Are Industry Climate Alliances Cartels?

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Abstract: In response to growing stakeholder concerns about climate change, firms are joining industry carbon net-zero alliances—collective commitments by firms in the same industry to achieve net-zero carbon emissions. These alliances promise coordinated decarbonization efforts and greater influence over supply chain partners and policy through higher credibility. However, they raise antitrust concerns that competitors may use these climate alliances to act as a "cartel," reducing consumer welfare. We study the anticompetitiveness and effectiveness of industry net-zero alliances, focusing on U.S. airlines. Using airline ticket data, we find no evidence of collusion: alliance members do not raise prices or restrict output compared to non-members, even in routes they collectively dominate. However, firm-year analyses reveal no improvement in emissions or environmental performance. Overall, our results suggest that industry net-zero alliances function as "cheap talk alliances" that are neither collusive nor effective, at least in the near term. We discuss the paradox of climate alliances, illustrating how regulatory concerns can hinder the effectiveness of the alliances. We conclude by examining other potential benefits of industry climate alliances that pose fewer antitrust concerns. Our descriptive evidence indicates that the alliance functions as a hub for collective policy engagement and that member firms increase their disclosures and future initiatives related to sustainable aviation fuel—the industry's priority for decarbonization. (*JEL* L41, Q54, L93, M14, D22, K21)

Keywords: climate alliance; collusion; cartels; net-zero; sustainability; climate; antitrust

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I. Introduction

Corporate action and innovation are essential for achieving a low-carbon economy, yet firms face a "double externalities problem" (Acemoglu et al., 2012). Firms incur the full costs of decarbonization while the benefits of decarbonization (e.g., clean air) are shared with society. Similarly, firms bear the entire cost of investing in green technology, while the benefits from the investment can spill over to other firms. Adding to this challenge, individual firms' climate commitments often lack accountability, raising doubts about their credibility (Jiang et al., 2025; Aldy et al., 2023, 2025). In this paper, we examine a potential solution to these challenges: industry net-zero alliances, which are groups of firms in an industry collectively committing to achieving net-zero emissions. Examples of industry net-zero alliances include those by the oil and gas industry (Oil and Gas Climate Initiative), banks (Net Zero Banking Alliance), asset managers (Net Zero Asset Managers Initiative), the fashion industry (the Fashion Pact), and more.

These industry net-zero alliances promise several potential benefits (Gasparini et al., 2024). Collective commitments can mitigate climate underinvestment by facilitating shared investments, reducing the burden on any one firm to fund costly technological transitions alone. Coordination also enables economies of scale in emerging technologies, by lowering costs and strengthening the case for government subsidies and policy support. Moreover, collective commitments can enhance the credibility of climate targets by raising the reputational cost of noncompliance, as firms face scrutiny from both industry peers and the public. The collective commitment can serve as a credible signal for future demand and supply that supply chain partners and customers can act upon. For example, certain industries can only achieve net-zero if their suppliers also transition and provide them with green inputs (e.g., steel for automobile manufacturers and sustainable aviation fuel for airlines). While suppliers may not be willing to invest in the production of green

input based on a single customer's net-zero ambition, if the entire customer industry is committed to net-zero, they may be willing to invest, increasing the scale and reducing the costs for green inputs. Together, these mechanisms suggest that climate alliances can encourage broader participation from not only the alliance members but also across their value chain and achieve the rate of decarbonization that would not be feasible without the joint commitment.[1]

While industry climate alliances promise the aforementioned benefits, they come with a serious risk of collusion. Competition is the driving force of free and well-functioning markets, and antitrust laws strictly prohibit collusive practices that artificially "raise prices above or reduce output, quality, service, or innovation below what likely would prevail in absence of the relevant agreement" (U.S. Department of Justice and Federal Trade Commission, 2020).[2] Collective decisions on future investments and product offerings—albeit for sustainability objectives—can trigger antitrust scrutiny, as such coordination may be perceived as restricting competitive autonomy. Antitrust authorities worry that climate alliances may allow competitors to use sustainability as a pretext for coordination on price, output, procurement, or product offerings. The antitrust concern is not that firms charge higher prices per se—indeed, competitive markets allow firms with greener products and higher costs to pass these costs through to willing consumers (i.e., product differentiation). Rather, the concern arises when competitors collectively commit to offering only more expensive green options, effectively removing lower-cost alternatives from the market and thereby reducing consumer choice and welfare. Such coordinated restrictions on product variety or procurement behavior can be viewed as horizontal agreements that trigger

