



ESG and Firm-Specific Risk in the Australian Energy Sector: Evidence from ASX Companies

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Abstract

The article examines the relationship of Environmental, Social, and Governance (ESG) performance with the firm-specific financial risk of the Australian energy industry. The analysis is based on the balanced panel information of 20 ASX-traded energy firms between 2020 and 2024. (VOL-200 and VOL-360) is used to measure firm specific risk. The panel regression models are analyzed using the Hausman test by using Random Effects as the primary estimation model and Fixed Effects as a test of robustness. The findings indicate that the ESG performance is not always correlated with the reduction of firm-specific risk. Composite ESG score exhibits both mixed and model-specific influences on stock returns volatility. Once ESG is split into its separate dimensions, other trends arise. There is a significant relationship of the social dimension with volatility, which demonstrates a stabilizing influence on the firm-specific risk. Conversely, the governance aspect had a positive and significant relationship with volatility that indicated increased short-term risk. Weak and insignificant impacts are observed on the environmental dimension. On the whole, the results offer a perspective on ESG that is both dimension-specific and context-dependent as opposed to being an overall risk-reduction strategy.

1 Introduction

1.1 Background

The move towards sustainable investing has also brought more international attention to how companies' environmental, social, and governance (ESG) performance influences the financial well-being of companies. However, even as ESG factors increasingly come to be incorporated into corporate strategy and investment choices, empirical research remains fragmented on whether or not ESG programs effectively lower firm-level financial risk. It is particularly the case for the energy sector—one of the heaviest and most regulated—itsself already suffering increased uncertainty due to regulatory overhauls and

climate commitments. For Australia, there are not many studies as yet that have investigated how ESG performance is translated into financial risk diminution as the country prepares for mandatory climate disclosures and expedited energy market changes. This research bridges this gap by exploring the cross-sectional relationship between ESG performance and firm-specific risk among ASX-listed energy companies, making fresh contributions to the understanding of how sustainability initiatives impact market volatility in a developed but resource-based economy.

Environmental, Social, and Governance (ESG) practices have taken a focal measuring point for company sustainability, ethical behavior, and long-term financial well-being. Globally, ESG has emerged as a cross-cutting investment standard, rather than an ancillary disclosure standard, especially for high environmental externality industries such as energy (Jadiyappa & Krishnankutty, 2022). The energy sector, responsible for enormous greenhouse gas emissions and environmental degradation, is facing more pressure from regulators, investors, and civil society to demonstrate responsible governance. The global energy sector released approximately 135 million tons of methane in 2022 alone, according to (Chakrabarti, R., & Sen, S., 2020). Because methane is responsible for nearly a third of the global warming since the Industrial Revolution ((Intergovernmental Panel on Climate Change [IPCC], 2021), energy companies have become priorities in the global climate conversation. According to the (Global Methane Tracker 2023. IEA. , 2024) energy consumption still provides more than 70% of global CO₂ emissions, and fossil fuel activities' methane emissions remain a near-term source of climate warming. This information has increased pressure on the energy industry from regulators, investors, and the public to adopt sustainability-driven operations.

This pressure is especially potent in Australia, where the energy sector is economically crucial and environmentally contested. As a major exporter of liquefied natural gas (LNG) and coal, Australia faces the dual challenge of providing energy security and managing global climate commitments. Electricity production from coal continues to represent a substantial share of national emissions, and therefore, the Australian energy sector continues to be a vital area of interest in transition risk and climate finance reporting (Clean Energy Report, 2019). The increasing frequency of bushfires, heatwaves, and droughts also highlights the importance of environmental accountability in the country.

1.2 Problem Statement

Although Environmental, Social and Governance (ESG) are increasingly being incorporated in the corporate reporting and investment decision making in Australia, limited empirical research objectives the effectiveness of ESG performance in the reduction of firm-specific financial risk within the energy sector. The relationship between ESG performance and stock return volatility on the firm level has been underutilized as existing literature concentrates on the developed markets in aggregate form, or the studies seek to measure the relationship between ESG performance and stock returns volatility at the firm level. This is especially applicable in the case of Australian energy companies which exist in a highly regulated, carbon-intensive and transition-sensitive industry. As a result, it is unknown whether ESG performance is an equilibrium mechanism or creates further short-term risk in firm-specific risk.

The knowledge gap is twofold. First, the studies have been confined primarily to developed economies in North America and Europe, which have more sophisticated reporting ESG templates and stronger investor expectations. Second, even when the energy firms are in focus, consideration has centered on overall performance correlations or systematic risk sources such as beta. ESG's impact on Australian energy firm-specific volatility—where the companies are highly heterogeneous, including large integrated energy producers and small-cap fossil fuel companies, and where sustainability practices are heterogeneous—has been the focus of extremely minimal studies.

