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The Impact of ESG Performance on Financial Profitability: Evidence from the Aviation Sector in EU Countries

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Abstract

This study investigates the impact of environmental, social, and governance (ESG) practices on the financial performance of airlines, with profitability measured by return on assets (ROA). While the ESG–performance nexus has been widely explored in the finance literature, empirical evidence specific to the airline industry remains limited, despite the sector's significant contribution to global emissions and its unique regulatory and competitive pressures. Drawing on stakeholder theory and the triple bottom line framework, the study examines whether ESG engagement serves as a strategic driver of financial outcomes alongside its social and environmental objectives.

Using a panel dataset of European Union airlines covering an eleven-year period, the analysis employs Random-Effects estimators with cluster-robust standard errors**,** complemented by Feasible Generalized Least Squares (FGLS) estimation as a robustness check against heteroskedasticity and autocorrelation. Regression results, reported across four model specifications, reveal a consistently positive and statistically significant association between ESG performance and ROA. This relationship indicates that higher ESG scores enhance firm profitability. Disaggregated findings further demonstrate that each ESG sub-dimension—environmental (E), social (S), and governance (G)—exerts a positive and statistically significant effect on ROA, underscoring that diverse sustainability-related practices collectively strengthen financial outcomes.

The study contributes to the literature by offering sector-specific evidence on the ESG–performance relationship in aviation. By integrating stakeholder and triple bottom line perspectives, it highlights that ESG practices are not merely compliance-oriented but represent a strategic pathway to profitability, competitive advantage, and long-term value creation.

1. Introduction

Sustainability practices have become increasingly salient in the airline industry, as the sector is widely recognized as a major contributor to global carbon emissions and climate change. According to EU Climate Action (2022), direct emissions from aviation account for 3.8–4% of the European Union's total greenhouse gas emissions and 13.9% of transport-related emissions, positioning aviation as the second-largest source of transport emissions after road transport. This environmental footprint underscores the importance of developing strategies to mitigate the sector's contribution to climate change while ensuring continued competitiveness and growth.

With the rapid expansion of air travel, airlines face the dual challenge of reducing operational costs while maintaining fair labor conditions and addressing environmental responsibilities. Scholars emphasize that companies should not compromise social well-being—including environmental protection and labor rights—for short-term profitability (Kao et al., 2022). This responsibility extends to a wide range of initiatives, including reducing greenhouse gas emissions, ensuring employee welfare, fostering community engagement, and adhering to ethical business practices (Sorsa and Bona-Sánchez, 2024). Such efforts are not only integral to advancing societal welfare but also critical to the survival and long-term growth of firms. For airlines in particular, consumer loyalty, compliance with increasingly stringent government regulations, and the financial perceptions of investors and partners depend heavily on the successful management of sustainability practices.

In line with stakeholder theory, companies must balance the expectations of diverse stakeholder groups with financial imperatives. Failure to do so may expose firms to risks such as increased costs or accusations of greenwashing. At the same time, triple bottom line theory posits that firms create value not solely through financial returns but also through their contributions to social and environmental well-being. Within this framework, sustainability practices must be assessed holistically, recognizing both their potential benefits and limitations for firm performance.

Although the relationship between ESG practices and financial outcomes has been widely studied in the broader corporate finance literature, research focusing specifically on

airlines remains limited. This study seeks to address this gap by examining the impact of ESG performance on airline profitability. Previous studies investigating the role of corporate social responsibility and sustainability in the airline sector generally adopt two perspectives. The first focuses on improvements in financial and accounting-based indicators, documenting a positive association between ESG performance and financial outcomes (Yang and Baasandorj, 2017; Lee et al., 2013). The second emphasizes the role of intangible assets, arguing that sustainability initiatives enhance brand value and corporate image, thereby fostering consumer trust and favorable customer attitudes (Vo et al., 2019; Chen et al., 2012; Kim et al., 2020). While both perspectives provide valuable insights, the present study concentrates primarily on the financial dimension, assessing how ESG and its sub-components—environmental (E), social (S), and governance (G)—affect profitability as measured by return on assets (ROA). A comprehensive assessment of these sub-dimensions is essential to reveal their relative contributions to firm performance.

Guided by stakeholder theory and triple bottom line theory, the study posits that financial performance is positively influenced by sustainability achievements. To test these hypotheses, 11 years of panel data from airline companies operating within the European Union are analyzed. This empirical focus is particularly relevant given the EU's strong emphasis on sustainability regulation and support for corporate responsibility in aviation. By doing so, the study contributes to both theory and practice. For financial managers, it offers insights into how ESG strategies can simultaneously advance profitability and sustainability goals. For academics, it provides evidence on the complex and multifaceted relationship between corporate sustainability and economic viability (Kaffash et al., 2024).

