Global Climate Uncertainty and Airlıne Carbon Emissions: Panel Data Evidence From OECD Countries withın Sustainability Accounting Framework *

Sürdürülebilirlik Muhasebesi Çerçevesinde Küresel İklim Belirsizliği ile Havayolu Karbon Emisyonları Arasındaki İlişki: OECD Ülkeleri Üzerine Panel Veri Analizi

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ABSTRACT

The aviation industry has become a prominent contributor to global carbon emissions because of rising passenger demand and heavy reliance on fossil fuels. At the same time, increasing global climate uncertainty has begun to shape environmental regulations, investment priorities, and sustainability-oriented policy frameworks across countries. Under such uncertainty, airline companies may be encouraged to adopt more risk-averse operational practices, improve fuel efficiency, and invest in technologies aimed at reducing emissions. OECD countries offer a suitable empirical context for examining this relationship due to their relatively stringent environmental standards and broader adoption of sustainable transport policies. From an accounting standpoint, sustainability reporting—an increasingly central component of the accounting discipline—has also gained strategic importance for airline firms. This study investigates the impact of global climate uncertainty on airline-related carbon emissions in OECD countries and evaluates this relationship within a sustainability perspective. The analysis covers 30 OECD member states with complete data for the 2013–2024 period. Employing panel data techniques, the study assesses the effect of the global climate uncertainty index on aviation carbon emissions while controlling Gross Domestic Product (GDP), passenger traffic, and jet fuel consumption. The empirical results reveal that both passenger numbers and jet fuel consumption contribute to higher aviation-related carbon emissions. However, in countries characterized by high passenger volumes and intensive jet fuel use, global climate uncertainty appears to mitigate airline-related carbon emissions.

Keywords: Sustainability Accounting, Global Climate Uncertainty, Carbon Emissions, OECD Countries

ÖZET

Havacılık sektörü, artan yolcu talebi ve fosil yakıtlara olan yüksek bağımlılığı nedeniyle küresel karbon emisyonlarının önemli kaynaklarından biri hâline gelmiştir. Buna paralel olarak, küresel iklim belirsizliğindeki artış; ülkelerin çevre düzenlemelerini, yatırım önceliklerini ve sürdürülebilirlik odaklı politika çerçevelerini şekillendirmeye başlamıştır. Bu tür bir belirsizlik ortamında, havayolu şirketleri daha temkinli operasyonel uygulamalara yönelmekte, yakıt verimliliğini artırmakta ve emisyon azaltımına yönelik teknolojilere yatırım yapmaya teşvik edilmektedir. OECD ülkeleri, görece sıkı çevresel standartları ve sürdürülebilir ulaşım politikalarını daha yaygın biçimde benimsemeleri nedeniyle bu ilişkinin incelenmesi açısından uygun bir ampirik zemin sunmaktadır. Muhasebe perspektifinden bakıldığında ise sürdürülebilirlik raporlaması, disiplinin giderek merkezi bir bileşeni hâline gelmiş ve havayolu şirketleri açısından stratejik önem kazanmıştır. Bu çalışma, küresel iklim belirsizliğinin OECD ülkelerinde havacılık kaynaklı karbon emisyonları üzerindeki etkisini incelemekte ve söz konusu ilişkiyi sürdürülebilirlik perspektifinden değerlendirmektedir. Analiz, 2013–2024 dönemine ait tam veri setine sahip 30 OECD üye ülkesini kapsamaktadır. Panel veri yöntemlerinin kullanıldığı çalışmada, küresel iklim belirsizliği endeksinin havacılık karbon emisyonları üzerindeki etkisi; Gayri Safi Yurtiçi Hasıla (GSYH), yolcu trafiği ve jet yakıtı tüketimi kontrol değişkenleri eşliğinde analiz edilmiştir. Ampirik bulgular, yolcu sayısı ile jet yakıtı tüketiminin havacılık kaynaklı karbon emisyonlarını artırdığını göstermektedir. Buna karşılık, yüksek yolcu hacmine ve yoğun jet yakıtı kullanımına sahip ülkelerde küresel iklim belirsizliğinin, havacılık emisyonlarını azaltıcı yönde bir etki yarattığı tespit edilmiştir.

Anahtar Kelimeler: Sürdürülebilirlik Muhasebesi, Küresel İklim Belirsizliği, Karbon Emisyonları, OECD Ülkeleri.