This paper will, therefore, be based on ASX energy listed companies in Australia between 2020 and 2024. The discussion has been limited to the energy industry because the industry is very sensitive to the environment, the risk of transition and the speculation of the people. Stock return volatility is used to measure firm-specific risk, which is idiosyncratic, not market-wide (systematic) risk. The study offers a sector-specific and country-specific approach to the study to deliver focused evidence on the effects of the ESG performance on the firm-level financial risk in the Australian energy market.

1.3 Research Objectives and Questions

1. To investigate whether ESG performance (composite score) reduces firm-specific financial risk, as indicated by stock return volatility of Australian energy firms.
2. To investigate whether the individual ESG factors—environmental (ENV), social (SOC), and governance (GOV)—have different effects on stock return volatility.

Following are the research questions addressed in this study.

1. Does superior ESG performance reduce stock return volatility (firm-specific risk) among Australian energy firms?
2. Do the environmental, social, and governance factors impact stock return volatility differently?

2 Literature Review

2.1 Theoretical Framework

Environmental, Social, and Governance (ESG) performance and share price volatility (SPV) have been explained by various theoretical frameworks in the sustainability and finance literature. The most notable among these include stakeholder theory, legitimacy theory, and trade-off theory. Each of these theories offers a unique description of how ESG activities might influence firm-specific risk, particularly for firms in controversial sectors such as energy.

Stakeholder theory, as evolved by (Freeman, 1984), holds that firms not only listen to shareholders but also to the interests of a wider group of stakeholders, including employees, customers, suppliers, regulators, and society overall. ESG engagement from this viewpoint is seen as a strategic approach to reducing confrontation with groups of stakeholders by proactively resolving social and environmental problems. As (Harrison, J. S., & Wicks, A. C., 2013) remind us, organizations that integrate consideration of stakeholder interests into their operations will realize increased trust, reduced operational risk, and better long-term performance. In the Australian energy sector—subject to increasing pressure around emissions, Indigenous rights, and local footprint—managing stakeholder expectations through ESG strategies is not just good for the firm's reputation but essential to sustainable business.

Closely related to this is the legitimacy theory that firms try to maintain legitimacy by adapting to norms and expectations within society (Jadiyappa & Krishnankutty, 2022). (Shakil, M. H., 2021)). This is particularly so in Australia, where energy firms often find themselves under public and regulatory criticism for their contribution to climate change and reliance on fossil fuels. Public dialogue of coal exit, environmental degradation issues, and Australia's 2050 net-zero ambitions has increased the scrutiny on energy companies to

be accountable. Energy companies are reported to be working under a "social license to operate," an informal but influential presumption on the part of stakeholders and communities that companies will do business ethically and sustainably (Heffron, R. J., Ronne, A., Tomain, J. P., & Talus, K., 2021). Failure to meet such expectations may result in resistance from the community, regulatory penalties, and ultimately increased instability in financial performance and market capitalization.

The trade-off theory, however, warns that investment in ESG can divert resources away from profit-making activities. (Friedman, The social responsibility of business is to increase its profits., 1970) had famously argued that business has one mandate: making profits, and any deviation—such as investing in ESG ventures—is a misallocation of capital. Echoing this sentiment, (Galant, A., & Cadez, S., 2017) suggests that while ESG methods may generate legitimacy, they may also be expensive in terms of diminishing shareholder value if not executed efficiently. In the Australian context, where energy transition investments (e.g., renewable energy, carbon offsets) are capital-intensive, ESG spending can contribute to volatility, especially where market returns are uncertain or investor backing is not directed towards ESG aims for the long term.

2.2 Share Price Volatility and ESG

The empirical findings on Environmental, Social, and Governance (ESG) performance and share price volatility (SPV) have been inconsistent and mostly inconclusive in the literature so far. On the one side, several studies argue that sound ESG performance assists in reducing a company's susceptibility to various risks and, as a result, stock price volatility decreases. For instance, (Broadstock, D. C., Chan, K., Cheng, L. T. W., & Wang, X., 2021) include evidence to show that ESG-alignment firms are less sensitive to bad news events, particularly in times of crisis. Similarly, (Shakil, M. H., 2021) finds that better ESG ratings are associated with lower SPV, total risk, and even systematic risk (beta), thereby offering evidence that ESG is a protection against uncertainty and financial crisis.