The structure of the study is as follows: the first section presents the introduction; the second provides a literature review and hypotheses; the third outlines the data and methodology; the fourth presents the results; the fifth provides robustness checks; the sixth offers a discussion; and the final section addresses limitations and directions for future research.

2. Literature Review and Hypothesis Development

2.1. Literature Review

While the broader finance literature provides substantial evidence on the interplay between corporate financial performance and sustainability, empirical investigations focusing on the airline industry are relatively limited. Addressing this gap is particularly important, as airlines operate under unique structural constraints and competitive pressures that may shape both the effectiveness and the perception of sustainability strategies.

Abdi et al. (2020), for example, analyzed data from 27 airlines worldwide between 2013 and 2019 and reported results broadly consistent with the wider finance literature. Their findings revealed that environmental (E) and governance (G) scores were positively associated with market-to-book ratios and Tobin's Q, suggesting that sustainability practices enhance firm value and financial performance. However, the social (S) dimension was negatively related to financial outcomes, a result attributed to the relatively high costs of social initiatives compared with their immediate financial benefits.

Extending this line of inquiry, Abdi et al. (2022) examined 36 airlines globally over the period 2008–2019 and reached somewhat different conclusions. Their study identified a significant negative relationship between financial performance and ESG engagement, indicating that financially stronger airlines were less likely to invest in sustainability practices. Importantly, they also demonstrated that state ownership moderated this relationship, underscoring the role of government involvement in shaping sustainability strategies in the aviation sector.

By contrast, Gangi et al. (2021) presented evidence more consistent with the dominant view in the broader literature, finding that sustainable practices contribute to higher profitability, greater recognition among financial stakeholders, and enhanced competitive advantage and market value. These results highlight the strategic importance of sustainability initiatives as mechanisms to safeguard the interests of both financial and non-financial stakeholders.

Similarly, Kaffash et al. (2024) examined panel data from nine U.S. passenger airlines between 2010 and 2019 to assess the influence of financial performance and efficiency on environmental sustainability outcomes. Their findings indicate that financially stronger airlines possess greater resources to mitigate their environmental footprint, underscoring the resource-dependency of sustainability practices in aviation.

Kao et al. (2022) also contributed to this discussion, showing that both energy efficiency and wealth creation efficiency are positively associated with ESG scores, and that overall production efficiency improves with higher levels of ESG engagement. They further noted that full-service airlines tend to achieve slightly higher ESG scores compared to low-cost carriers. More importantly, their results highlight the necessity for airlines to adopt sustainability-oriented practices in order to secure long-term and stable financial benefits, thereby providing empirical support for the resource-based view (RBV) of the firm.

From a governance perspective, Weber et al. (2025) argued that ESG practices affect both costs and revenues in the airline industry, a dynamic that can be explained through good governance theory. Their study emphasized that such initiatives ultimately contribute positively to financial performance.

Karaman and Akman (2018) stressed the pivotal role of corporate social responsibility (CSR) in enhancing company quality, strategy, sustainability, and brand image by addressing the expectations of social stakeholders. Their findings delineated the subcomponents of CSR and their relative importance, recommending that aviation managers in Türkiye design CSR strategies that prioritize economic, social, and environmental dimensions, respectively. The strong emphasis on economic considerations highlights the dual need for financial performance alongside long-term sustainability.

Nonetheless, not all studies report uniformly positive results. Kuo et al. (2021), for example, identified a U-shaped relationship between corporate social responsibility and firms' ROA. They showed that in the initial stages of CSR initiatives, both public and private airlines experienced a decline in ROA, but following the implementation and integration phases, profitability gradually improved.

In a more recent study, Yıldız et al. (2024) examined the impact of ESG scores on operational efficiency, risk reduction, and financial performance for 32 airlines between 2018 and 2023. Their findings suggest that while strong governance practices may effectively reduce risks, they can also increase costs and therefore do not necessarily lead to higher short-term firm value. This outcome may be explained by high levels of

transparency that do not necessarily capture the quality of disclosed information. Furthermore, the absence of statistically significant relationships between ESG and the environmental or social dimensions was attributed to the complex and difficult-to-assess structure of the airline industry.

Taken together, these studies illustrate that while ESG practices in the airline industry have the potential to enhance financial performance, firm value, and long-term competitiveness, the evidence remains mixed and often contingent upon contextual factors such as state ownership, governance quality, and the temporal horizon of benefits. In particular, the contrasting findings suggest that the relationship between ESG engagement and financial outcomes is neither straightforward nor uniform. These discrepancies may stem from variations in sample composition, time horizons, measurement of ESG dimensions, or institutional and regulatory environments across studies. This ambiguity underscores the need for further investigation through theoretical frameworks such as stakeholder theory and the triple bottom line (TBL), which provide a structured lens for examining the multifaceted link between ESG performance and financial outcomes.