INTRODUCTION

Global climate change has evolved beyond being merely an environmental issue. It has become a multidimensional transformation that shapes the organization of economic activities, the investment decisions of industries, and the direction of public policies. In this transformation process, climate-related risks and uncertainties have become central to the policy frameworks developed by countries in line with their sustainability goals. In particular, uncertainties regarding the scope, duration, and effectiveness of regulations implemented to combat climate change

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are widely discussed in the literature. These uncertainties are addressed under the concepts of global climate uncertainty or, more specifically, climate policy uncertainty. (Eyime & Ushie, 2025; Ritchie, 2020).

Recent studies indicate that climate policy uncertainty exerts significant effects on economic cycles and that uncertainty shocks can trigger economic contractions (Yang et al., 2024). Similarly, empirical evidence suggests that uncertainty constrains energy transition processes (Lin & Cheung, 2024), reduces firm-level investment (Huang & Sun, 2024; Zhao et al., 2024), and diminishes green total factor productivity (Dai & Zhu, 2024). Within this perspective, climate uncertainty is considered a factor that heightens risk perceptions among economic actors and reinforces "wait-and-see" behavior.

However, the literature on the effects of climate uncertainty is not unidirectional. Some studies suggest that uncertainty can encourage firms, particularly in carbon-intensive sectors, to adopt more cautious strategies, mitigate environmental risks, and increase investments in green innovation (Li et al., 2024; Borozan & Pirgaip, 2024). This finding indicates that climate uncertainty may assume not only a constraining role but also a transformative and catalytic one.

The aviation industry represents one of the most suitable sectors in which this set of contradictory effects can be observed. Aviation accounts for a significant share of global carbon emissions due to rising passenger demand and intensive reliance on fossil fuels (Xiong et al., 2023). Passenger volumes and jet fuel consumption are widely recognized in the literature as key determinants of airline-related carbon emissions (Hirunsit et al., 2024; Yıldız & Akbulut Yıldız, 2024). At the same time, the sector is among the most exposed to stringent environmental regulations, carbon markets, and technological transformations such as sustainable aviation fuels (Gedik Göçer & Arabacı, 2024). The evolution of aviation-related carbon emissions across OECD countries further illustrates the environmental significance of the sector and its growing contribution to global emissions. Figure 1 presents the annual CO_2 emissions from aviation in selected OECD countries between 2013 and 2024, indicating a general upward trend despite temporary declines during the pandemic period.
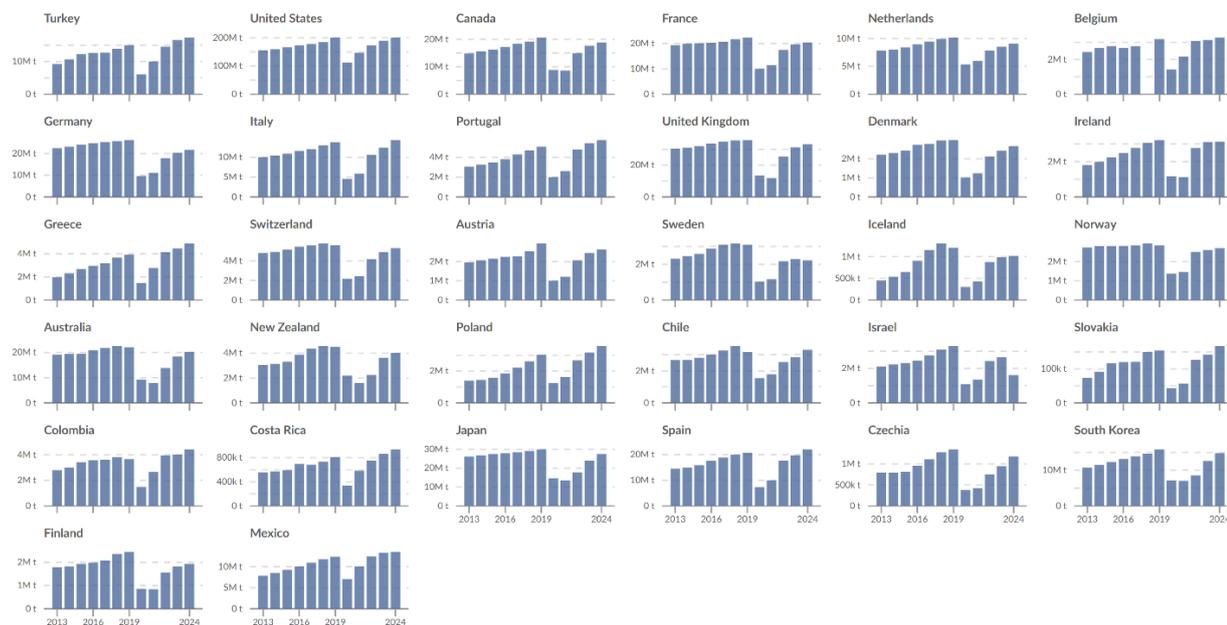
Figure 1: Annual CO2 Emissions from Aviation in OECD Countries.

