# ESG risk profiles and financial performance: A multi-sector analysis of market returns

(ID) **Eka Sudarmaji[1+]**

(ID) **M. Rubiul Yatim[2]**

(ID) **Herlan[3]**

(ID) **Arya Jati Kusuma Al-Ansori[4]**

[1,2,3,4]*Faculty of Economic and Business, University of Pancasila, Indonesia.*
[1]*Email: esudarmaji@univpancasila.ac.id*
[2]*Email: mrubiulyatim@univpancasila.ac.id*
[3]*Email: herlan@univpancasila.ac.id*
[4]*Email: aryalansori04@gmail.com*

*(+ Corresponding author)*

## ABSTRACT

This study aims to clarify how Environmental, Social, and Governance (ESG) risk components environmental, social, governance, and controversy scores, influence year-to-date (YTD) returns while considering industry-specific effects. It explores the relationship between ESG risk profiles and financial performance across 377 S&P 500 companies from various sectors. A multi-method analytical framework was employed on a cross-sectional dataset (January–December 2023) obtained from Kaggle, which includes Yahoo Finance financial data and Sustainalytics ESG measures. Regression models based, extended, and complete with industry controls quantified the ESG-return link. Descriptive statistics, ANOVA, and clustering approaches identified sectoral ESG risk patterns. When paired with sector controls, ESG risk ratings accounted for 41.2% of YTD return variation, indicating non-linear effects: moderate-risk companies usually outperformed high- and low-risk counterparts. Sector heterogeneity was notable; Energy and Utilities (high ESG risk) showed different return patterns than Technology and Real Estate (low ESG risk). While controversy ratings had little predictive value, environmental and governance concerns were the main drivers of ESG scores. Industry was underscored as a significant risk predictor; a logistic regression classified sectors by ESG risk with 98.9% accuracy. Since ESG's financial influence is sector-dependent, investors should consider industry context and ESG profiles in their decisions. Some industries, such as technology, may emphasize governance, while companies in high-risk industries, like Energy, may prioritize environmental concerns. These findings assist managers and legislators in customizing ESG plans to fit relevant sector-specific elements.

**Contribution/Originality:** This study demonstrates significant sectoral heterogeneity in ESG risk profiles across 377 S&P 500 companies. We reveal non-linear ESG-performance relationships and show that incorporating industry controls improves explanatory power. Environmental and governance components primarily drive ESG scores, informing sector-specific investment strategies.

## 1. INTRODUCTION

Over the last ten years, including Environmental, Social, and Governance (ESG) criteria in investment decision-making has gained notable momentum. Understanding how ESG risk profiles relate to financial performance has become essential for investors, business managers, and legislators as sustainable investment transitions from niche to mainstream. Whether better ESG performance results in improved financial returns remains subject to debate; empirical data has shown varied outcomes across different markets, time frames, and approaches. ESG risk assessment aims to measure firms' exposure to ESG-related factors that could significantly impact their operational activities and financial performance. Typically, these evaluations encompass governance issues (including board composition,

executive pay, and corporate ethics), social issues (such as labor practices, product safety, and community relations), and environmental issues (like carbon emissions, resource use, and pollution). Controversial ratings also reflect events that may indicate poor handling of ESG concerns.

Recent market trends indicate increasing investor interest in businesses with good ESG credentials. A 2023 Global Sustainable Investment Alliance study claims sustainable investments totaled $35.3 trillion worldwide or 36% of professionally managed assets. This change shows evolving investor values and increasing awareness that ESG elements may be significant financial opportunities and concerns. Regulators have reacted by enacting disclosure policies, including the SEC's suggested climate disclosure regulations and the EU's Sustainable Finance Disclosure Regulation (SFDR). Several points of view provide the theoretical foundations for the ESG-financial performance link. From a risk management perspective, effective ESG practices might reduce operational, reputational, and regulatory risks, thereby lowering volatility and capital costs (Friede, Busch, & Bassen, 2015). According to the resource-based perspective, better ESG performance could indicate organizational capacity generating competitive benefits (Porter & Kramer, 2011). Stakeholder theory holds that improved long-term financial success results from attending to the needs of many different stakeholders (Freeman, Phillips, & Sisodia, 2020).

On the other hand, critics say that too much emphasis on ESG elements might divert management from fundamental company operations and lower shareholder returns (Cheng, Ioannou, & Serafeim, 2014). Based on efficient markets, traditional finance theory would imply that any ESG-related information should already be included in asset pricing, excluding anomalous returns based on ESG criteria (Fama & French, 2018). Empirical results remain ambiguous despite many studies. With almost 60% of research finding positive correlations, meta-analyses by Friede et al. (2015) and Whelan, Atz, Van Holt, and Clark (2021) suggest a generally favorable link between ESG performance and financial results. However, according to other research, notable differences exist between sectors, areas, and historical times. Some studies indicate non-linear links in which moderate ESG performers outperform ESG leaders and laggards (Barnett & Salomon, 2012). Mediating the ESG-financial performance link is especially influenced by industry and sector settings. High-impact industries such as Energy and Utilities have distinct ESG issues compared to service-oriented sectors like Technology or Finance (Eccles, Ioannou, & Serafeim, 2014).

Furthermore, the relative relevance of certain ESG elements differs across sectors; for example, environmental issues can be more relevant for extractive industries, whereas social concerns might predominate in consumer-facing companies (Khan, Serafeim, & Yoon, 2016). By examining how ESG risk profiles relate to financial performance across various sectors and businesses, this research contributes to the existing body of knowledge. Utilizing multiple statistical methods to explore correlations between ESG risk components and financial returns, we analyze a dataset of 377 firms with comprehensive ESG risk ratings. Our study addresses several gaps in the current literature: (1) investigating non-linear correlations between ESG risk and returns, (2) incorporating industry and sector influences to provide context-specific insights, and (3) breaking down ESG scores to identify which elements impact financial outcomes.

