relationship between systemic risks and ESG performance.

From a managerial perspective, the findings supported the integration of geopolitical and climate risks into Enterprise Risk Management (ERM) frameworks (COSO, 2017), with differentiated risk tolerances across subsectors and periodic stress testing against national energy-transition milestones. For regulators, differentiated incentives for subsectors with lower ESG disclosure maturity may help transform external risk pressures into more consistent improvements in sustainable performance across the energy sector. Future research should develop firm-level geopolitical risk measures, extend the observation period, and examine potential mediating mechanisms, such as capital intensity, to provide a deeper understanding of the pathways linking systemic risk exposure and corporate ESG performance.

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