As shown in Figure 1, aviation emissions in OECD countries display a generally increasing trajectory over the last decade, reflecting the structural growth of air transport demand. Although emissions temporarily declined during the COVID-19 pandemic, the rapid rebound highlights the sector's continued dependence on fossil fuels and its vulnerability to climate-related regulatory pressures. This pattern underscores the relevance of examining aviation emissions within the context of global climate uncertainty.

This dual structure necessitates examining the impact of global climate uncertainty on aviation emissions not as a direct effect, but rather as a conditional and interaction-based relationship. This issue is particularly relevant in countries characterized by high passenger volumes and intensive fuel use. In such contexts, the question arises as to whether uncertainty induces firms to adopt more efficient operational strategies and invest in carbon-reducing technologies.

At this point, sustainability accounting plays a critical role in measuring emissions, reporting them, and ensuring their comparability across countries. The quantification and reporting of carbon emissions make it possible to empirically analyze the relationship between uncertainty and emissions. They also provide a foundation for accountability and transparency from a policymaking perspective. (Borozan & Pirgaip, 2024).

The aim of this study is to examine the effect of global climate uncertainty on airline-related carbon emissions in OECD countries and to evaluate this relationship from a sustainability perspective. The study aims to fill an important gap in literature by revealing how climate uncertainty transforms emissions into countries where emission-intensive factors such as passenger volumes and jet fuel consumption are high.

LITERATURE REVIEW

The literature on global climate uncertainty and climate policy uncertainty has expanded considerably in recent years, with a primary focus on macroeconomic fluctuations, investment behavior, and energy transition dynamics. Yang et al. (2024) demonstrate that climate policy uncertainty significantly affects economic cycles and that uncertainty shocks may trigger recessions. Similarly, Huang and Sun (2023) and Zhao et al. (2025) show that firms reduce investment levels in response to rising climate policy uncertainty, reinforcing "wait-and-see" behavior through the channel of investment irreversibility. These findings suggest that uncertainty exerts contractionary pressures on real economic activity.

Research on energy transition and green productivity further supports the predominantly restrictive role of climate policy uncertainty. Lin and Cheung (2024) find that uncertainty negatively affects energy transition processes at the city level in China, while Dai and Zhu (2024) reveal that climate policy uncertainty reduces urban green total factor productivity, particularly through the technical efficiency channel. Collectively, these studies indicate that uncertainty may weaken environmental performance by discouraging structural transformation.

However, the literature does not present a uniform picture. Borozan and Pirgaip (2024) and Li et al. (2024) provide evidence that climate policy uncertainty can, under certain conditions, encourage firms—especially in carbon-intensive sectors—to adopt emission-reducing strategies and increase green innovation investments. In this sense, uncertainty may function not only as a constraint but also as a transformative mechanism. Nevertheless, most of these studies are conducted at the firm level or within single-country contexts.

The aviation literature, by contrast, primarily concentrates on emission determinants and regulatory frameworks. Xiong et al. (2023) show that airport operations significantly increase city-level carbon emissions, while Kiracı (2025) identifies economic growth and tourism as key drivers of aviation-related CO_2 emissions in OECD countries. Yıldız and Akbulut Yıldız (2024) analyze the relationship between air transport and emissions in G5 countries, and Eyime and Ushie (2024) project that aviation emissions will grow faster than those of other hard-to-abate sectors under multiple policy scenarios.

Studies focusing on regulatory mechanisms and sustainability practices (Taşdemir & Aydın, 2021; Gedik Göçer & Arabacı, 2024; Barutçu & Çolakoğlu, 2024) discuss carbon markets, CORSIA, and the EU-ETS as transformative instruments within the aviation sector. However, these contributions are largely qualitative and do not empirically test the relationship between macro-level uncertainty and sectoral emission dynamics.