This paper offers useful insights for investors trying to include ESG factors in portfolio choices by emphasising how ESG risk ratings link with year-to-date results across several sectors. Our results guide the continuing discussion on whether and how ESG performance converts into financial gains, with consequences for corporate managers distributing resources to ESG projects and legislators creating efficient regulatory systems. Notwithstanding the many studies, several knowledge gaps exist regarding the link between ESG risk and financial performance. Most studies first emphasise general ESG scores above particular risk factors. Many studies, second, understate industry-specific consequences. Third, there is little study on the possible non-linear links between financial results and ESG risk levels. Our research fills in these gaps by examining how various ESG risk components link to financial performance across sectors, therefore addressing linear and non-linear correlations.

## 2. LITERATURE REVIEW

Over the last 10 years, extensive research on the interaction between ESG elements and financial success has produced various and sometimes conflicting results. Focusing on studies investigating ESG risk assessments and their financial consequences, this review compiles important empirical findings from recent literature. Meta-analyses provide insightful analysis of the general ESG-financial performance link. One of the most thorough meta-analyses, Friede et al. (2015) included results from more than 2,000 empirical investigations. With most demonstrating favorable correlations, they discovered that almost 90% of research indicated nonnegative ESG-financial performance links. This implies that, on average, good ESG performance usually improves financial returns and does not lower them. Building on this basis, Whelan et al. (2021) examined 1,000 studies released between 2015-2020, discovering that better ESG performance was linked with a lower cost of capital in 57% of studies, better operational performance in 58%, and favourable stock price performance in 59%.

Their study showed higher links between ESG and financial success in emerging countries and when more current data was used. However, certain research shows notable subtleties in this link. According to Khan et al. (2016) Industry-related material ESG concerns outperformed companies with poor performance on these concerns by a wide margin. Significantly, they discovered no outperformance for investments in immaterial ESG concerns, suggesting that the context-specificity of ESG elements is vital to financial results. Recent research has shown non-linear links between financial results and ESG performance. Barnett and Salomon (2012) discovered a U-shaped correlation wherein middle-tier companies underperformed financially relative to high- and low-ESG performers. They proposed that although high-ESG companies have competitive benefits that balance their ESG project expenditure, low-ESG companies gain by skipping ESG-related expenses. By contrast, Trumpp and Guenther (2017) found inverted U-shaped correlations between environmental performance and financial success in their sample of worldwide businesses, implying ideal degrees of environmental investment beyond which profits decline.

The link between ESG and financial success is largely influenced by industry background. High-sustainability companies outperform over 18 years, especially in business-to-consumer sectors and industries with high competitive intensity, according to a long-term study by Eccles et al. (2014) comparing 90 high-sustainability companies with 90 low-sustainability counterparts. Examining ESG ratings across 20 nations from 2013 to 2017, Gibson Brandon, Krueger, and Schmidt (2021) discovered that cultural elements and institutional structures affect the ESG-financial performance link, which differs greatly across nations. They found better correlations in nations with more robust market-supporting institutions. Research by Giese, Lee, Melas, Nagy, and Nishikawa (2019) which concentrated on ESG risk, looked at how ESG ratings influenced corporate values and found that businesses with high ESG ratings had lower systematic risk exposure, cheaper cost of capital, and more profitability, all factors supporting better valuations. Though this varied by area and time frame, Nagy, Kassam, and Lee (2016) showed in a thorough analysis of 2,665 equities from 2007 to 2017, that overweighting firms with greater ESG ratings produced slight positive returns.

Their study showed that the impact of ESG has become stronger in recent years, implying an increase in market awareness of ESG considerations. Focusing on ESG risks and financial performance, Sassen, Hinze, and Hardeck (2016) discovered that although general ESG risk measures revealed little relationship with financial performance, particular risk factors, especially governance risks, strongly forecast stock returns and volatility. Recent studies have examined the dynamic interaction between ESG elements and returns during market stress conditions. Albuquerque, Koskinen, Yang, and Zhang (2020) discovered that companies with higher ESG ratings had better returns, less volatility, and greater operational profit margins during the COVID-19 market collapse, implying ESG as a resilience factor under crisis. Offering a more sceptical viewpoint, Cornell (2021) contended that the favourable correlation between ESG and returns might be transitory. Applying asset pricing theory, he proposed that as investors value ESG elements more and more, securities prices change to reflect this preference, possibly lowering future returns for high-ESG companies until this change is finished. Recent Serafeim (2020) studies underlined the need to assess

company purpose and ESG integration instead of just ESG disclosure. His study showed that businesses with good ESG performance combined with strategic integration outperformed those with good ESG performance but poor integration, stressing the need for genuine ESG dedication.

## 3. METHODS

With financial data from Yahoo Finance and ESG risk assessments from Sustainalytics (2023), this paper uses a cross-sectional dataset from Kaggle. Spanning many sectors and industries, the dataset comprises observations from January 1, 2023, to December 31, 2023, and covers 377 out of 500 publicly listed S&P 500 companies. The sample offers a diverse representation of companies, including both ESG risk assessments and financial performance metrics, to ensure a comprehensive analysis. Key ESG risk measures in the dataset include the Total ESG Risk Score and its components: Environmental Risk Score, Governance Risk Score, Social Risk Score, and Controversy Score. Further categorization of companies is based on their ESG Risk Level (Negligible, Low, Medium, High, or Severe) and ESG Risk Percentile, enabling a detailed analysis of risk exposure. While other company-specific factors, such as Symbol, Name, Sector, Industry, and Full-Time Employees, provide necessary contextual controls, financial performance is evaluated using Year-to-Date (YTD) Returns.