2.2. Hypothesis Development

Studies examining the relationship between ESG performance and financial outcomes predominantly draw upon stakeholder theory as their explanatory framework. More recent research has also employed the triple bottom line (TBL) theory, which posits that firms should pursue objectives that extend beyond profit to include social and environmental dimensions (Gupta et al., 2020; Elkington, 1998). Often summarized as the 3Ps—people, planet, and profit—this perspective emphasizes that sustainable value creation requires businesses to integrate economic performance with social responsibility and environmental stewardship (Li et al., 2023; Crace and Gehman, 2022).

Airlines, operating in an industry that is highly visible and sensitive to societal expectations, are increasingly aligning their strategies with both stakeholder theory and the TBL framework. By addressing stakeholder concerns while simultaneously pursuing profitability, airlines can differentiate themselves from competitors, strengthen long-term relationships with passengers and investors, and enhance firm value (Gupta et al., 2020; Zieba and Johansson, 2022). Empirical evidence suggests that ESG practices in the aviation sector can generate wide-reaching impacts, improve competitive positioning, and positively influence both profitability and firm valuation.

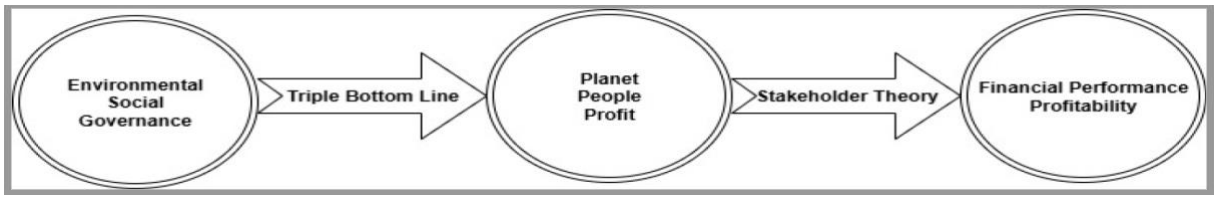

Figure 1. Research Framework (own elaboration)

As depicted in the conceptual framework (Figure 1), ESG is expected to contribute positively to firm performance, consistent with the assumptions of stakeholder and TBL theories. While shareholder theory traditionally emphasizes profit maximization as the sole objective, recent scholarship underscores the need to incorporate the financial relevance of social and environmental initiatives.

Within this context, ESG performance may be viewed as an intangible asset—enhancing brand equity, consumer trust, and overall firm reputation—thereby influencing both market-based and accounting-based measures of financial performance (Chung et al., 2022).

Although debates remain regarding the precise direction and magnitude of the ESG–financial performance nexus, the preponderance of empirical studies suggests a positive association. Building on this literature, the present study examines whether airlines with stronger sustainability performance, as reflected by higher ESG scores, achieve superior profitability. Accordingly, the following hypotheses are proposed:

H1: There is a positive relationship between ESG and ROA.

H2: There is a positive relationship between Environmental (E) and ROA.

H3: There is a positive relationship between Social (S) and ROA.

H4: There is a positive relationship between Governance (G) and ROA.

3. Data and Methodology

3.1. Data

The study aims to present an assessment based on 11 years of data from 10 airlines in the European Union for which data is available. The data in the study, which examines the relationship between ESG and the financial performance of airlines, was obtained from Thomson Reuters DataStream. A panel data model was used to evaluate these relationships.

The airline sector was selected because environmental, social, and corporate sustainability practices are a significant element in companies in this sector. Companies prioritize these practices because they believe these practices significantly impact a company's value for consumers, regulators, investors, and creditors. The European Union, one of the regulatory bodies, has also emphasized this issue. This sector is specifically addressed in the European Union's climate-neutrality by 2050 and GHG emissions reduction target of at least 55% by 2030 targets (European Union, 2022).

The study will draw conclusions based on how ESG activities, both holistically and through their subcomponents, impact companies' financial performance, as reflected in ROA.

Therefore, ROA was used as the dependent variable, while ESG scores, E, S, and G scores were used as explanatory variables.