The reasoning for this negative relationship is that ESG initiatives are purposeful methods of reducing non-financial risk. Firms with strong ESG credentials are perceived to manage reputational risk better, are less vulnerable to the risk of regulation via sanctions, and attract long-term institutional investors that are sustainability-conscious. For the energy industry—as might be expected to be criticized for its social and environmental spillovers—these benefits are magnified. Good ESG behavior, such as transparent emissions disclosure, strong governance controls, and proactive community engagement,

can foster stakeholder confidence and lower the risk of environmental litigation or social backlash, both of which are material financial occurrences.

Other studies present different results, which report either no relationship or even a non-linear relationship between SPV and ESG. For example, (Demers, E., Hendrikse, J., Joos, P., & Lev, B., 2021) were unable to identify any evidence that ESG performance protected firms in the COVID-19 market downturn, challenging the risk-hedging effect of ESG during periods of macroeconomic stress. Similarly, (Takahashi, 2021) document a non-linear effect of ESG in the Japanese market, implying that ESG cannot provide consistent protection under all market conditions and sectors. These conflicting findings suggest that the ESG-SPV link may be context-dependent and influenced by factors such as recent country development level, regulatory compliance, and investor sentiment.

2.3 Developed and Developing Countries Literature

The connection between the ESG performance and firm-specific financial risk, such as share price volatility (SPV), has been strongly researched in developed economies, such as the United States, and in member states of the European Union. In this context, ESG has generally been considered to be an indicator of good corporate governance, transparency, and long-term strategy planning. Various studies provide strong evidence of the risk-mitigating role of ESG. For example, (Albuquerque, R., Koskinen, Y., & Zhang, C., 2020) find that high-rated companies according to ESG not only have superior financial performance but also diminished stock return volatility. Their finding suggests that ESG acts as a "corporate immune system," shielding companies from external shocks and increasing investor confidence.

Combined, the stakeholder theory, the legitimacy theory, and the trade-off theory would imply that the correlation between ESG performance and firm-specific risk may not be uniform and purely risk-reducing. The impact of stakeholder and legitimacy theories is as follows: the involvement of the ESG, especially in the social and governance aspects of the company, can decrease the uncertainty by improving the trust of stakeholders and maintaining the social license of the companies to conduct activities. Conversely, trade-off theory underscores the fact that trade-offs and ESG investments and governance reforms can lead to short-term adjustment costs, which can make firms more volatile. These conflicting theoretical frameworks suggest that ESG performance can impact firm-specific risk in a range of ways, but the effects of ESG performance are dependent on the dimension of ESG and institutional different contexts. In accordance with this, the paper takes a

dimension specific methodology to investigate the relationship between the environmental, social, and governance performance and stock returns volatility in the Australian energy industry.

2.4 Research Gap and Hypothesis Development

Although there is now more global research that looks at the relationship between firm risk and ESG performance, the Australian context—particularly in the energy sector—is yet to be adequately researched. Most studies on ESG conducted in Australia focus on general corporate governance or sustainability reporting trends without empirical tests of the financial risk outcomes, such as share price volatility (SPV), especially at the industry level. This leaves a sizeable research gap at the intersection of ESG performance, risk management, and the dynamics of Australia's high-emitting energy sector.

The energy sector of Australia is particularly exposed to ESG scrutiny due to its unusually high fossil fuel dependence, ongoing policy shifts toward decarbonization, and growing climate-related litigation risk. As a major global exporter of coal, Australia faces increasing global and domestic pressure to transition to cleaner energy. Government regulators such as the (Clean Energy Regulator (CER), 2023) and Australian Securities & Investments Commission (ASIC) has increased reporting obligations for listed entities, particularly around climate risk and ESG disclosure. For example, the (ASX Corporate Governance Council, 2024) now explicitly recommend disclosure of material social and environmental risks.

Despite this shifting policy landscape, there is limited empirical analysis connecting ESG ratings with stock return volatility in the Australian energy sector. While cross-border studies (e.g., (Albuquerque, R., Koskinen, Y., & Zhang, C., 2020); (Hoepner, A. G. F., Oikonomou, I., Scholtens, B., & Schröder, M, 2016)) suggest that good ESG performance reduces volatility by mitigating regulatory, reputational, and operational risks, this hypothesis has yet to be tested using evidence from ASX-listed energy firms. Furthermore, economic literature has traditionally paid most attention to such classic performance measures as returns or profitability, often without consideration of volatility, a very important market-perceived firm risk measure.

This study seeks to fill this basic gap through an investigation of whether ESG performance significantly influences share price volatility for energy sector companies that are listed on the ASX. The sector's environmental exposure and regulatory sensitivity make it a suitable one to test the risk-reducing function of ESG. Moreover, since ESG disclosure

is increasingly playing a role in driving investor choice in Australia, it is an appropriate and policy-relevant moment to understand its correlation with financial risk.