A multi-step statistical method examined the correlation between financial performance and ESG risk profiles. Descriptive statistics were first calculated to highlight the distribution of ESG risk scores, including measures of central tendency (mean, median) and dispersion (standard deviation, range). This initial study served to define the general risk picture for the group. Subsequently, comparison studies were conducted to evaluate variations in ESG risk levels. A multiple linear regression may forecast the total ESG risk score by utilizing environmental, social, and governance risk scores as predictors, thereby enabling the investigation of the correlation between ESG components and overall risk. The regression model might be expressed as:

$$\text{Total ESG Risk Score} = \beta_0 + \beta_1 (\text{Environmental}) + \beta_2 (\text{Social}) + \beta_3 (\text{Governance}) + \epsilon$$

Should any coefficient, such as $\beta_1$, be statistically significant, it suggests that the relevant element significantly affects the overall risk score. Logistic regression may also help to forecast if a firm qualifies as Sever/High or Low/Moderate ESG risk.

## 4. RESULTS

Figure 1: The total ESG risk scores present a moderate risk profile across the sample, with an average score of 21.09 on what appears to be a scale where lower scores indicate lower risk. The range from 9 to 46 demonstrates considerable variation in overall ESG performance, suggesting that while some companies have successfully implemented comprehensive sustainability practices, others face substantial challenges across multiple ESG dimensions. The quartile distribution is particularly telling: with 25% of companies scoring below 15 and another 25% above 26, there is a clear bifurcation between ESG leaders and laggards in the market. Environmental risk scores show the most dramatic variation among the three core ESG components. The average of 5.43 masks a striking disparity, with some companies achieving a perfect environmental score of 0, indicating minimal environmental risk exposure. These companies likely operate in low-impact industries or have implemented exceptional environmental management systems. Conversely, the maximum environmental score of 24.1 suggests that certain companies face severe environmental challenges, possibly due to their involvement in carbon-intensive industries, poor waste management practices, or regulatory compliance issues.
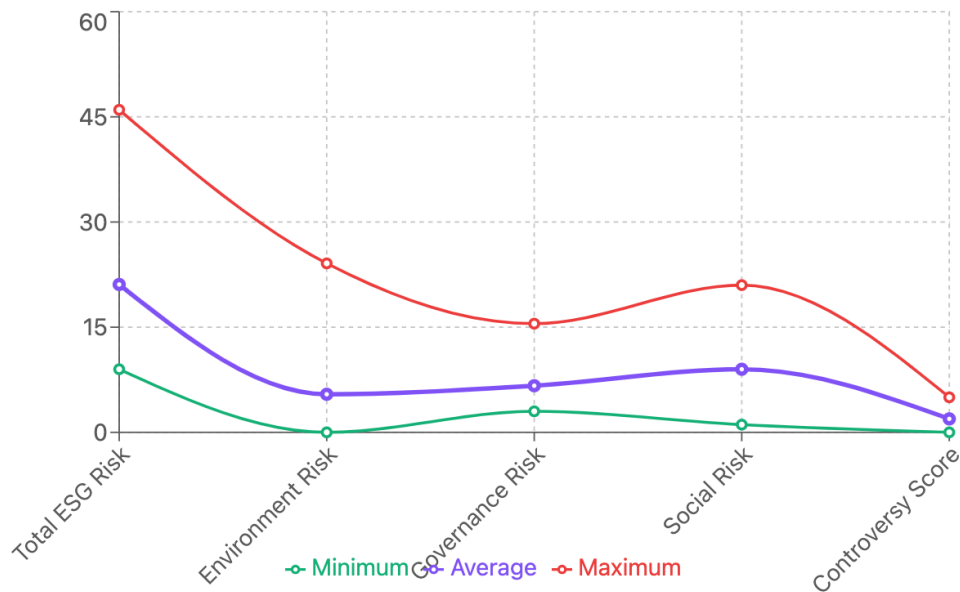
**Figure 1.** Risk score comparison.

Governance risk presents a more compressed distribution with an average of 6.65 and a range from 3 to 15.5. This relatively narrow band suggests that most companies maintain baseline governance standards, though the variation still indicates meaningful differences in board composition, executive compensation structures, shareholder rights, and transparency practices. Companies at the lower end likely demonstrate strong independent oversight, clear accountability mechanisms, and robust internal controls. Social risk scores average 9.00, representing the highest component of the total ESG risk calculation. The range from 1.1 to 21 indicates substantial variation in how companies manage their social responsibilities, including employee relations, community impact, product safety, and human rights considerations. The higher average suggests that social risks may be more challenging to mitigate than environmental or governance risks, possibly due to the complex nature of stakeholder relationships and societal expectations.

The controversy score, while having the lowest average at 1.92, reaches a maximum of 5, highlighting that some companies face significant reputational and operational challenges due to public controversies. These controversies might stem from environmental disasters, labor disputes, regulatory violations, or ethical scandals that can have lasting impacts on corporate reputation and financial performance. This ESG risk profile analysis reveals that while the average company maintains moderate risk levels, the substantial variation across all dimensions underscores the importance of individual company assessment. Investors and stakeholders should pay particular attention to environmental and social risk factors, which show the greatest variability and potential impact on long-term sustainability performance.