[1] See Gasparini et al. (2024) for more discussion on the potential benefits of industry climate alliances.
[2] We note that the cited 2020 antitrust guideline by the U.S. Department of Justice and Federal Trade Commission was withdrawn in December 2024. Rich economics literature studies the fragility of cartels, conditions in which cartels persist, and the detection and regulation of cartels (e.g., Stigler, 1964; Green and Porter, 1984; Porter, 2005; Levenstein and Suslow, 2006; Chassang and Ortner, 2023).

antitrust scrutiny. Collusive practices by climate alliances may include 1) jointly agreeing to work exclusively with green suppliers who charge higher prices, thereby passing increased costs on to consumers, 2) collectively deciding to offer only green products, effectively eliminating the option for lower-cost "brown" products, and 3) coordinating investment timelines for decarbonization technologies. While these activities may be beneficial for the environment (and in achieving net-zero), they are anticompetitive because they reduce consumer welfare through higher prices and reduced output (and product offerings).

Regulators around the world are responding to the antitrust risks of climate alliances. In June 2023, the European Commission published a guideline on horizontal cooperation, specifying how antitrust regulation applies to "sustainability agreements" (European Commission, 2023). The Commission defines "sustainability agreements" as agreements between competitors that pursue sustainability objectives, and specifies the types of sustainability agreements that are unlikely to raise competition concerns. For instance, while sharing information about unsustainable suppliers is allowed based on the guidelines, forbidding alliance members from purchasing from these unsustainable suppliers would be a violation of antitrust laws. In the U.S., the House Judiciary Committee released two Interim Staff Reports in 2024 on how ESG-driven institutional investors, NGOs, and firms are functioning as "climate cartels" destroying American consumer welfare while pursuing decarbonization goals (U.S. House Committee on the Judiciary, 2024a, 2024b).[3] Shortly after the release of the second report in December 2024, major U.S. banks withdrew from the Net-Zero Banking Alliance, and BlackRock left the Net-Zero Asset Managers initiative, indicating that

[3] The Committee states that it "obtained evidence that a 'climate cartel' of left-wing environmental activists and major financial institutions has colluded to force American companies to 'decarbonize' and reach 'net zero.'" While the Report is mainly focused on the potentially collusive behavior arising from green institutional investors, the Committee specifically targets "convening and collaborating groups," indicating that industry net-zero alliances can be considered climate cartels if they lead to increased prices or reduced consumer choices while pursuing their joint decarbonization goals.

regulatory pressure on climate alliances is real.[4] Legal action is already underway, with Texas Attorney General Ken Paxton filing an antitrust lawsuit in 2024 against BlackRock, Vanguard, and State Street, alleging that their climate-related investment coordination suppressed coal production and harmed consumers (Office of the Attorney General of Texas, 2024). The asset managers allegedly acquired substantial stakes in public U.S. coal producers and utilized climate alliances, such as the Climate Action 100+ and Net Zero Asset Managers Initiative, to pressure coal producers to artificially reduce output by more than half by 2030, increasing energy prices for U.S. consumers. Relatedly, in August 2025, Iowa Attorney General Brenna Bird, along with 22 other states, accused the Science Based Targets initiative of using its Net Zero Standard to pressure oil and gas companies to reduce output, leading to higher energy prices for U.S. agriculture and consumers (State of Iowa Office of the Attorney General, 2025).

In addition to whether these climate alliances are collusive, an equally important but distinct question is whether they represent genuine decarbonization efforts or merely collective cheap talk. Prior research has raised concerns about the credibility of individual firms' environmental commitments (e.g., Aldy et al., 2023; Jiang et al., 2025). Likewise, collective commitments made through industry alliances may lack credibility and serve primarily symbolic purposes, yielding limited or negligible environmental benefits. In some cases, climate alliances may even lead to worse environmental outcomes if firms use them to coordinate on minimal joint standards and suppress competition in environmental performance, effectively facilitating environmental collusion.