Although the existing literature extensively examines the effects of climate policy uncertainty on macroeconomic fluctuations, firm-level investment, and energy transition processes, cross-country evidence on its sector-specific impact on carbon emissions remains limited. In particular, for the aviation sector—characterized by high carbon intensity and direct exposure to global regulatory frameworks—the mechanisms through which climate uncertainty shapes emission dynamics have not been sufficiently clarified. Most existing studies focus either on emission determinants or on regulatory structures, while the conditional and interaction-based nature of the uncertainty–aviation emissions nexus has not been empirically tested.

This study contributes to the literature in three main respects by employing panel data analysis for OECD countries over the 2013–2024 period. First, it addresses an important research gap by examining the uncertainty–emissions relationship at the sectoral level within a multi-country framework. Second, it uncovers the conditional nature of this relationship by analyzing whether climate uncertainty assumes a transformative role in contexts characterized by

high passenger volumes and intensive jet fuel consumption. Third, by situating the analysis within a sustainability accounting framework, the study emphasizes the measurability, cross-country comparability, and policy accountability dimensions of aviation-related carbon emissions. In doing so, it advances the literature beyond macroeconomic outcomes and provides new insights into the environmental performance implications of climate uncertainty at the sectoral level.

DATA AND METHODOLOGY

The purpose of this study is to examine the impact of global climate uncertainty on aviation-related carbon emissions in OECD countries. To achieve this research objective, panel data analysis is employed, as it allows the simultaneous inclusion of both cross-sectional units (countries) and the time dimension, given that the data of multiple countries for the period 2013–2024 are analyzed. Specifically, a static panel data framework is adopted to estimate the relationship between global climate uncertainty and aviation-related carbon emissions. At the outset of the study, the dataset was intended to include all 38 OECD countries and to cover the period from 2013 to 2024. This implies that the intended dataset would consist of 456 observations for each variable. However, because the required data could not be obtained for every country across the study period—and, in some cases, were not reported at all or were unavailable from relevant sources—eight countries had to be excluded from the analysis. Accordingly, data for 30 countries covering the period 2013–2024 were obtained, resulting in 360 observations for each variable.

The study examines the effect of the global climate uncertainty index on airline-related carbon emissions, while Gross Domestic Product (GDP), airline passenger numbers, and jet fuel consumption are included as control variables. Since the global climate uncertainty index does not vary across countries within the study period but remains common to all, interaction terms between the index and countries' airline passenger numbers as well as jet fuel consumption were incorporated into the model, and the empirical findings were interpreted accordingly. In line with these explanations, the research model is presented in Figure 2.
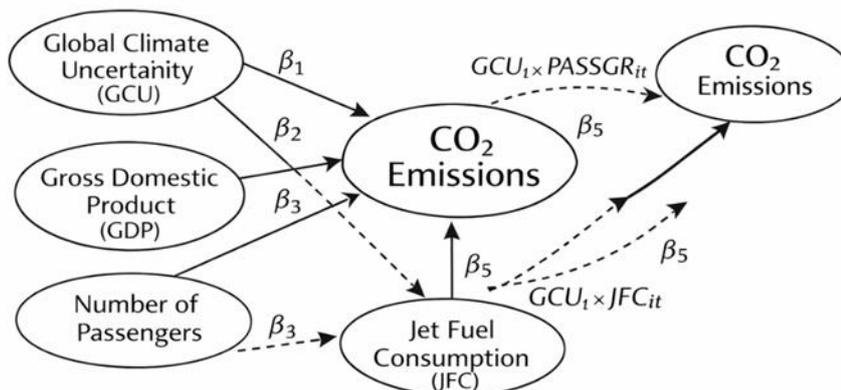
Figure 2: Research Model

Based on the research model, the panel data regression equations presented in Equations (1) and (2) were constructed:

$$CO2_{it} = \alpha_{it} + \beta_1 GCU_{it} + \beta_2 GDP_{it} + \beta_3 PASSGR_{it} + \beta_4 JFC_{it} + \beta_5 GCU_{it} \times PASSGR_{it} + \mu_{it} + \varepsilon_{it} \tag{1}$$

$$CO2_{it} = \alpha_{it} + \beta_1 GCU_{it} + \beta_2 GDP_{it} + \beta_3 PASSGR_{it} + \beta_4 JFC_{it} + \beta_5 GCU_{it} \times JFC_{it} + \mu_{it} + \varepsilon_{it} \tag{2}$$

In Equations (1) and (2), the symbols represent the following:

✓ α_{it} denotes the intercept terms of the equations,

✓ β_1, β_2, β_3, β_4, and β_5 represent the coefficients of the equations,

✓ μ_{it} indicates error terms that vary across units or over time, and

✓ ε_{it} refers to conventional disturbance terms.