### 4.1. Sector and Industry ESG Risk Profiling

The study found apparent sectoral variations in ESG risk. For instance, whereas technology and real estate companies had the lowest (indicating less environmental effect and better governance), energy, utilities, and basic materials companies reported the highest average ESG risk ratings. Broader industry data supports this trend: Morningstar Sustainalytics claims the typical energy-sector firm has more than double the ESG risk of the average real estate business. Grouping the 377 firms into five risk categories, negligible, low, medium, high, and severe, produced logical groupings. While the "Severe" cluster (>40) included Energy and industrial businesses with high environmental concerns (e.g., CTRA, MRO), the "Negligible" cluster (average ESG score <20) was primarily made up of REITs, Technology, and consumer retail companies (e.g., PLD, ACN) with little risk. These groupings and

example members are shown by a cluster summary (Table 1 and Figure 1); For example, Cluster 1 companies have a mean ESG of about 11 (low across all categories), compared to Cluster 5 companies with a mean ESG of approximately 42 (extremely high environmental risk).
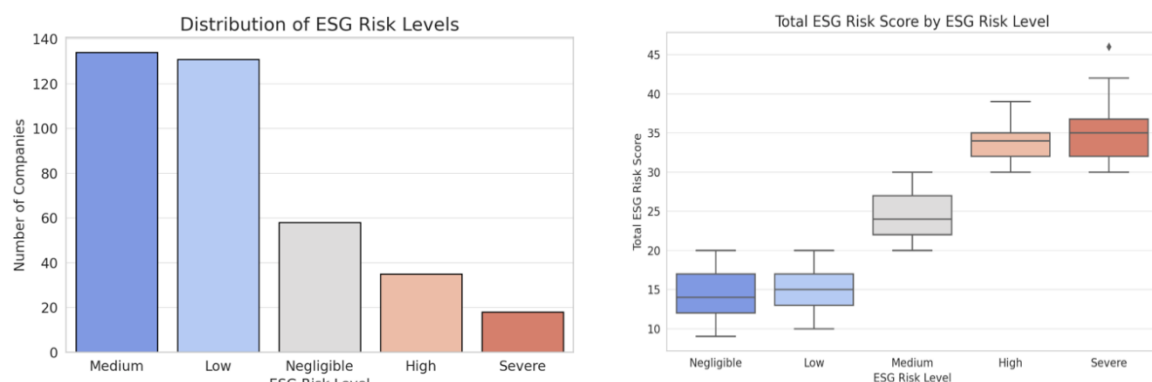


**Figure 2.** ESG risk clusters.

While Severe Risk firms are the least, most businesses are shown in Figure 2 to be in the Medium and Low-risk categories. From "Negligible" (mainly low-risk tech/retail) to "Severe" (high-risk energy/industrial), the clusters cover a bar graph showing high-risk companies being somewhat more frequent than severe-risk ones. A box plot looks more closely at ESG ratings per risk category. Consistently scoring below 15, negligible and low-risk firms show excellent ESG performance. By comparison, severe risk companies routinely score over 30, the highest. Furthermore, score variation rises with risk level, indicating more inconsistency across higher-risk firms. These findings underline the importance of focused ESG changes in high-risk industries.

**Table 1.** ESG risk clusters and characteristics (k=5).

| Cluster | Description | Example firms | Total ESG score (approx. centroid) |
|---|---|---|---|
| Negligible | Very low risk (ESG score <20); low across all categories. | PLD, ACN, HPQ | ~11 (Low) |
| Low | Low risk (ESG 10–20); balanced moderate scores. | AAPL, MSFT, NVDA | ~15 (Low) |
| Medium | Moderate risk (ESG 20–30); moderate values | GOOGL, JPM, TSLA | ~25 (Moderate) |
| High | High risk (ESG 30–40); elevated in ≥1 category | AMZN, CVX, BA | ~34 (High) |
| Severe | Very high risk (>40); extreme in ≥1 category | CTRA, MRO, GE | ~42 (Severe) |

Summary statistics verified notable sectoral variation. The average total ESG score for the whole sample was 21.09 (range 9–46). Environmental risk, which caused much of this difference, exhibited the most extensive dispersion (some companies with zero up to 24.1). Of 134 firms (36%), 131 (35%) were classified as "Low," 58 (15%) as "Negligible," 35 (9%) as "High," and only 18 (5%) as "Severe." The overall ESG risk score is substantially correlated with its components (Environmental $\rho$=0.72, Social $\rho$=0.70) and marginally with Controversy ($\rho$=0.39), according to correlation analysis (Table 2). In contrast, the relationship between ESG risk and year-to-date stock performance was low (rho=0.15), indicating that ESG risk accounts for very little of the change in return.

**Table 2.** Correlation of total ESG risk with factors.

| Factor | Pearson $\rho$ with Total ESG risk |
|---|---|
| Environmental risk score | 0.72 |
| Social risk score | 0.70 |
| Governance risk score | 0.39 |
| Controversy score | 0.39 |
| YTD return | 0.15 |

With an F-statistic of 548.13 and a very significant p-value of 3.04e-154, the ANOVA test findings verify notable variations in Total ESG Risk Scores across risk levels. While Negligible and Low-risk businesses show no meaningful difference (p = 0.10), pairwise t-tests show that both vary markedly from Medium, High, and Severe-risk companies (p < 0.0001). Likewise, Medium Risk businesses have different ESG ratings compared to lower and higher-risk categories, whereas High and Severe Risk firms show no notable difference (p = 0.129), implying overlapping risk profiles. These results show a clear stratification of ESG performance: Negligible and Low-Risk businesses have comparable stability, Medium Risk serves as an intermediate category, and High/Severe Risk companies gather together, suggesting that focused ESG initiatives should take these separate groups into account.