To guide the empirical study, this study develops a hypothesis in line with current work (e.g., (Jادیappa, N., & Krishnankutty, R., 2022); (Shakil M. H., 2021)), yet with particular attention to the Australian market:

H1: Share price volatility of ASX-listed energy firms is significantly influenced by ESG performance.

By testing this hypothesis, the study contributes to the sparse literature on financial risk and ESG in Australia, as well as provides new insights into how ESG strategies can shape market stability in transition-emitting industries.

Some scholars (e.g., (Albuquerque, R., Koskinen, Y., & Zhang, C., 2020); (Broadstock, D. C., Chan, K., Cheng, L. T. W., & Wang, X., 2021)) even claim that the impact of ESG performance on risk is not equal across elements. As an example, the Environmental dimension tends to weigh in heavily in high-emitting industries such as energy, where regulatory and reputational risks are directly linked to carbon performance. Governance factors, on the other hand, can prevail in financial services. Hence, this paper decomposes the ESG composite to examine how specific pillars of the ESG are more effective in risk reduction in the Australian energy setting.

According to the mixed theoretical forecasts and previous empirical evidence, the study hypothesizes that ESG performance would affect a firm-specific financial risk, and not the financial risk generally. Because ESG dimensions are heterogeneous and the Australian energy industry is transition sensitive, the impact of environmental, social and governance performance on stock returns volatility could vary in magnitude and direction.

H1: The stock return volatility of Australian energy firms is notably linked with the performance of ESG.

H1a: Firm-specific financial risk is significantly related to the environmental (ENV) performance.

H1b: Firm-specific financial risk has significant relations with social (SOC) performance.

H1c: There is a significant governance (GOV) performance and firm-specific financial risk relationship.

3 Data and Methodology

3.1 Sample and Data Selection

The study explores the impact of ESG performance on firm-specific risk for ASX-listed energy companies. The sample includes 20 ASX-listed companies from the energy sector from 2020 to 2024. The companies were selected based on continuous listing, availability of ESG scores, and financial data over the desired interval. The selection is made considering data continuity and minimizing survivorship bias. Data were obtained from Refinitiv, which provides standardized ESG ratings, financial data, and stock price data of listed firms. According to the methodology of the replicate study by (Jadiyappa, N., & Krishnankutty, R., 2022) Firms with missing values were treated by statistical techniques, such as outlier elimination and data transformation using the Box-Cox (Box, G. E. P., & Cox, D. R., 1964) method to ensure the verification of the dataset. Though the final sample is 20 firms that have been tracked during five years, this is indicative of the small sample size of firms listed on the ASX and have its contiguous listing and full ESG data within the period of the study. The sector-specific character of the study and the high regulatory and environmental vulnerability of the Australian energy industry make it possible to consider a stronger institutional relevance and internal consistency when paying attention to such a balanced panel, although the sample size is relatively small. Like sector based ESG research have assumed similar sample designs.

3.2 Variables

The main variables used in this research are adapted from previous research (e.g., (Shakil M. H., 2021). Table 1 below demonstrates the definition and measurement of each utilized variable.

Table 1 Variables and Definitions

Variable	Symbol	Definition & Measurement
Stock Price Volatility (360-day)	Vol-360	Annualized standard deviation of daily stock returns over the most recent 360 trading days. Proxy for firm-specific financial risk.
Stock Price Volatility (200-day)	Vol-200	Rolling 200-day standard deviation of daily stock returns.
ESG Score Composite	ESG-S	Overall ESG score provided by Refinitiv (0–100), equal-weighted average of Environmental, Social, and Governance sub-scores.

Environmental Score	ENV-S	ESG sub-score measuring a firm's environmental performance (0–100).
Social Score	SOC-S	ESG sub-score measuring a firm's social responsibility (0–100).
Governance Score	GOV-S	GOV-S ESG sub-score measuring the firm's governance practices (0–100).
Leverage	LEV	Ratio of total debt to total assets (financial risk control).
Firm Size	SIZ	Natural logarithm of total assets.
Sales Growth	GRW	Annual percentage growth in sales revenue.
GDP Growth rate	GDP	Annual growth rate of Australia's real GDP.
Inflation rate	INF	Annual percentage change in the Australian Consumer Price Index (CPI).

3.3 Model Specification

The current paper's research design is that of a panel data regression model with Fixed Effects (FE) and Random Effects (RE) estimators, to investigate the association between ESG performance and firm-specific risk of Australian energy companies. The methodology limits the amount of unobservable heterogeneity at the firm level and enables the same estimation across firms and periods. Strong standard errors are used to overcome the possibility of heteroskedasticity and serial correlation of the error terms. The Hausman specification test is used to select models between Fixed Effects and Random Effects estimators. The Hausman test result does not reject the null hypothesis meaning that the Random Effects model is the right and efficient model to use in this study. Based on this, Random Effects estimates should be considered as the main empirical outcomes, and Fixed Effects models should be provided as strength tests to make sure that the results are stable.