Explanations of the variables included in the equations, along with the sources from which these variables were obtained, are presented in Table 1.

Table 1: Explanations of the Research Variables

Variables	Explanation	Source
GCU	Global Climate Uncertainty	policyuncertainty.com
GDP	Gross Domestic Product of OECD Countries	OECD Data
PASSGR	OECD Countries' Domestic and International Airline Passenger Numbers	OECD Data
JFC	OECD Countries' Jet Fuel Consumption	theglobaleconomy.com

It is useful to clarify the measurement units of the variables presented in Table 1. Global Climate Uncertainty is reported as an index value; countries' GDP is expressed in million U.S. dollars, passenger numbers in millions of passengers, and jet fuel consumption in thousand barrels.

RESEARCH FINDINGS AND DISCUSSION

Before commencing the analysis, it was necessary to transform the variables into a common scale, as each was reported in different units. Accordingly, the logarithmic values of all variables were taken, and each variable was standardized on the same logarithmic basis. In this context, descriptive statistics for the variables included in the study are presented in Table 2.

Table 2: Descriptive Statistics

Variables	Obs.	Mean	Std. Deviation	Min.	Max.	Skewness	Kurtosis
log_CO_2	360	1,5969	1,4469	-4,6052	5,3056	-0,3637	4,5292
log_GCU	360	5,0095	0,4826	4,0832	5,6060	-0,5606	1,8608
log_GDP	360	10,7130	0,3960	9,4930	11,8370	-0,5036	3,6052
log_PASSGR	360	3,1883	1,7940	-4,6052	7,0104	-1,7687	8,8939
log_JFC	360	3,6921	1,4384	-0,7550	7,4636	-0,1696	3,9779
log_GCU×log_PASSGR	360	8,1978	1,8441	-0,1648	12,4542	-1,6303	8,3254
log_GCU×log_JFC	360	8,7016	1,5049	3,9324	12,8888	-0,1566	3,7522

According to the descriptive statistics presented in Table 2, all variables consist of 360 observations. The mean and standard deviation values indicate relatively higher volatility, particularly for the number of passengers variable and the interaction term GCU×PASSGR. In contrast, gross domestic products and global climate uncertainty exhibit a more stable structure with lower standard deviation values.

The skewness coefficients are generally negative, suggesting that the distributions are left-skewed. The kurtosis values, especially for number of passengers and GCU×PASSGR, are well above 3, indicating a peaked distribution and the possible presence of outliers. Overall, although some variables deviate from normal distribution, the logarithmic transformation has helped achieve a relatively more balanced distribution.

Given the relatively short time (T) and cross-sectional (N) dimensions of the panel dataset, panel unit root tests were not conducted. First-generation panel unit root tests rely on large-sample assumptions; therefore, when the time dimension is limited, their statistical power may weaken and yield potentially misleading results. Accordingly, considering the structural characteristics of the panel, the analysis proceeded directly to the estimation stage (Yerdelen Tatoglu, 2020).

The results of the correlation analysis conducted within the scope of the study are presented in Table 3. The findings indicate that passenger numbers, jet fuel consumption, and the interaction terms of these variables with the global climate uncertainty index exhibit strong correlations with airline-related carbon emissions.

Table 3: Correlation Matrix

Variables	1	2	3	4	5	6	7
log_CO_2 (1)	1,0000						
log_GCU (2)	-0,0189	1,0000					
log_GDP (3)	0,1174	0,3306	1,0000				
log_PASSGR (4)	0,8505	-0,0292	0,2165	1,0000			
log_JFC (5)	0,9682	-0,0265	0,1293	0,8614	1,0000		
log_GCU×log_PASSGR (6)	0,8347	0,1368	0,2679	0,9818	0,8453	1,0000	
log_GCU×log_JFC (7)	0,9367	0,2105	0,2007	0,8309	0,9671	0,8620	1,0000

In addition, the Variance Inflation Factor (VIF) values of the variables included in the study were examined. The VIF values, ranging between 1.00 and 4.09 with an average of 2.27, do not indicate a multicollinearity problem in the model; all variables remain within acceptable thresholds.