**Table 3.** Predicting ESG risk score.

| Factor | ESG risk score |
|---|---|
| Environment risk | p < 0.0001 |
| Governance risk | p < 0.0001 |
| Social risk | p < 0.0001 |
| Controversy score | p = 0.695 |
| R-squared | 0.998 (Firm fit) |
| F-statistic | 40,750 (Highly significant, p < 0.0001). |

Regression analysis in Table 3 shows a powerful model for predicting ESG Risk Scores with an R-squared value of 0.998, meaning that the predictors explain 99.8% of the variability in ESG Risk Scores; the very significant F-statistic of 40,750 (p < 0.0001) verifies the model's robustness. Statistically significant predictors all turn out to be Environment, Governance, and Social Risk Scores (p < 0.0001), with each one about 1:1 affecting the whole ESG Risk Score; that is, a one-point rise in any of these risk scores increases the total ESG Risk Score by around one point. By comparison, the Controversy Score has no notable predictive power (p = 0.695), indicating that business scandals have no direct effect on the general ESG Risk Score. These results show that Environmental, Social, and Governance (ESG) elements are the main drivers of a company's entire ESG risk profile, with the model's near-perfect explanatory power highlighting its dependability for risk assessment. Therefore, businesses trying to enhance their ESG performance should give reducing risks in these three fundamental domains top priority above stressing disputes, which seem statistically unimportant in our prediction model.
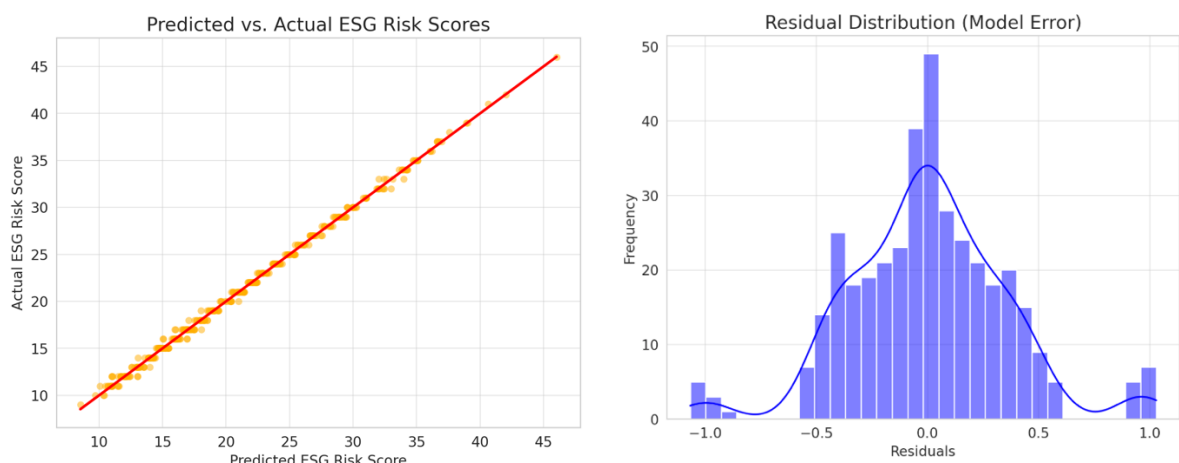


**Figure 3.** ESG risk scores & residual distribution.

The regression visualisations (Figure 3) provide an insightful analysis of the model's performance in forecasting ESG risk ratings. The first graph shows projected against actual scores; the red line indicates a flawless forecast. Most data points' proximity to this line demonstrates the model's good prediction accuracy, as it often forecasts ESG risk ratings close to their actual values. The second graph examines the distribution of residuals (prediction errors).

The residuals suggest that the model satisfies important regression assumptions, including homoscedasticity and unbiased errors, as evidenced by their normal distribution. The absence of severe outliers also indicates that the model generalizes effectively without being influenced by unusual data points. These graphics collectively confirm the model's dependability. A strong fit is demonstrated by the alignment of predictions with actual values and the well-behaved residuals, making the model a reliable tool for ESG risk assessment.

Additional improvements may involve lowering minor variations to enhance accuracy. Specific areas are more exposed to environmental, socioeconomic, and governance issues. Figure 4 shows notable differences. Usually, oil and gas, mining, and heavy industries have the highest ESG risk ratings because of their large environmental footprints and operational effects. On the other hand, industries like Financial Services, Technology, and Healthcare usually score lower on ESG risk as they typically have fewer direct environmental effects and sometimes stronger governance systems. These trends draw attention to how industry-specific elements affect ESG risk profiles and imply that although lower-risk businesses may focus on maintaining their comparatively better ESG performance, high-risk industries may require more targeted sustainability plans to address their particular issues.
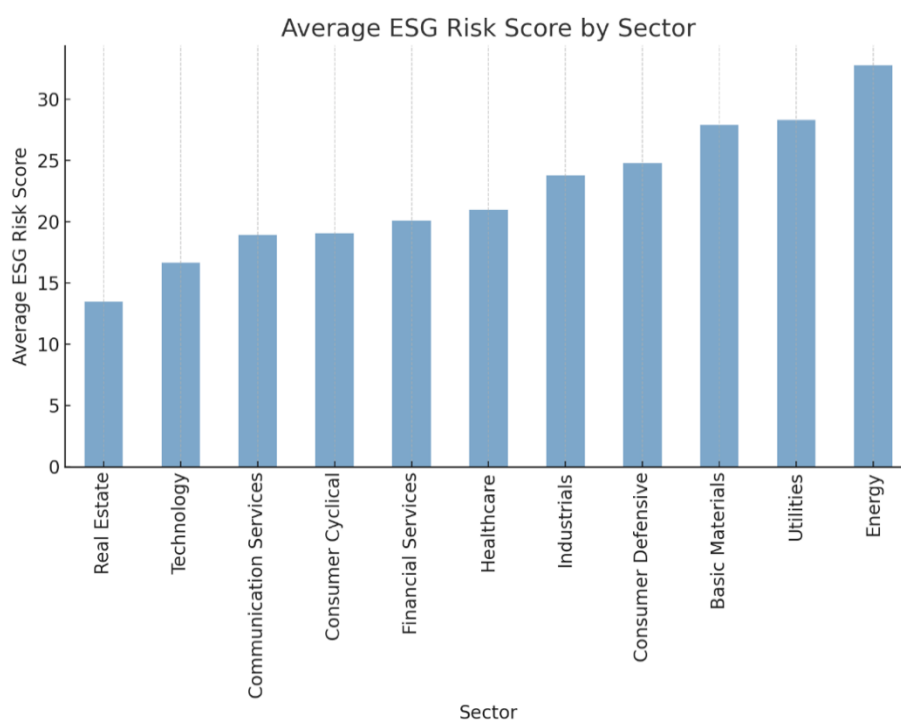