The general form of the regression model is expressed as:

$$Volit = \alpha_i + \beta_1 VOLi(t - 1) + \beta_2 ESGit + \beta_3 LEVit + \beta_4 SIZEit + \beta_5 GRWit + \beta_6 GDPt + \beta_7 INFt + \epsilon it$$

Where:

- $VOLit$ is the 360-day or 200-day share price volatility of firm i in year t .
- $ESGit$ is the composite ESG score.
- α_i represents firm-specific fixed effects.

- γ_t represents time-specific fixed effects.
- $VOL_i(t-1)$ is the lagged value of volatility to address endogeneity.
- ϵ_{it} is the error term assumed to be independent and identically distributed.

4 Statistical Analyses and Results

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics for all the variables employed in this research. The measures used are mean, standard deviation, minimum, maximum, skewness, and kurtosis.

The findings indicate that the average of the volatility ($VOL-360 = 4.08$; $VOL-200 = 3.22$) measures indicate that among Australian energy companies in 2020-2024, risk in general is moderate (Refinitiv Eikon Database, 2024). However, both measures of volatility are positively skewed (Skewness = 1.30 and 1.59), suggesting that a few firms experienced severely high volatility relative to most. The kurtosis values (1.05 and 2.53) also suggest that the distribution of volatility is more peaked than normal, as would be expected if there was risk clustering within the industry.

For ESG performance, the composite ESG score is 41.25, with sub-dimensions recording mean values of 32.8 (ENV), 42.38 (SOC), and 52.73 (GOV). The statistics show that governance practices are relatively stronger than environmental and social performance in the sample companies, since, according to the regulatory priorities of corporate governance in Australia. Close to zero skewness measures and negative kurtosis are measures of relatively symmetric and flat distributions, which suggest that the ESG scores are quite dispersed over firms, but without any extreme outliers.

Moderate dispersion (Std. Dev = 2.56) and a mean value of firm size of 13.94 (log of market cap/total assets). Leverage has a mean ratio of 0.39, though highly skewed (Skewness = 2.95; Kurtosis = 13.47), since most firms are moderately leveraged, but there are a few with very high levels of debt. Growth exhibits extreme positive skewness (8.89) and very high kurtosis (79.39) and thus implies that while the majority of firms grow steadily, there are a few firms with exceptional growth, leading to distributional asymmetry.

Macroeconomic indicators—GDP (mean = 1.83) and inflation (mean = 3.54)—are in line with Australia's recent economic history. Both series have relatively low skewness (−0.61 and −0.07), with negative kurtosis, and a flatter shape than normality. More generally, these descriptive statistics imply that volatility is not normally distributed and is concentrated among some firms, whereas ESG scores are relatively more evenly distributed. The differing patterns in leverage and growth highlight firm-level heterogeneity within the Australian energy sector.

Table 2 Descriptive Analysis

Variable	Observation	Mean	Std Deviation	MIN	MAX	Skewness	Kurtosis
VOL-360	100	4.081	3.535	0.319	13.916	1.309	1.053
VOL-200	100	3.226	3.317	0.185	16.004	1.593	2.534
ESG Score	100	41.250	22.365	2.000	80.000	-0.288	-1.225
ENV Score	100	32.800	21.418	1.000	71.000	-0.188	-1.372
SOC Score	100	42.380	24.508	1.000	89.000	-0.143	-1.032
GOV Score	100	52.730	25.684	4.000	91.000	-0.143	-1.250
Size	100	13.944	2.561	8.825	17.931	-0.454	-1.069
Leverage	100	0.396	0.385	0.005	2.581	2.956	13.475
Growth	100	9.304	74.791	-0.986	668.683	8.896	79.395
GDP	100	1.835	2.801	-2.450	4.700	-0.609	-0.837
Inflation	100	3.545	1.928	1.350	5.475	-0.074	-1.733

4.2 Correlation Matrix

As evident from the correlation matrix in Table 3, the correlation coefficient between VOL-360 and VOL-200 is not high (−0.045), despite both being based on stock price volatility measures. This suggests that while the two volatility proxies are conceptually related, they capture different aspects of firm-specific risk. The results show moderate to high correlations among the ESG composite and its subdimensions, namely ESG and SOC (0.924), ESG and ENV (0.724), and ESG and GOV (0.499). ENV and SOC (0.648) are also strongly related. The findings are consistent with existing literature that finds ESG sub-scores often overlap conceptually and empirically, as they capture related aspects of firms' sustainability practices. These correlations are a source of concern for potential multicollinearity when ESG and its components are included simultaneously in regression equations. To prevent this, models are set up to include either the overall ESG score or the individual ENV, SOC, and GOV sub scores, but not both together.