Control variables included intangible assets, debt/asset ratio, cash flow from operating, firm size measured by the logarithm of assets, and firm age. Table 1 shows all variables and data sources below:

Table 1. Definitions of the Variables

Variable Name	Variable
ROA	Return on Assets – Dependent Variable
ESG	Environmental, Social and Governance Score– Explanatory variable
E	Environmental Score - Explanatory variable
S	Social Score - Explanatory variable
G	Governance Score - Explanatory variable
IA	Intangible Assets – Control variable
DA	Debt/Assets – Control variable
CFO	Cash flow from Operating – Control variable
log_Assets	Firm Size – Control variable
Age	Firm Age - Control variable

3.2. Methodology

The main research question of this study is to examine how the ESG practices of firms in the airline industry influence Return on Assets (ROA), a widely used indicator of financial performance. Given the European Union's strong policy orientation toward sustainability, and in particular its support for environmentally and socially responsible practices in the airline sector, this study focuses specifically on airlines operating within the EU. The analysis relies on data from only 10 EU-based airlines over an 11-year period, which represents a relatively small and geographically constrained sample. While this focus allows for an in-depth examination of EU-specific dynamics, it also limits the generalizability of the findings to broader global contexts and other segments of the aviation industry.

A panel data methodology was employed, with ROA as the dependent variable and the aggregate ESG score as well as its three sub-dimensions—environmental (E), social (S), and governance (G)—as the main explanatory variables. Since correlations among these explanatory variables and their potential cross-sectional dependence are found to be relatively high, four separate model specifications are developed. To strengthen the reliability of the estimation, several control variables commonly used in the literature were incorporated: intangible assets (IA), debt-to-assets ratio (DA), cash flow from operating (CFO), firm size (log of total assets), and firm age (Age).

The general specification of the four panel models can be expressed as follows:

$$ROA_{\{it\}} = \beta_0 + \beta_1 ESG_{\{i,t\}} + \beta_2 IA_{\{i,t\}} + \beta_3 DA_{\{it\}} + \beta_4 CFO_{\{it\}} + \beta_5 log(Assets_{\{it\}}) + \beta_6 Age_{\{it\}} + \varepsilon_{\{it\}} \quad (1)$$

$$ROA_{\{it\}} = \beta_0 + \beta_1 E_{\{i,t\}} + \beta_2 IA_{\{i,t\}} + \beta_3 DA_{\{it\}} + \beta_4 CFO_{\{it\}} + \beta_5 log(Assets_{\{it\}}) + \beta_6 Age_{\{it\}} + \varepsilon_{\{it\}} \quad (2)$$

$$ROA_{\{it\}} = \beta_0 + \beta_1 S_{\{i,t\}} + \beta_2 IA_{\{i,t\}} + \beta_3 DA_{\{it\}} + \beta_4 CFO_{\{it\}} + \beta_5 log(Assets_{\{it\}}) + \beta_6 Age_{\{it\}} + \varepsilon_{\{it\}} \quad (3)$$

$$ROA_{\{it\}} = \beta_0 + \beta_1 G_{\{i,t\}} + \beta_2 IA_{\{i,t\}} + \beta_3 DA_{\{it\}} + \beta_4 CFO_{\{it\}} + \beta_5 log(Assets_{\{it\}}) + \beta_6 Age_{\{it\}} + \varepsilon_{\{it\}} \quad (4)$$

To ensure the robustness and validity of the panel data estimations, a series of diagnostic tests were conducted, including checks for multicollinearity, autocorrelation, and heteroskedasticity. Following these diagnostic results, a Random-Effects model with Cluster-Robust Standard Errors was employed as the primary estimation method, as it accounts for firm-level heterogeneity and corrects for potential violations of classical assumptions. In addition, to further validate the robustness of the results, the Feasible Generalized Least Squares (FGLS) estimator was applied as an alternative model, and its results were compared with those obtained from the random-effects regressions.

4. Conclusion

Descriptive statistics for the variables used in the analysis are presented in Table 2.

Table 2. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
ROA	4.256	4.243	-9.509	14.331
ESG	57.444	18.224	23	89
E	60.348	22.269	21	95
S	54.513	18.582	20	90
G	58.023	17.045	20	92
IA	3068287	4303844	77441	15996142
DA	.305	.161	.025	.632
CFO	1854522	2443091	-3226748	11819514
log_Asset	16.306	1.158	13.439	18.118
Age	83.5	44.85	19	194