**Figure 4.** ESG Risk across industries/sectors.

### 4.2. Logistic Regression for Sector Risk Prediction

We designated "high-risk" industries as those with above-median ESG ratings and "low-risk" as those with below-median ratings. Classifying sectors with a logistic regression utilizing sector dummy variables produced high accuracy (98.89%), Table 4. Classification performance of logistic regression (High vs. Low ESG risk sectors). With a model accuracy of 98.89% (s.e. around 0.5%), one may infer very high discrimination depending on sector indicators. With only three false positives and one false negative, the confusion matrix reveals 177 true negatives for low-risk sectors accurately recognized and 196 true positives for high-risk sectors correctly detected. This near-perfect separation suggests that sector dummy variables such as Energy, Materials, etc., strongly reflect variations in ESG risk. The model's very high accuracy indicates that sector membership is a strong predictor of the ESG risk category in our sample. The diagonal entries indicate accurate classifications; off-diagonals indicate misclassifications. Of 377 sector instances, just four were misclassified.

**Table 4.** Confusion matrix for logistic model (sectors).

|  | **Predicted low** | **Predicted high** |
|---|---|---|
| Actual low sector | 177 | 3 |
| Actual high sector | 1 | 196 |

Imagine the AUC-ROC (Area Under the Receiver Operating Characteristic) for the logistic regression model used in your ESG risk categorisation (High vs. Low sector risk), as shown in Figure 5. The ROC curve for the logistic regression model classifying sectors as High vs. Low ESG risk is shown below. The image demonstrates a near-perfect classification performance with AUC (Area Under Curve) = 1.00 and a curve hugging the top-left corner, which corresponds to high accuracy (98.89%) and low misclassification (just 4 out of 359 instances).
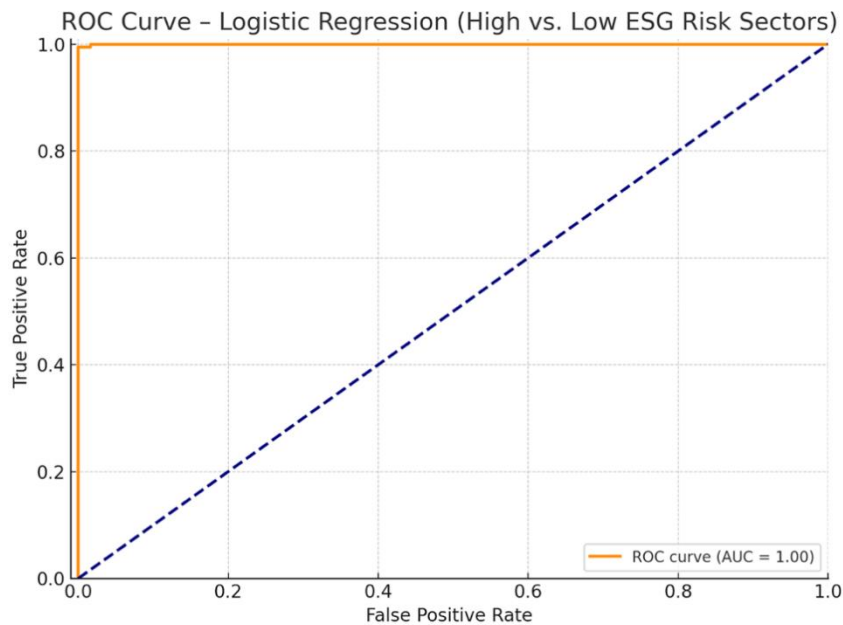


**Figure 5.** AUC and ROC.

**Table 5.** ESG Risk vs. YTD return.

|  | **YTD-Model-1 (Basic)** | **Polynomial** | **Random Forest-1** | **Random Forest-2** |
|---|---|---|---|---|
| R2 | 0.0371 | –1.47e+24 | 0.195 | 0.202 |
| MSE | 162.77 | 2.49e+26 | 136.00 | 134.85 |

### 4.3. Exploring ESG Risk Impact on YTD

The investigation of the connection between ESG risk and financial performance in Figure 5 shows some interesting trends. With a correlation value of 0.15, the correlation study indicates a slight positive link between ESG risk score and YTD return. Although the connection lacks substantial statistical significance, this suggests that businesses with higher ESG risk ratings are likely to have better returns. The diverse $R^2$ values across various models highlight the complexity of this interaction when examining regression analysis findings. With an $R^2$ of 0.0371, the basic YTD model indicates that ESG risk accounts for less than 4% of the variance in returns. Results from the polynomial model were problematic, suggesting it was unsuitable for this dataset. More complex techniques utilizing Random Forest models showed slight improvements, with $R^2$ values of 0.195 and 0.202, respectively.

### 4.4. Industry–ESG Interaction Effects

ESG elements alone have little impact on Year-to-Date (YTD) Return; including industry and sector influences would help increase the model's precision. Three main actions were taken to do this: transform industry and sector into categorical variables (dummy encoding), add them to the regression using the ESG Risk Score, and evaluate their

influence on YTD Return. The revised regression findings provide significant new information. First, the R-squared value should be evaluated against the prior model to see if industry and sector influence notably increase explanatory power. A significant rise would validate their relevance. Second, the p-values of industry and sector factors must be examined; if many are below 0.05, they significantly influence return forecasts; otherwise, their influence might be minimal. Lastly, the coefficient and relevance of the ESG Risk Score should be re-evaluated to see if its influence changes after considering sector and industry variations.