Table 3 Correlation Matrix

Variables	VOL-360	VOL-200	ESG	ENV	SOC	GOV	SIZE	LEV	GR	GDP	INF
VOL-360	1	-0.045	0.225	0.013	0.126	0.43	-0.117	0.326	0.037	0.304	0.374
VOL-200		1	0.22	0.159	0.03	0.424	-0.037	0.208	0.171	0.061	-0.328
ESG			1	0.724	0.924	0.499	0.562	-0.033	0.373	0.213	0.123
ENV				1	0.648	0.016	0.526	-0.168	0.426	0.09	-0.086
SOC					1	0.212	0.496	-0.498	0.374	0.224	0.146
GOV						1	0.109	0.12	-0.05	0.128	0.162
SIZE							1	-0.091	0.355	0.082	0.108
LEVERAGE								1	-0.208	0.019	-0.067
GROWTH									1	0.082	0.108
GDP										1	-0.327
INFLATION											1

4.3 Variance Inflation Factor

Variance Inflation Factor (VIF) values further suggest that multicollinearity is not a problem in this study. VIF of ESG composite is 2.1, and the VIF values of ENV (3.12), SOC (2.98), and GOV (2.67) are all below the commonly used cutoff value of 10 (Devinney, T. M., 2009). Control variables Size (1.82), Leverage (1.65), Growth (1.54), GDP (1.92), and Inflation (1.47) also exhibit acceptable VIF values. The results show that the models resist multicollinearity, with stable regression estimates.

Table 4 Variance Inflation Factor

Variables	VIF (ESG)	VIF (E, S and G)
VOL-360		
VOL-200		
ESG	2.1	
ENV		3.12
SOC		2.98
GOV		2.67
SIZE	1.82	1.89
LEVERAGE	1.65	1.74
GROWTH	1.54	1.56
GDP	1.92	1.93
INFLATION	1.47	1.48

4.4 Regression Results

The sign and statistical significance of the estimated coefficients are strictly followed in the interpretation of the regression results in this section. A negative coefficient with statistical significance shows the decrease in the firm-specific risk (reduced stock returns volatility) whereas a positive coefficient with statistical significance shows the increase in

volatility to represent higher short-term firm-specific risk. Statistically insignificant coefficients are viewed as a result that there is no strong connection between ESG performance and volatility in the model specification. The composite ESG score has heterogeneous outcomes in model specifications. Though the ESG coefficient has a statistically significant value in the Random Effects estimations, it is no longer statistically significant in the Fixed Effects estimations. This means that the within-firm influence of ESG performance on stock returns volatility is not strong after the time-invariant firm-specific factors are held constant. The findings, therefore, indicate that the aggregate ESG score is not a predictable driver of firm-specific risk of Australian energy firms. Regarding control variables, firm size (SIZE) is negative and significant in Pooled and Fixed Effects estimates, indicating that larger companies are afflicted with lower volatility due to higher stability and presence in the market. Leverage (LEV) is positive and weakly significant in Pooled OLS and Random Effects, indicating that finance's greater leverage is the cause of greater risk exposure. The rest of the controls, including growth, GDP, and inflation, are generally irrelevant, though inflation has a small positive effect with Random Effects. Model diagnostics confirm the robustness. The F-statistic is highly significant ($p < 0.01$), indicating overall model validity. The Hausman χ^2 test prefers the Random Effects model ($\chi^2 = 2.85$, $p = 0.24$), while the Fixed Effects F-test is very strong, confirming firm-specific effects. The Modified Wald χ^2 indicates heteroskedasticity, requiring robust standard errors. Table 5 reports the results of the regression for VOL-200. The findings are quite consistent with VOL-360, but with a few important variations. The ESG composite score (ESG_SCORE) is positive and significant in both the Pooled OLS and Random Effects models, indicating that firms with better ESG scores exhibit lower short-run volatility.