The Return on Assets (ROA) results indicate that, on average, aviation sector companies in the European Union generated a return of 4.26% on their assets. The relatively large standard deviation and negative minimum value point to substantial variability in operational efficiency, with some firms experiencing significant losses in certain years. The mean Environmental, Social, and Governance (ESG) score is 57.44 (SD = 18.22), ranging from 23 to 89. This suggests a moderate level of sustainability performance overall, but with considerable dispersion, reflecting differences in sustainability strategies, reporting standards, and regulatory compliance. Across ESG sub-dimensions, the mean Environmental (E) score (60.35) exceeds both the Social (S) score (54.51) and the Governance (G) score (58.02), likely reflecting the direct impact of EU-level environmental regulations—such as the EU Emissions Trading System (EU ETS)—on aviation emissions. Intangible Assets (IA), representing factors such as brand equity, patents, and route rights, display substantial heterogeneity across firms. The high standard deviation suggests that while some companies possess extensive intangible resources, others operate with minimal intangible assets. The average Debt-to-Assets ratio (DA) of 30.5% (SD = 16.1%) indicates diverse capital structures, likely linked to varying strategic and operational models within the sector. The mean Cash Flow from Operating (CFO) is €1.85 million, with notable variance and the presence of negative values, underscoring the cyclical volatility and operational challenges in the industry—such as demand shocks, fluctuating fuel costs, and seasonality. The average log of total assets is 16.31, consistent with the large-scale asset base characteristic of aviation companies.

Overall, these statistics reveal considerable heterogeneity in size, age, capital structure, and ESG performance among EU aviation companies. The moderate average ESG score,

coupled with its wide dispersion, suggests that while some firms have fully integrated ESG principles into their business models, others remain in the early stages of adoption. Meanwhile, negative values in ROA and CFO highlight the financial and operational risks inherent to the sector, particularly in the context of post-pandemic recovery.

Table 3 reports the Pearson correlation coefficients for all variables included in the analysis.

Table 3. Matrix of Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) ROA	1.000									
(2) ESG	-0.091	1.000								
	(0.347)									
(3) E	-0.113	0.950	1.000							
	(0.238)	(0.000)								
(4) S	-0.089	0.964	0.877	1.000						
	(0.356)	(0.000)	(0.000)							
(5) G	-0.040	0.955	0.871	0.878	1.000					
	(0.675)	(0.000)	(0.000)	(0.000)						
(6) IA	0.064	0.256	0.281	0.261	0.181	1.000				
	(0.507)	(0.007)	(0.003)	(0.006)	(0.058)					
(7) DA	-0.665	0.060	0.158	0.037	-0.013	-0.030	1.000			
	(0.000)	(0.535)	(0.099)	(0.703)	(0.894)	(0.754)				
(8) CFO	0.156	0.287	0.291	0.322	0.187	0.646	-0.068	1.000		
	(0.103)	(0.002)	(0.002)	(0.001)	(0.051)	(0.000)	(0.482)			
(9) log Assets	-0.409	0.528	0.532	0.498	0.464	0.558	0.294	0.620	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)		
(10) Age	0.110	0.621	0.576	0.670	0.528	0.522	-0.277	0.441	0.331	1.000
	(0.251)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	

The return on assets (ROA), a measure of firm profitability, exhibits a negative correlation with the ESG composite score and each of its sub-dimensions -Environmental (E), Social (S), and Governance (G). However, these coefficients are small in magnitude and statistically insignificant, indicating that any potential relationship between financial performance and sustainability should be further investigated through regression analysis. As expected, ESG is highly and positively correlated with its sub-components: E ($r = 0.950$, $p < 0.01$), S ($r = 0.964$, $p < 0.01$), and G ($r = 0.955$, $p < 0.01$). Furthermore, E, S, and G are strongly intercorrelated ($p < 0.01$), reflecting either conceptual overlap in measurement or consistent firm performance across sustainability dimensions. This is indicated by asterisks in the table. This high degree of intercorrelation raises concerns regarding multicollinearity when ESG and its sub-dimensions are entered simultaneously in regression models. To mitigate this risk, subsequent analyses will estimate separate models for ESG and each of its sub-components.

The Debt-to-Asset ratio (DA) demonstrates a strong negative correlation with ROA, suggesting that higher leverage is generally associated with lower profitability within the sampled firms. Cash flow from operating (CFO) is positively correlated with ROA, consistent with the expectation that stronger internal cash generation supports higher returns. Firm size (log_Assets) is positively associated with ESG, implying that larger firms may have greater capacity and institutional pressure to invest in sustainability initiatives. Firm age also shows a positive correlation with ESG and its sub-dimensions, suggesting that more established firms tend to have more formalized sustainability practices. However, age does not exhibit a significant correlation with ROA, indicating that longevity alone does not necessarily translate into superior profitability in the European Union aviation sector.

Because ESG and its sub-dimensions (E, S, and G) are included in separate models, all correlation coefficients in the Pearson matrix fall within the acceptable range, remaining below the 0.80 threshold (Gujarati and Porter, 2008). To further assess the potential for multicollinearity, Variance Inflation Factor (VIF) tests are conducted, with the results presented in Table 4. VIF values below 10 –and, more conservatively, below 5- are considered indicative of an acceptable level of collinearity among explanatory variables. Across all model specifications, the observed VIF values remain well below these thresholds, confirming that multicollinearity is not a concern in this study.