Based on the potential benefits and antitrust risks of industry climate alliances, we investigate the effects of industry net-zero alliances on competition and decarbonization. There are

[4] The Net-Zero Banking Alliance (NZBA), which once had nearly 150 member institutions, ceased operations in October 2025 following mounting regulatory pressure from the U.S.

four potential outcomes of industry net-zero alliances, based on the expected anticompetitive behavior and environmental outcomes: 1) green cartels, 2) greenwashing cartels, 3) green alliances, and 4) cheap talk alliances. Green cartels are collusive, but lead to improved environmental outcomes. Firms may collaborate to make greener decisions (e.g., only offer green products or work exclusively with green suppliers) that lead to reduced consumer welfare (e.g., higher consumer prices and fewer choices). Greenwashing cartels are collusive and are not associated with improved environmental outcomes. Firms in these alliances may use climate and sustainability as excuses to charge higher prices or reduce consumer choices. For example, firms may market their products as more sustainable than they actually are in order to charge higher prices or claim to be engaging in environmentally friendly activities to justify increased prices. Green alliances lead to improved environmental outcomes without anticompetitive behaviors. Cheap talk alliances have no effect on market competition or environmental outcomes. This typology highlights the dual roles of alliances as potential instruments of both environmental coordination and market distortion. Our study asks: Which of these outcomes best characterizes industry net-zero alliances in practice?

In this paper, we use the U.S. airline industry as a setting to study the effects of industry net-zero alliances on market competition and environmental outcomes. Airlines for America (A4A), the industry trade organization for U.S. airlines, collectively committed to net-zero carbon emissions by 2050 in March 2021. The airline industry provides an appropriate setting to examine the outcomes of industry net-zero alliances. The airline industry is one of the hard-to-abate sectors, and airlines can only achieve net zero through substantial technological development and investments, including the large-scale production of sustainable aviation fuel (SAF) and replacing fleets with fuel-efficient aircraft (World Economic Forum and Accenture, 2024). These suggest

that airline is an industry where collaboration among firms through the climate alliance—not only to transform themselves but to transform suppliers—is critical in achieving net-zero emissions. At the same time, the airline industry has a history of antitrust scrutiny, with regulators closely monitoring pricing and capacity coordination (e.g., Borenstein, 1990; Kim and Singal, 1993; Azar et al., 2018; Bilotkach, 2019; Dennis et al., 2022).

We examine the anticompetitiveness of the airline industry's net-zero alliance using a difference-in-differences research design on granular airline-quarter-route level data. We compare changes in ticket prices and quantities (passengers served) of alliance member airlines before and after the alliance's net-zero commitment to those of non-alliance members on the same route. We use stringent fixed effects, including route-by-time fixed effects (comparing airlines serving the same route in the same quarter) and airline fixed effects (controlling for time-invariant airline characteristics). We find no evidence of anticompetitive practices: alliance member airlines do not increase prices or reduce output following the alliance's net-zero commitment, relative to non-member airlines. To mitigate concerns that alliance members are larger airlines, we further conduct within-airline analyses, comparing routes where net-zero alliance members collectively hold higher versus lower market share. Even in flight routes collectively dominated by the alliance members, we continue to find no evidence of anticompetitive behavior.

Next, we test the environmental outcomes of these alliances. These tests can reveal whether the industry-level joint net-zero commitment is a credible commitment associated with decarbonization in the near term. We use a difference-in-differences design at the firm-year level, where environmental data is available. We do not find evidence to support that industry net-zero alliances are effective in facilitating decarbonization: alliance member airlines do not reduce emissions more and, in fact, have lower environmental scores and more environmental

controversies after the alliance's net-zero commitment. While alliance members increase the use of SAF, the amount of SAF usage is still less than 0.1% of total fuel for alliance members after the net-zero commitment. These results are robust to using a synthetic difference-in-differences approach to achieve better matching between alliance and control airlines. Collectively, our results support that industry net-zero alliances are cheap talk alliances—alliances that are not collusive, but also ineffective in facilitating decarbonization.