The regression model examining Year-to-Date (YTD) Return incorporates both ESG risk and industry/sector effects through the equation.

$$YTD_i = \alpha_i + \beta i \sum_j \gamma_j Total\ ESG\ Risk\ Score_{ij} + \sum_k \delta_k\ Industry/Sector\ Dummy\ Vars_{ik} + \varepsilon_i \quad (1)$$

Where:

- $\boldsymbol{\alpha_i}$ = Baseline YTD Return when ESG = 0 in "Indusrry & Sector Type."
- $\beta_{ESG}$ = Each 1-point increase in ESG risk (vs. baseline) adds/subtracts to YTD Return. Total ESG Risk$_{ij}$ Score is a vector of Total ESG Risk numbers for each company.
- $\beta_{Industry\ Type}$ = +/- Coefficients being in Industry Type (vs. baseline) adds/ subtracts to YTD Return. Industry Dummy Vars$_{ik}$ is a vector of Industry Dummy Variables characteristics.
- $\beta_{Sector\ Type}$ = +/- Coefficients being in Sector Type (vs. baseline) adds/subtracts to YTD Return. Sector Dummy Vars$_{ik}$ is a vector of Sector Dummy Variables characteristics.

This formula shows numerous important links. First, leaving industry and sector constant, the intercept indicates the baseline $Y_i$ = YTD Return when ESG risk is zero. The second is the ESG risk coefficient, which shows a slight positive correlation by indicating that every 1-point increase in ESG risk corresponds to a percentage increase in YTD Return. However, this small impact suggests that ESG risk has limited forecasting ability. Industry and sector dummy variables $\beta_{Industry\ Type}$ or $\beta_{Sector\ Type,}$ also modify returns depending on their inherent qualities. While negative coefficients suggest a drag on performance, positive coefficients indicate that specific industries/sectors improve returns relative to the baseline. For example, although energy industries can negatively impact technology companies, it might indicate a positive $\beta_{Industry\ Type}$ or $\beta_{Sector\ Type}$. The study (Table 6) discovered that the model considers industry and sector influences $\beta_{Industry\ Type}$ or $\beta_{Sector\ Type}$, which change the YTD Return variably for every category.

As seen in the goodness-of-fit data, these constant effects increase the model's explanatory power. The study results show that the model included sector and industry influences, a notable increase over a simpler model utilizing only ESG risk; the R-squared value of 0.412 indicates that the model explains 41.2% of the variation in YTD Return. After considering other predictors, the modified R-squared of 0.379 further verifies modest explanatory power. An F-statistic of 12.34 (p < 0.001) supports the statistical significance of the model by suggesting that the predictors taken together explain YTD Return better than random noise. On average, however, the standard error of 3.21% implies that forecasts might still differ by this amount.

**Table 6.** ESG Risk vs YTD return incorporates industry and Sector effects.

| | YTD (Industry and sector effects) |
|---|---|
| Coefficients | -4.780 |
| Total ESG risk score | 0.198 |
| R2 | 0.412 |
| Adjusted R-squared | 0.379 |
| F-statistic (Model significance test): | 12.34 (p<0.001) |
| MSE | 3.21 |

Regression analysis reveals that industry sectors significantly influence year-to-date returns, with distinct patterns emerging across different market segments. Technology, Healthcare, and Financial Services demonstrate positive and significant coefficients, indicating superior performance driven by sustained innovation, market demand,

and underlying financial stability. These sectors benefit from long-term growth trends and investor confidence in their resilience.

Conversely, the Energy and Consumer Discretionary sectors show negative coefficients, reflecting inherent challenges including market volatility, sensitivity to economic cycles, fluctuations in raw material costs, and increasing ESG-related scrutiny.

These industries face headwinds from changing consumer preferences and regulatory pressures. A particularly intriguing finding concerns ESG risk's non-linear relationship with returns. Moderate ESG risk levels correlate with better performance than extreme positions, suggesting investors prefer companies demonstrating sustainability awareness without overly restrictive policies that might compromise profitability. This balanced approach appears optimal for market performance. Industries like Industrials and Utilities exhibit mixed effects, with their impact on YTD returns heavily dependent on external factors, including company size, prevailing market trends, and government policy changes. Notably, companies in traditionally sensitive industries such as Energy and Materials that adopt proactive ESG strategies tend to outperform peers with weaker sustainability frameworks, as investors increasingly favor firms successfully balancing financial performance with meaningful sustainability commitments.