Table 4. Variance Inflation Factor (VIF)

ESG		E		S		G	
log_Assets	2.946	log_Assets	2.705	Age	3.099	log_Assets	2.973
Age	2.752	Age	2.518	log_Assets	2.744	CFO	2.359
ESG	2.478	CFO	2.253	S	2.661	IA	2.258
IA	2.318	E	2.227	IA	2.391	Age	2.239
CFO	2.276	IA	2.208	CFO	2.23	G	1.966
DA	1.41	DA	1.473	DA	1.425	DA	1.406
Mean VIF	2.363	Mean VIF	2.231	Mean VIF	2.425	Mean VIF	2.2

F Test, LM Test and Hausman Test are used as pre-tests before panel data analysis. The specification test results are reported in Table 5. The F-tests for individual effects are statistically significant at the 1% level across all model specifications, providing strong evidence of unobserved firm-level heterogeneity. Conversely, the time effects are statistically insignificant in most models, suggesting the absence of systematic year-to-year variation in the dependent variable once the explanatory variables are accounted for. The sole exception is the Environmental (E) model, where the time effect attains marginal significance at the 5% level; however, the magnitude of this effect is likely negligible.

Consistent with the F-test findings, the Breusch–Pagan Lagrange Multiplier (LM) test also indicates the presence of significant individual effects, while time effects remain statistically insignificant across all specifications. The cluster-robust Hausman test fails to reject the null hypothesis in all cases ($p > 0.05$), implying no systematic differences between the fixed-effects and random-effects estimators. Accordingly, the random-effects model is deemed appropriate for the analysis, as it adequately captures unobserved firm-specific heterogeneity without compromising estimator efficiency.

Table 5. Model Selection

	(1) ESG p-value	(2) E p-value	(3) S p-value	(4) G p-value
F Test				
Individual effect	0.0000	0.0000	0.0000	0.0000
Time effect	0.0989	0.0355	0.0699	0.1190
Breusch-Pagan LM Test				
Individual effect	0.0000	0.0000	0.0000	0.0000
Time effect	0.2288	0.0625	0.2351	0.2760
Cluster-Robust Hausman Test	0.4519	0.0947	0.6935	0.6193

The diagnostic test results are reported in Table 6. To verify the validity of the random-effects panel data models, diagnostic tests are conducted on key assumptions. The modified Wald test for groupwise heteroskedasticity indicates the presence of heteroskedasticity across entities in all model specifications ($p < 0.01$).

The Durbin–Watson statistics, consistently below the benchmark value of 2, suggested the existence of positive first-order serial correlation in the residuals. With respect to cross-sectional dependence, the Pesaran CD test failed to reject the null hypothesis of cross-sectional independence in all models, as the p-values exceeded the 5% significance threshold.

Table 6. Diagnostic Tests

	Wald Test	Durbin-Watson	Pesaran	Heteroskedasticity	Autocorrelation	Cross-sectional Dependence	Estimation Method
ESG	0.0000	1.4302	0.2003	YES	YES	NO	RE + Cluster Robust SE
E	0.0000	1.4696	0.1750	YES	YES	NO	RE + Cluster Robust SE
S	0.0000	1.4321	0.2328	YES	YES	NO	RE + Cluster Robust SE
G	0.0000	1.4280	0.2773	YES	YES	NO	RE + Cluster Robust SE

In light of the detected heteroskedasticity and serial correlation, the adoption of random-effects estimators with cluster-robust standard errors is considered appropriate to obtain consistent and efficient inference.

Regression results presented in four model specifications are reported in Table 7. The regression results reveal a consistently positive and statistically significant association between ESG performance and ROA. This relationship, significant at the 5% level, indicates that enhancements in ESG scores are associated with improved firm profitability.

When examining the ESG sub-dimensions -environmental (E), social (S), and governance (G)- each dimension shows a positive and statistically significant relationship with ROA. These results reinforce the conclusion that diverse sustainability-related practices collectively contribute to enhancing firm profitability.

Regarding the control variables, the Debt-to-Asset Ratio (DA) exhibits a strong and negative relationship with ROA in all specifications. The magnitude of the coefficients, coupled with their significance at the 1% level, suggests that higher leverage exerts a detrimental effect on profitability.

Cash Flow from Operating (CFO) displays a positive and statistically significant association with ROA at the 1% level across all models, underscoring the importance of robust operational cash flows in sustaining firm performance.