In static panel analysis, it is necessary to carry out the model estimation process in order to determine which specification—Fixed Effects (FE) or Random Effects (RE)—is appropriate. This process begins with the implementation of the F (Chow) test, followed by the Breusch–Pagan (1980) test, and is ultimately completed with the Hausman test. The results of the model estimation procedure are presented in Table 4.

Table 4: Fixed Effects (FE) or Random Effects (RE) Decision Process

	Model 1		Model 2	
	Results	Effect/Result	Results	Effect/Result
Country Effect	38,16 (0,00)	Yes	37,86 (0,00)	Yes
Time Effect	0,00 (1,00)	No	0,00 (1,00)	No
Hausman	0,67 (0,98)	RE	4,82 (0,31)	RE

In the first model, the Hausman test statistic was obtained as 0.67 (0.98), indicating that the random effects model is appropriate. The results further reveal the presence of country-specific effects, while no significant time effects were detected. In the second model, the Hausman test statistic was 4.82 (0.31), again suggesting that the random effects specification is valid. Similarly, the findings indicate the existence of country effects but no statistically significant time effects in the model.

Following the model estimation process, key diagnostic tests were conducted separately for both models to examine the presence of heteroskedasticity, autocorrelation, and cross-sectional dependence. Since the random effects specification was found to be valid for both equations, the Levene–Brown–Forsythe test was employed to assess heteroskedasticity in the first equation, the Bhargava et al. Durbin–Watson and Baltagi–Wu LBI tests were used to detect autocorrelation, and the Pesaran test was applied to examine cross-sectional dependence.

Table 5: Key Diagnostic Tests

Models		1	2
Heteroscedasticity (LBF Test)	W0**	4,3308	4,3308
	W50**	1,3524	1,3524
	W10**	1,4310	1,4310
Autocorrelation	Bhargava DW*	2,0608	2,0600
	Baltagi-Wu LBI*	2,1100	2,1109
Cross-Sectional Dependence	Friedman	6,2190 (0,0000)	6,2270 (0,0000)

* A test value below 2 signifies the presence of autocorrelation.
** The p-values of the tests are less than 0.05.

An examination of the values reported in Table 5 indicates the presence of partial heteroskedasticity, no evidence of autocorrelation, and the existence of cross-sectional dependence. The diagnostic test results for the second equation similarly to the presence of these issues. To address heteroskedasticity and cross-sectional dependence in both models, cluster-robust standard errors at the country level were employed. The results obtained from the robust estimators are presented in Table 6.

Table 6: Research Results

Models/ Variables	Model 1 CO_2	Model 2 CO_2
Constant(c)	-1,6618* (0,6072)	-1,7315* (0,6587)
log_GCU	0,1138** (0,0557)	0,1359** (0,0577)
log_GCU×log_PASSGR	-0,0221* (0,0057)	
log_GCU×log_JFC		-0,0249* (0,0093)
log_GDP	-0,0814 (0,0812)	-0,0853 (0,0812)
log_PASSGR	0,1839* (0,0513)	0,0701** (0,0303)
log_JFC	0,9012* (0,0291)	1,0286* (0,0572)
R^2	0,9823	0,9824
Observations	360	360

* and ** denote statistical significance at the 1% and 5% levels.

An examination of the results reported in Table 6 indicates that variables representing the physical inputs of aviation activity—namely passenger numbers and jet fuel consumption—are key determinants in explaining aviation-related carbon emissions. In both models, jet fuel consumption (JFC) is positive and strongly significant in the random effects estimations, while passenger numbers (PASSGR) also exhibit a positive relationship with aviation-related carbon emissions in each specification. On the other hand, the most significant finding of the study indicates that the effect of global climate uncertainty on airline-related CO_2 emissions varies depending on the level of aviation activity across countries. In particular, in countries characterized by high passenger volumes or intensive jet fuel consumption, increases in global climate uncertainty are found to exert a mitigating effect on airline-related carbon emissions. That is, within the OECD context, this pattern directly affects countries such as the United States, Japan,

Canada, France, Germany, and the United Kingdom. The negative and statistically significant interaction terms indicate that the marginal effect of global climate uncertainty on CO_2 emissions decreases in countries with high aviation exposure and may become negative beyond a certain threshold. Based on this explanation, it can be argued that interpreting the model results by relying on conditional marginal effects—rather than solely on the coefficient of global climate uncertainty (GCU)—provides a more appropriate and accurate approach.