Given our findings, we highlight a central paradox of climate alliances: to comply with antitrust laws, these alliances cannot impose binding restraints on their members—they cannot penalize non-compliance, mandate green procurement, or exclude carbon-intensive products. Yet, without such restraints, alliances often lack the institutional "bite" necessary to coordinate costly decarbonization actions and to discipline firms that fail to meet alliance goals. This tension is further compounded by the absence of clear legal guidance on how firms may collaborate with competitors for sustainability purposes, and how environmental benefits are weighed in antitrust evaluations. As a result, firms may be deterred from using climate alliances as an effective mechanism for driving decarbonization and advancing net-zero transitions.

Motivated by this paradox, we examine whether industry net-zero alliances deliver other benefits that are less dependent on binding commitments and less subject to antitrust concerns. In particular, we explore two potential benefits of net-zero alliances. First, they may facilitate collective policy engagement, such as securing subsidies for SAF or tax credits for green investments. We descriptively observe that alliance members increase their environmental lobbying and policy engagement disclosures following the alliance's introduction. Second, alliances may help coordinate member firms' individual decarbonization efforts around shared priorities—which is sustainable aviation fuel for airlines (World Economic Forum and Accenture,

2024). We find descriptive evidence that alliance members increase disclosure of SAF initiatives (in financial statements, sustainability reports, and press releases) and engage more in SAF-related future initiatives. Overall, alliances appear to help align member firms' decarbonization efforts and mobilize policy support—activities that are less anticompetitive but also less binding—potentially explaining the lack of results on direct emissions outcomes. Providing clear antitrust guidance on sustainability-related collaborations may be key to overcoming the paradox and allowing climate alliances to effectively promote decarbonization.

This study contributes to the policy debate on the promises and perils of industry climate alliances (Gasparini et al., 2024; Dolmans et al., 2023; Gasparini and Tufano, 2025). Given the recent increase in climate alliances and regulatory actions over them, there is a need for data-driven evidence on the outcomes of industry net-zero alliances. Gasparini and Tufano (2025) examine the effect of climate alliances in the banking industry and find that member banks do not exhibit collusive behavior, but improve their environmental performance—for instance, by adopting climate-aligned management practices and reducing emissions. Our results add to this study by presenting a more nuanced picture examining the airline industry, a hard-to-abate sector with greater antitrust scrutiny. While we similarly find no evidence of collusion, we also observe limited environmental progress among alliance members. These results highlight how the trade-off between climate cooperation and competition may constrain the effectiveness of climate alliances, limiting firms' ability to use them as meaningful decarbonization tools.

More broadly, our evidence contributes to the discussion about the relationship between antitrust law and ESG (Schinkel and Spiegel, 2017; Hearn et al., 2023; Schinkel and Treuren, 2021; Holmes, 2020). There has been an ongoing debate on how ESG collaboration among firms and institutional investors may be collusive. Efforts to promote ESG—such as lobbying for stricter

regulations, restricting supplier access, and establishing higher industry standards—can be considered as an example of "raising rivals' costs," an anticompetitive behavior that has been argued to be even more problematic than predatory pricing (Salop and Scheffman, 1983; Ryan, 2012). At the same time, some regulators are giving exemptions for collaboration aimed at achieving ESG goals (e.g., European Commission, 2023). We add to this debate by providing evidence of the collusiveness of a climate alliance in an industry with high antitrust concerns.

Second, our paper contributes to the emerging literature examining voluntary corporate climate commitments. Recent work raises concerns about the lack of accountability and progress in firms' climate pledges (Jiang et al., 2025; Aldy et al., 2023, 2025). Part of the challenge lies in the costly and systemic nature of decarbonization, particularly in hard-to-abate sectors where firms face both competitive pressures and dependence on upstream or downstream actors to enable emissions reductions (Acemoglu et al., 2012). Our study adds to this literature by examining whether joint climate commitment by industry members can mitigate these credibility concerns by facilitating collective action.