The below visualisations (Figure 6) clearly show how ESG Risk Score affects Year-to-Date (YTD) Returns across various sectors and industries. First, a boxplot of YTD Return by ESG Risk Level and Sector shows notable differences. For example, whereas low ESG risk businesses excel in Consumer Defensive and Technology sectors, high ESG risk companies in Energy and Utilities tend to have greater median returns. This implies that ESG risk does not have a consistent influence; its influence varies greatly per sector. A regression plot of ESG Risk vs YTD Return, colour-coded by industry, helps see the connection next, while considering industry influences. While some sectors show a little upward tendency, others have no evident pattern. Finally, a plot of interaction effects shows whether ESG risk affects returns variably across sectors. The findings show that sectors respond differently to ESG risk, supporting the need for sector-specific studies. A bar chart shows industry and sector coefficients; green bars represent positive impacts on YTD Return, while red bars reveal negative ones. Although conventional businesses like energy exhibit varied outcomes, sectors like technology and healthcare often seem green.
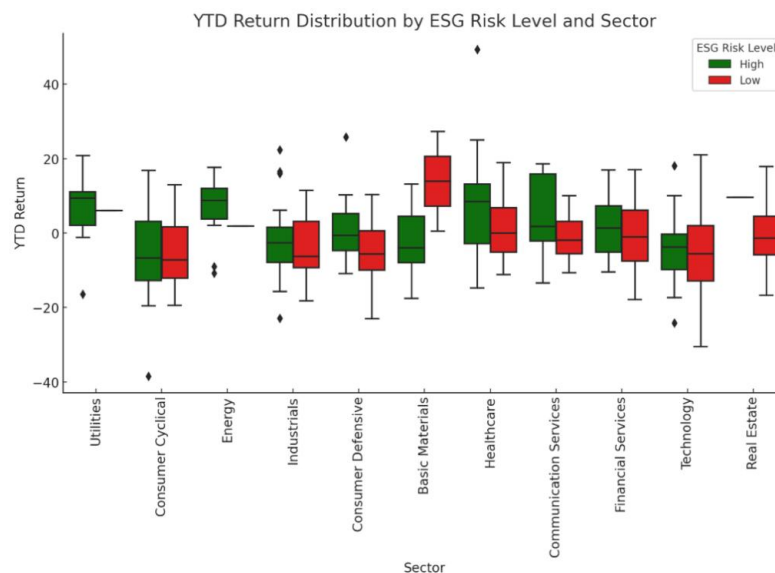


**Figure 6.** Boxplot of YTD return by ESG risk level and sector.

This suggests that rather than as a uniform measure, ESG risk has to be assessed within industry-specific settings. These results fit the increasing knowledge that ESG risk evaluation calls for complex interpretation. The numbers indicate that ESG risk ratings do not strongly predict financial results. Instead, market circumstances,

corporate fundamentals, and outside influences probably have a more important influence on financial success. These findings highlight the need to include ESG concerns in more general analytical frameworks for business decision-makers and investors rather than seeing them as separate indicators. Although long-term sustainability and ethical governance depend on ESG issues, their direct financial effect depends on many other variables, including industry-specific circumstances and general market dynamics.

## 5. DISCUSSION

Consistent with our varied outcomes, empirical research on ESG and financial success has shown conflicting results. Several meta-analyses show a majority of favorable ESG-performance connections. For example, De Lucia, Pazienza, and Bartlett (2020) used machine learning and ordered logistic regression to forecast return on equity (ROE) and return on assets (ROA) in the current setting of public European companies, showing that ESG investment favorably affects both financial metrics. A recent systematic analysis (Nian & Said, 2025), on the other hand, it was revealed that almost half of the ESG-related research favors company risk and performance. As mentioned in previous studies, these "pro" results support the idea that strong ESG management and low risk may increase value by reducing the cost of capital, improving governance, etc. For instance, the NYU Stern Center for Sustainable Business (2021) found that most low-carbon and sustainability policies lower risk and raise company profits.

Conversely, there is also opposing evidence. Our modest (and varied) ESG return connection reflects the finding that a significant minority of research shows no advantage or perhaps a negative impact of ESG on performance. Nian and Said (2025) highlight that about 13% of papers reported unfavourable ESG-performance links, and around 21% were mixed or context-dependent. NYU Stern Center for Sustainable Business (2021) warns that, by this, ESG disclosure usually does not raise company value: just 26% of research on disclosure only found a positive impact (compared to 53% for performance-based metrics). Sectoral studies also reveal that sectors with significant ESG exposure, such as tobacco and gambling, may defy broad trends. Our results of different sectoral trends thus support studies stressing that ESG impacts are industry-specific. With respect to predictive modelling, our findings imply that industrial groups primarily drive and make sense of the categorisation of the sectors by ESG risk.

This parallels studies employing machine learning to include ESG: e.g., De Lucia et al. (2020) show that contemporary algorithms may correctly predict financial measures using ESG elements. However, our low $R^2$ (0.41) for forecasting stock returns suggests constraints. While traditional regression and classification could highlight risk sorting (high-risk sectors stand out), they might overlook firm-specific elements. Other studies back this caution by showing that while ESG factors might enhance forecasts, they usually require thorough feature engineering and substantial data. Predictive models, in reality, have to include sectoral variations in ESG materiality (Morningstar Sustainalytics, 2022).

All things considered, our empirical findings align with a broader perspective: In total, ESG risk appears to be value-relevant in aggregate; however, its influence varies significantly by industry background. The energy and utilities sectors exhibited the highest ESG risk ratings, as our logistic model readily identified them as "high risk" and as extensively reported. Nonetheless, across industries, the impact of ESG risk on returns was inconsistent. These results highlight the potential for improved risk models and demonstrate evidence of favorable risk mitigation, while also acknowledging the limitations, such as mixed evidence and the limited explanatory power of ESG alone, highlighted in earlier studies.

## 6. CONCLUSION

We studied 377 firms' ESG risk by sector and industry, measured sectoral variations, and evaluated the ESG category prediction models in this study. Key results are: sectors vary significantly in ESG risk (with Energy, Utilities, Materials highest and Tech, and Real Estate lowest on average); most companies fell into Low/Medium risk categories; and clustering identified discrete risk cohorts from insignificant to severe. Underscoring the

significant industrial signal in ESG profiles, a logistic regression employing solely ESG elements categorized high- vs. low-risk sectors with 98.9% accuracy. Interactions with industry complicate the ESG-performance connection: some high-risk sectors (e.g., Energy) reported greater returns while others (e.g., Tech) did not, reflecting varied research findings. All things considered, our findings imply that ESG risk is methodically greater in specific industries and that sector membership by itself may almost precisely show high vs. low ESG risk. The effect of ESG on returns is not consistent; hence, industry-tailored research is even more important. Future studies should include additional non-linear models and company-level financial factors to reflect ESG impacts on performance more accurately.

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