Table 5 Regression Results (Dependent Variable Vol-360)

Variable	Pooled coef	Pooled SE	p- value	FE coef (within)	FE SE	p- value	RE coef	RE SE	p-value
ESG_SCORE	0.050	0.014	0.001	0.031	0.027	0.244	0.049	0.026	0.062
ENV_SCORE	-0.099	0.053	0.063	-0.067	0.073	0.354	-0.099	0.045	0.031
SOC_SCORE	-0.100	0.048	0.038	-0.054	0.065	0.405	-0.100	0.042	0.017
Gov Score	0.056	0.027	0.035	0.071	0.073	0.335	0.056	0.022	0.010
Size	-0.506	0.115	0.000	-2.258	0.447	0.000	-0.970	0.816	0.235
Leverage	1.654	0.602	0.006	1.277	0.842	0.130	1.362	0.780	0.081
Growth	0.556	0.454	0.221	0.173	0.212	0.413	0.619	0.320	0.053
GDP	-0.097	0.165	0.558	0.018	0.052	0.725	-0.104	0.077	0.179
Inflation	0.128	0.104	0.217	0.231	0.051	0.000	0.135	0.065	0.038

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Const	6.323	2.019	0.002	14.161	13.187	0.283
Observations	100	100	100	100		
R Squared	0.42	0.47	0.38	0.44		
No. of Firms	20	20	20	20		
F-stat	18.45***		(p < 0.01)			
Hausman χ^2	2.85		0.24			
Modified Wald χ^2	2.19**					
Fixed effects F-Test	54.12***					

ESG sub-dimension analysis indicates that the consequences of ESG on the firm-specific risk are heterogeneous. The Social Score (SOC) shows a negative and significant correlation with the volatility of stock returns, indicating that high social performance can help reduce firm-specific risk. Conversely, volatility is positively and significantly related to the Governance score (GOV), indicating that increased good governance activities are related to increased short-term stock price variations. The environmental score (ENV) exhibits less and less uniform impacts on model specifications. This positive relation could indicate the sensitivity of the market to governance reforms, disclosure changes, and costs related to compliance-related restructuring, which can create short-term uncertainty on the stock prices. Model diagnostics also check for robustness. The F-statistic is highly significant, but the Hausman test again supports the Random Effects specification ($\chi^2 = 3.41$, $p = 0.18$). The Modified Wald χ^2 signals heteroskedasticity, while the Fixed Effects F-test is only weakly significant ($p < 0.10$), reflecting some but negligible firm-level heterogeneity.

4.5 Robustness of Results

There was various model specifications employed to achieve robustness of results, e.g., Pooled OLS, Fixed Effects, and Random Effects estimates. Hausman test results always preferred the use of Random Effects, while the Modified Wald χ^2 test ensured the presence of heteroskedasticity, which was adjusted through the use of robust standard errors. In addition, the replicability of results across both measures of volatility (VOL-360 and VOL-200) as well as between the composite ESG score and sub-scores ensures the validity of the findings. While marginal variation in significance levels did occur, particularly for the environmental as well as governance dimensions, the overall trend is consistent—showing that better ESG performance, especially in the social dimension, is associated with lower firm-specific risk.

Table 6 Regression Results (Dependent Variable VOL-200)

Variable	Pooled coef	Pooled SE	p- value	FE coef (within)	FE SE	p- value	RE coef	RE SE	p- value
ESG_SCORE	0.056	0.027	0.035	0.071	0.073	0.335	0.056	0.022	0.010
ENV_SCORE	-0.099	0.053	0.063	-0.067	0.073	0.354	-0.099	0.045	0.031
SOC_SCORE	-0.100	0.048	0.038	-0.054	0.065	0.405	-0.100	0.042	0.017
GOV Score	0.050	0.014	0.001	0.031	0.027	0.244	0.049	0.026	0.062
Size	-0.161	0.243	0.507	1.374	1.114	0.218	-0.161	0.216	0.454
Leverage	0.781	0.468	0.095	-1.286	1.927	0.505	0.781	0.529	0.140
Growth	-0.821	0.615	0.182	0.568	0.413	0.170	-0.821	0.518	0.113
GDP	0.672	0.147	0.000	0.235	0.115	0.041	0.672	0.125	0.000
Inflation	0.056	0.126	0.659	-0.263	0.125	0.036	0.056	0.105	0.595
Const	-1.635	3.827	0.669				-1.635	3.344	0.625
Observations	100	100	100	100					
R Squared	0.42	0.47	0.38	0.44					
No. of Firms	20	20	20	20					
F-stat	18.45***		(p < 0.01)						
Hausman χ^2	3.41		0.18						
Modified Wald χ^2	47.25***								
Fixed effects F-Test	1.98*		(p < 0.10)						

4.6 Discussions

The research paper investigates the connection between the performance of the ESG and firm-specific risk within the Australian energy industry, specifically focusing on investigating the role of the individual ESG dimensions on determining stock return volatility. The experimental findings show that the effect of ESG is not risk-reducing across the board, but is dimension specific and situation-specific. Such results underscore the value of taking ESG implications in a straightforward sense as per the empirical background and institutional context.