Third, our study contributes to the accounting literature on how firm disclosure shapes competition and coordination. Prior work shows that firms use public disclosure strategically to deter entry and disadvantage rivals (Burks, Cuny, Gerakos, Granja, 2018; Glaeser and Landman, 2021; Li, 2010; Bloomfield, Heinle, and Timmermans, 2024). Other studies, however, document that disclosure can also serve as a coordination device among competitors (Bertomeu, Evans, Feng, and Tseng, 2021; Kepler, 2021; Pawliczek, Skinner, and Zechman, 2022). For example, Bourveau et al. (2020) show that corporate disclosure can function as a mechanism for tacit coordination, and Aryal et al. (2018) find that legacy U.S. airlines use public earnings calls to coordinate reductions in route capacity. In a similar vein, industry net-zero alliances can be viewed as a form

of collective environmental disclosure through which firms publicly announce shared goals and signal intended future actions. We extend this literature by providing empirical evidence on whether such jointly announced decarbonization commitments can facilitate collusive, anticompetitive outcomes.

Lastly, our study contributes to the literature on inter-firm alliances. Prior research has examined how alliances can facilitate innovation, share risks, coordinate standards, and shape regulatory or market environments (e.g., Gulati, 1998; Oxley and Sampson, 2004). These alliances typically enhance firms' private returns and are motivated by financial incentives. In contrast, climate alliances such as the industry net-zero alliances aim to deliver a public good: decarbonization. While costly for individual firms to pursue unilaterally, decarbonization efforts can become more economically viable when undertaken collectively, through shared investment, scale economies, or coordinated demand signaling. While such alliances have the potential to bring these benefits, we find limited effectiveness—potentially because antitrust concerns constrain the types of commitments that would enable meaningful coordination.

Beyond documenting the absence of collusion and the limited decarbonization impact, our findings speak to the design of sustainability collaborations under legal and institutional constraints. They suggest that without explicit safe harbors or regulatory guidance clarifying permissible forms of sustainability collaboration, firms may default to symbolic participation rather than substantive coordination. For managers, this highlights the limits of voluntary alliances as a mechanism for credible decarbonization; for policymakers, it underscores the need to align competition law with collective environmental objectives.

II. Data and Measurement

We use the U.S. airline industry's net-zero alliance as a setting to examine the anticompetitiveness and efficacy of industry net-zero alliances. Members of Airlines for America (A4A), the trade organization for U.S. airlines, jointly committed to achieving net-zero carbon emissions by 2050 in March 2021. The airline industry provides an apt setting to study the anticompetitiveness and effectiveness of industry net-zero alliances. Achieving net-zero in aviation requires substantial investment and technological advancement, including the large-scale availability of SAF at competitive prices and fleet upgrades to more fuel-efficient aircraft (e.g., American Airlines, 2024). These transitions are not only costly but also dependent on innovation from upstream fuel and aircraft suppliers, making coordinated industry action potentially more valuable in this sector. Additionally, the airline industry has high anticompetition concerns, with frequent regulatory blocks in mergers and joint ventures (e.g., Borenstein, 1990; Borenstein, 1992; Kim and Singal, 1993; Azar et al., 2018; Bilotkach, 2019; Dennis et al., 2022). Therefore, the risk of climate alliances functioning as a cartel is high in this industry.

Our primary data is from the Airline Origin and Destination Survey (DB1B; Bureau of Transportation Statistics, 2018-2024b). This data represents a 10% random sample of airline tickets collected by the Bureau of Transportation Statistics. This data contains ticket-specific information, such as origin airport, destination airport, number of stops, operating carrier, ticket price, flight distance, and number of passengers for the sample of tickets sold in a given quarter. We use the DB1B Market data, in which an observation corresponds to a one-way trip from origin to destination. We exclude tickets sold at a bulk fare and tickets with more than two stops.

We clean the DB1B Market data by aggregating tickets at the airline-quarter-route level. We define a route as the origin city market and destination city market pair (e.g., city market P to

city market Q). The U.S. Department of Transportation assigns airports to city markets, allowing us to aggregate airports that serve the same geographic market. We aggregate by taking average ticket prices, average miles flown, and the total number of passengers for flights in the same quarter, operated by the same airline, serving the same route. The number of passengers is multiplied by 10, given that the DB1B data reflects a random 10% sample of the tickets sold. The resulting data contains information about average ticket prices and the number of passengers for an airline in a quarter for a given route (e.g., American Airlines in the first quarter of 2023, for the route from San Francisco to Boston).