Firm size, proxied by the natural logarithm of total assets, consistently demonstrates a negative and significant effect on ROA, implying that larger firms may experience diminishing returns to scale or heightened operational inefficiencies.

Similarly, firm age exhibits a negative and statistically significant coefficient in all specifications, indicating that older firms may encounter structural rigidities or reduced growth potential relative to their younger rivals.

Beyond the statistical significance of these findings, the results have important managerial implications. The positive role of ESG performance highlights that investments in sustainability are not merely symbolic or reputational tools, but rather mechanisms that can generate tangible financial benefits. Managers and decision-makers in the aviation sector may thus perceive ESG initiatives as strategic investments that enhance long-term value creation. At the same time, the adverse effect of excessive leverage warns against over-reliance on debt financing, suggesting that maintaining financial flexibility is essential for profitability in capital-intensive industries such as aviation.

Furthermore, the evidence that firm size and age negatively influence profitability provides an important perspective for policymakers and investors. These findings imply that younger and relatively smaller firms may be more agile in adopting innovative practices, while mature and large-scale firms could face efficiency losses. Policymakers aiming to foster competitiveness in the aviation industry should therefore consider frameworks that support innovation and structural adaptation among established firms. For investors, the results indicate that ESG performance can be a meaningful screening criterion when evaluating firms, while also emphasizing the risks associated with high leverage and operational inefficiencies.

Table 7. Random-Effects Estimators with Cluster-Robust Standard Errors

	ROA (1)	ROA (2)	ROA (3)	ROA (4)
ESG	0.0493**			
	(0.0311)			
IA	0.0000	0.0000	0.0000	0.0000
	(0.3337)	(0.2534)	(0.4049)	(0.3323)
DA	-16.1587***	-15.8311***	-16.7326***	-15.9625***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CFO	0.0000***	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
log_Assets	-2.4452**	-2.5143**	-2.3232*	-2.3751**
	(0.0392)	(0.0107)	(0.0668)	(0.0414)
Age	-0.0077***	-0.0069**	-0.0079***	-0.0071***
	(0.0068)	(0.0100)	(0.0082)	(0.0058)
E		0.0401***		
		(0.0019)		
S			0.0437*	
			(0.0620)	
G				0.0454**
				(0.0444)
_cons	45.0497**	46.4513***	43.7716**	43.9005**
	(0.0122)	(0.0024)	(0.0243)	(0.0116)
R-squared	0.584	0.646	0.545	0.579

5. Robustness Check

The Feasible Generalized Least Squares (FGLS) estimation is employed to assess the robustness of the regression results across the four model specifications.

Table 8. Feasible Generalized Least Squares (FGLS) Regression Results

	(1) ROA	(2) ROA	(3) ROA	(4) ROA
ESG	0.0502***			
	(0.0097)			
IA	0.0000***	0.0000***	0.0000***	0.0000***
	(0.0011)	(0.0023)	(0.0023)	(0.0027)
DA	-13.3595***	-13.6979***	-13.7853***	-13.0336***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
CFO	0.0000***	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
log_Assets	-3.6704***	-3.5372***	-3.5235***	-3.4987***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Age	-0.0094***	-0.0090***	-0.0092***	-0.0083***
	(0.0000)	(0.0001)	(0.0001)	(0.0002)
E		0.0345**		
		(0.0163)		
S			0.0396**	
			(0.0258)	
G				0.0401**
				(0.0273)
_cons	64.6543***	63.4189***	63.1897***	62.1738***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	110	110	110	110

The findings, which are consistent with those obtained from Random-Effects estimations with cluster-robust standard errors, reveal a strong, positive, and statistically significant association between ESG performance and ROA. The ESG coefficient, significant at the 1% level in all specifications, indicates that higher ESG scores are systematically associated with increased firm profitability. Furthermore, when the ESG score is decomposed into its environmental (E), social (S), and governance (G) components, each dimension exhibits a positive and statistically significant relationship with ROA, thereby reinforcing the study's overall conclusions.

Among the control variables, the Debt-to-Asset Ratio (DA) emerges as a particularly influential determinant. DA demonstrates a strong negative relationship with ROA, significant at the 1% level, suggesting that greater leverage substantially diminishes profitability. This result is consistent with the earlier regression findings. Likewise, Cash Flow from Operating (CFO) maintains a positive and significant association with ROA at the 1% level across all models, underscoring the critical role of operational cash flows in sustaining firm performance. By contrast, intangible assets (IA) diverge from the earlier regression outcomes, displaying a small but positive and highly significant effect on ROA. This finding suggests that investment in intangible assets is systematically linked to enhanced financial performance. The results for firm size and firm age also align with prior findings. Both variables are negatively and significantly associated with ROA across all models, implying that larger and older firms may be less profitable, potentially due to structural rigidities, diseconomies of scale, or reduced adaptability.