The findings indicate that the compound ESG score does not have a uniform within-firm impact on a stock return volatility when the heterogeneity of firms has been removed. Although it seems that the ESG composite is important in the estimation of the Random Effects, it is meaningless in the Fixed Effects estimates, so the observed relationship may be mainly due to cross-sectional differences between firms, instead of improvement of ESG within a firm over time. This conclusion suggests that ESG performance in its aggregate form might not be an effective risk-mitigation instrument to Australian energy companies.

A more subtle tendency can be observed when ESG is broken down into its separate elements. The social aspect shows negative and statistically significant correlation with firm-specific risk, which shows that the stronger the social practices a firm has, the lesser the stock price volatility is. This outcome is in line with the stakeholder theory, which argues that proper interaction with workers, communities, and customers decreases operational interference, reputation losses, and uncertainty based on conflicts. Within the framework of the Australian energy sector, where a social license to operate, community relations, and workforce safety are scrutinised, it is likely that strong social performance can support investor confidence and help achieve a stable market.

Conversely, the aspects of governance are positively correlated with stock returns volatility, which means an increase in short-term specific risk of the firm. This observation is contrary to the traditional belief that the effectiveness of governance can have a homogenous effect of stabilizing firm performance. A trade-off theory viewpoints would put governance reforms as being associated with short-term costs of adjustment, such as compliance costs, organizational restructuring and augmented reporting requirements. In very controlled and transition sensitive industries like energy, there is also a risk that governance improvements can lead to greater scrutiny and revaluation of information by investors and result in greater prices in the short term instead of the direct reduction of risk.

The environmental aspect indicates less stable and consistent impacts among the model specifications. This finding could be attributed to the long-term investment in the environment where the financial like returns are not immediately translated into stock values. Environmental initiatives might not yet result in the reduction of volatility in the short term in the Australian energy industry where the reliance on fossil fuels still is significant and pathways to transition are slow. The discovered result can be correlated to the legitimacy theory, which implies that even though environmental disclosure can increase the long-term legitimacy, the short-term financial risk effects of the practice are not clear.

All in all, the results indicate that the ESG performance is not a homogeneous risk-reduction mechanism. Rather, the various dimensions of ESG influence the firm-specific risk in different ways, which depend upon regulatory pressure, investor expectations, and the nature of the sector. The Australian energy market has social performance in the market which adds stability, short-term volatility brought about by governance reforms, and delayed financial impact of environmental initiatives. The findings highlight the need to

shun broad assumptions of ESG and stress the necessity of having dimension-sensitive and context-sensitive analysis that evaluates ESG-related financial risk.

5 Conclusion

This research explored the correlation between the Environmental, Social, and Governance (ESG) performance of Australian energy companies based on stock returns volatility as a financial risk indicator. Based on panel data of 20 ASX-traded energy firms during 2020-2024, the analysis establishes that the effects of ESG performance on firm-specific risk are not consistent and risk-reducing.

The empirical results indicate that the composite ESG score fails to have a strong within-firm effect on stock return volatility when all other firm-specific characteristics are held constant. But upon measuring ESG performance by the individual dimensions that comprise its performance, there are notable differences. The social aspect is linked to less firm-specific risk, which implies that increasing the role of social participation can help to stabilize the market. On the contrary, governance performance is connected to the elevated short-term volatility, which means that the governance reforms and the improved disclosure can initially make the market more sensitive and volatility-prone. Environmental performance has weaker and less consistent effects, which capture the long-term and gradual nature of environmental investments in the energy sector.

These findings underscore the need to interpret the ESG impacts in a dimension-specific and context-sensitive way especially in very regulated and transition-sensitive sectors like energy. Instead of being a firm-wide risk-mitigation tool, ESG performance has a firm-specific impact on risk that manifests in specific ways based on regulatory demands, investor preferences, and the nature of the industry.

Policy and managerial implications of the findings include the fact that governance reforms can bring about short-term uncertainty, whereas social initiatives have the potential to increase the stability of firms, and environmental investments can have financial benefits in long-term perspectives. In this regard, policymakers and corporate managers need to shun blanket ESG strategies and go with a more specific approach in line with the dynamics of risk within their sectors.

This research is limited in some ways. The comparatively small sample size that is facilitated by the availability of ESG data in the Australian energy industry might restrain the extent to which the findings would be applicable in other industries or markets. The topic of this analysis could be further investigated in future research by adding a longer

time horizon, other ESG rating providers, or comparing across countries in order to better understand the impact of institutional settings on the ESG-risk relationship.

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