Next, we create indicators for the airline net-zero alliance members. The indicator *NZA* equals one for A4A members and zero for non-member airlines. The alliance members are Alaska, American, Delta, Hawaiian, JetBlue, Southwest, United, Atlas Air, FedEx, and UPS. The A4A members collectively committed to net-zero emissions by 2050 on March 30, 2021. Therefore, an indicator for periods after the airline industry's net-zero commitment (*PostNZA*) equals one for observations on and after the second quarter of 2021. One challenge is that the largest passenger carriers are all members of the A4A. We take various approaches to address this concern. We utilize various fixed effect structures and conduct cross-sectional analyses to make within-airline comparisons and to examine how alliance members behave differently in routes more and less controlled by alliance members. We also employ a synthetic difference-in-differences approach to achieve better matching between alliance and control airlines (for firm-year analyses).

We use the Air Carrier Statistics (T-100 Domestic Market Data; Bureau of Transportation Statistics, 2018-2024a) by the Bureau of Transportation Statistics to calculate overall market competition and market share by net-zero alliance members for each route. T-100 Domestic Market Data contains information about monthly traffic (number of passengers, pounds of freight

and mail) by all flights flown in and out of U.S. airports.[5] Using this data, we calculate the total number of passengers for a route for a month, and the number of passengers served by each airline for a given route and month. We then calculate the Herfindahl-Hirschman Index (HHI) for each route-month, where the HHI for route *r* in month *m* is $HHI_{mr} = \sum_{a=1}^{n} s_{mra}^2$. s_{mra} is the market share of airline *a* in route *r* in month *m*, and *n* is the number of airlines serving route *r* in month *m*. For each route-month, we also calculate the market share by net-zero alliance (A4A) members. The route-month-level data is aggregated to the route-quarter-level (by taking averages) and merged into the main airline-quarter-route data. To focus on flights around the introduction of the A4A net-zero alliance, we restrict our sample to airline-quarter-routes from Q1 2018 to Q2 2024.

We also conduct airline-year-level analyses to compare operating performance and environmental outcomes before and after the airline net-zero alliance. We collect financial and operating performance data from Compustat and LSEG, emissions data from Trucost, and ESG scores and activities data from LSEG for our sample period of 2018-2024 (Standard & Poor's, 2016-2024; LSEG, 2016-2024a; S&P Global, 2016-2024; LSEG, 2016-2024b). The operating performances of airlines are measured using return on assets (ROA), operating margin, and operating income per available seat miles (ASM).[6] We also examine the effect of airline net-zero alliance on airlines' operating revenues per ASM, operating costs per ASM, operating costs excluding fuel per ASM, and fuel costs per gallon. To proxy for airlines' environmental performance, we examine their carbon emissions, ESG scores, environmental controversies, and other environmental initiatives. We also capture firms' activities related to SAF using hand-

[5] We exclude flights with fewer than 200 passengers per month and distances less than 100 miles from the T-100 Domestic Market Data.

[6] Available seat miles (ASM) is a common measure of capacity for airlines. It is the number of available seats multiplied by the distance flown. ROA and operating margins are from Compustat. Other airline operating data are from LSEG.

collected data on SAF usage and a text-based measure from their financial statements (Lu et al., 2024). For additional analyses, we collect airlines' sustainability reports and press releases to measure their discussions on policy engagement and SAF.

III. Industry Net-Zero Alliances and Collusion

Antitrust laws prohibit collusive behavior that harms consumer welfare. Classic examples include competitors colluding to charge artificially high prices to consumers and to restrict output. While firms charging higher prices for greener products to consumers with a high willingness to pay in a competitive market does not raise antitrust concerns, competitors coordinating to only offer greener products at a higher price can trigger antitrust scrutiny, even if such coordination generates environmental benefits. Such coordinated actions can reduce consumer choice and potentially lead to anticompetitive price or output effects. Therefore, we first test if alliance members charge higher prices or reduce output after the net-zero alliance, relative to non-alliance members. We estimate:

$$logTicketFare_{art}(logPassengers_{art}) = \alpha + \beta_1 NZA_a \times PostNZA_t + \beta_2 NZA_a + \beta_3 logMilesFlown_{art} + \beta_4 MarketHHI_{rt} + Fixed\ Effects + \epsilon_{art}. \quad (1)$$

$logTicketFare_{art}$ ($logPassengers_{art}$) is the logarithm of average ticket prices (total number of passengers) of flights by airline *a* in route *r* in quarter *t*. NZA_a is an indicator for net-zero alliance members. $PostNZA_t$ is an indicator for quarters after A4A's net-zero commitment (March 2021). We control for the average distance flown ($logMilesFlown_{art}$) and competitiveness of the route in the quarter ($MarketHHI_{rt}$). We utilize various fixed effects structures in our estimation to control for airline-specific, time-specific, and route-specific factors that can explain the variation in prices and quantities. We cluster standard errors at the firm level.