6. Discussion

The empirical findings of this study provide robust evidence that ESG performance exerts a positive and significant effect on firm profitability, as measured by ROA, across all model specifications. Both the Random-Effects estimations with cluster-robust standard errors and the Feasible Generalized Least Squares (FGLS) analyses converge on this result, underscoring the stability and reliability of the findings. Moreover, the decomposition of ESG into its environmental, social, and governance dimensions confirms that each subcomponent independently contributes to enhancing financial performance.

These results are well aligned with the stakeholder theory, which posits that companies generate long-term value not solely by maximizing shareholder wealth but by addressing the needs and expectations of multiple stakeholder groups (Freeman, 1984; Gupta et al., 2020). Airlines that adopt sustainability practices and improve their ESG performance enhance their relationships with passengers, employees, regulators, and local communities, thereby fostering customer loyalty and strengthening brand reputation (Chung et al., 2022). This effect is consistent with the interpretation of ESG as an intangible asset, which contributes to both market-based outcomes, such as brand equity, and accounting-based measures of profitability.

The results also resonate with the triple bottom line theory (Elkington, 1998), which emphasizes the balance of economic, environmental, and social goals—the "3Ps" of people, planet, and profit. The positive impact of ESG and its dimensions on ROA demonstrates that airlines can achieve financial gains while simultaneously addressing environmental sustainability and social responsibility concerns. This finding provides evidence that sustainability-oriented strategies not only improve stakeholder relations but also enhance operational efficiency and resource allocation, thereby contributing to firm performance. In the specific context of the airline industry, these results should also be understood against the strong regulatory environment in the European Union. Ambitious policies such as the climate-neutrality target for 2050 and the "Fit for 55" plan, which aims to cut emissions by 55% by 2030, create significant pressure on airlines to strengthen their ESG performance (European Commission, 2021; European Union, 2022). At the same time, these policies provide incentives for companies to align with sustainability goals, which may help explain why ESG practices show a positive link with financial outcomes in this study. Given the capital-intensive and highly visible nature of the sector, compliance with such regulations and proactive engagement in ESG are not only regulatory requirements but also strategic tools for competitiveness and legitimacy.

The control variables further enrich the interpretation of the results. The strong negative association between leverage (DA) and profitability suggests that financial sustainability remains a crucial determinant of firm performance in the airline sector, a finding consistent with the capital structure literature. By contrast, the positive impact of cash flow from operating (CFO) on profitability highlights the fundamental role of liquidity in supporting long-term sustainability initiatives. The significance of intangible assets in the FGLS estimations suggests that investments in non-physical resources such as innovation, digitalization, and reputation management may generate additional value in line with the resource-based theory (Kao et al., 2022; Kaffash et al., 2024).

In addition, the analysis reveals that both firm size and firm age are negatively associated with profitability. This suggests that larger airlines may suffer from diseconomies of scale, operational inefficiencies, or increased stakeholder pressures, while older firms may face structural rigidities and reduced adaptability compared to younger competitors. From the perspectives of stakeholder theory and the triple bottom line framework, these results indicate that the broader social and environmental responsibilities of larger and older firms can generate additional costs, which may constrain short-term profitability despite potential long-term legitimacy benefits.

7. Literature Limitations and Future Research

While the findings of this study offer strong empirical support for the positive association between ESG performance and firm profitability in the airline sector, several limitations warrant caution. First, the analysis is restricted to airlines operating within the European Union. Although this focus is justified given the EU's strong sustainability agenda, it limits the generalizability of the results to other geographical contexts, particularly regions with less stringent sustainability regulations. Future research should expand the scope by incorporating airlines from North America, Asia, and emerging markets to explore potential regional heterogeneity.

Second, the study employs profitability (ROA) as the primary measure of financial performance. While this indicator captures accounting-based outcomes, it does not fully reflect market-based valuations such as Tobin's Q or stock returns. Integrating both market-based and accounting-based measures in future research could provide a more holistic understanding of the ESG–financial performance nexus. Finally, due to potential endogeneity concerns, such as

reverse causality, future research could address this issue by employing dynamic panel estimators, such as system GMM.

In conclusion, this study contributes to the growing literature by demonstrating that ESG performance is positively and significantly associated with firm profitability in the airline sector, consistent with stakeholder theory and the triple bottom line framework. Future research building on these findings may provide deeper insights into the mechanisms through which ESG practices create value, particularly in industries where sustainability is both a regulatory necessity and a strategic opportunity.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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