CONCLUSION

This study aims to evaluate the uncertainty–emissions relationship from a sustainability perspective by examining the impact of global climate uncertainty on airline-related carbon emissions in a sample of OECD countries. The panel data analysis findings reveal that passenger numbers and jet fuel consumption—representing the physical inputs of aviation activity—significantly increase airline-related carbon emissions, as expected. This finding is consistent with the existing literature (Yang et al., 2024; Lin & Cheung, 2024; Zhao et al., 2025; Borozan & Pirgaip, 2024) emphasizing the decisive role of demand growth and fuel intensity in shaping emissions within the aviation sector.

The most noteworthy result of the study is that the effect of global climate uncertainty on airline carbon emissions is neither unidirectional nor linear; rather, it exhibits a conditional structure depending on countries' levels of aviation activity. The findings indicate that in OECD countries characterized by high passenger volumes and intensive jet fuel consumption, increases in global climate uncertainty exert a mitigating effect on airline-related carbon emissions. The negative and statistically significant interaction terms suggest that, in these countries, uncertainty encourages firms to adopt more cautious operational strategies, improve fuel efficiency, and shift toward carbon-reduction practices.

These results indicate that global climate uncertainty should not be viewed solely as a risk factor that suppresses investment and economic activity, and that its role extends beyond purely contractionary effects. Particularly in emission-intensive sectors, uncertainty can strengthen expectations of stricter future regulations, thereby exerting a disciplining and transformative effect on firms. In this respect, the study contributes to the literature by demonstrating that climate uncertainty may, under certain conditions, encourage emission reductions, thereby offering an explanatory perspective on the mixed findings reported in prior research.

The findings offer important implications for policymakers. First, it becomes evident that, beyond the predictability of climate policies, their capacity to generate regulatory pressure and provide directional signals is also critical. Particularly in countries with intensive aviation activity, rather than eliminating uncertainties surrounding climate policies, it is important to support them with clear targets and long-term frameworks that steer firms toward carbon-reducing investments. In this context, carbon markets, emissions trading systems, and incentive mechanisms for sustainable aviation fuels can be considered instruments that reinforce the transformative effects of uncertainty.

From the perspective of the aviation sector, the findings suggest that airline companies may view global climate uncertainty not only as a risk factor but also as a driving force for enhancing operational efficiency and sustainability performance. Investments in fuel-efficiency technologies, enhanced optimization in flight planning, and the wider adoption of sustainable aviation fuels emerge as strategic responses that can provide a competitive advantage under conditions of uncertainty (Kiracı, 2025; Yıldız & Yıldız, 2024; Sekartadji et al., 2024; Gedik Göçer & Arabacı, 2024).

From a sustainability accounting and reporting perspective, the study once again highlights the importance of reporting emissions in a regular, comparable, and transparent manner. Reliable accounting data on carbon emissions enable policymakers to design more effective regulations under conditions of uncertainty, while also allowing firms to integrate environmental performance into their strategic decision-making processes.

These findings can also be interpreted within the framework of sustainability accounting, which emphasizes the systematic measurement, monitoring, and disclosure of environmental impacts alongside financial performance. From this perspective, the relationship identified in the study suggests that uncertainty surrounding climate policies may strengthen the importance of transparent carbon accounting practices in the aviation sector. As regulatory expectations become less predictable yet potentially more stringent, firms may rely more heavily on robust emissions measurement and reporting systems to manage environmental risks and demonstrate compliance with emerging sustainability standards. Consequently, sustainability accounting does not merely function as a reporting mechanism but also as a strategic tool that enables firms to anticipate regulatory developments, improve environmental performance, and align their operational decisions with long-term climate objectives.

This study is subject to certain limitations. First, the analysis is limited to OECD countries, and the generalizability of the findings to developing economies or countries with different regulatory frameworks should be considered with caution. Moreover, since the global climate uncertainty index does not vary across countries, the results are interpreted primarily through interaction terms and conditional effects. Future research could develop country-

specific climate uncertainty indicators and utilize firm-level aviation data, which would enable a more detailed analysis of the uncertainty–emissions relationship. In addition, studies examining the mediating role of sustainable aviation fuels and technological innovations could further enrich the literature in this field.

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