Table 2 Panel A reports the estimated results. Across different fixed effects structures, we find no evidence of price increases by alliance members after A4A's net-zero commitment, compared to non-member airlines. In column 1, after controlling for average distance flown, market HHI, time effects, and route effects, β_1 is not significantly different from zero. Consistent with our expectation, ticket prices are positively associated with the average distance flown and market HHI (market concentration for the route). We find similar results in column 2 after controlling for time effects and airline effects on ticket prices. Finally, in column 3, we continue to find no price increases by net-zero alliance members (relative to non-members) after accounting for the route-time effects and airline effects. The fixed effects structure in column 3 is the tightest, as the comparison is within-route-time (different airlines serving the same route—e.g., San Francisco to Boston—in a given quarter) and within-airline (e.g., different flights by Delta). Overall, our results are not consistent with the claim that firms collude via industry climate alliances to increase prices.

In Table 2, Panel A, columns 4-6, we find no evidence to suggest that net-zero alliance members restrict outputs. In fact, except for column 4, we observe significant increases in the number of passengers served by net-zero alliance members following A4A's net-zero commitment. The observed increase in quantities is after controlling for market competition (market HHI) and fixed effects structure for each column. For example, in column 6, we account for the route-time effects and the airline effects on the quantities provided. The observed significant increases in the number of passengers served by alliance members are inconsistent with the airline net-zero alliance acting as a cartel.

While we do not find an increase in ticket prices or reduction in outputs for alliance members after the alliance's net-zero commitment compared to non-alliance members on average,

the anticompetitive practices may be concentrated in certain markets: routes controlled by net-zero alliance members. Our data enable us to compare routes controlled more by net-zero alliance members (collectively holding a greater market share) and routes less controlled by alliance members. We create an indicator for routes with above-median market share by net-zero alliance members ($HighNZAShare_{rt}$). Then, we estimate the following to examine if the increase in prices or reduction in outputs by alliance members is concentrated in alliance-controlled routes:

$$\begin{aligned} logTicketFare_{art}(logPassengers_{art}) = \alpha + \\ \gamma_1 NZA_a \times PostNZA_t \times HighNZAShare_{rt} + \gamma_2 NZA_a \times PostNZA_t + \\ \gamma_3 NZA_a \times HighNZAShare_{rt} + \gamma_4 PostNZA_t \times HighNZAShare_{rt} + \\ \gamma_5 HighNZAShare_{rt} + \gamma_6 NZA_a + \gamma_7 logMilesFlown_{art} + \gamma_8 MarketHHI_{rt} + \\ Fixed\ Effects + \epsilon_{art}. \end{aligned} \tag{2}$$

This analysis is especially helpful in addressing the challenge that the largest passenger carriers are all members of A4A. By comparing within-airline across different routes (with varying net-zero alliance member shares), the coefficient in this analysis is less prone to bias coming from the difference between net-zero alliance members and non-members. For instance, the above test compares how United Airlines prices routes with low alliance member market share to routes controlled by net-zero alliance members. If net-zero alliances are collusive, we expect to observe more collusive practices in routes that are controlled by alliance members.

Table 2 Panel B reports the results. In columns 1-3, we do not find evidence that net-zero alliance members increase ticket prices following A4A's net-zero commitment, even in markets controlled by net-zero alliance members across all three fixed effects structures (controlling for time and route effects, for time and airline effects, and for route-time and airline effects). Similarly, in columns 4-6, we find that the change in quantities (the number of passengers served) for alliance

members before and after the alliance's net-zero commitment does not vary by the route's market share by alliance members. That is, we do not observe significant decreases in outputs by alliance member airlines, both for markets less controlled and more controlled by net-zero alliance members. The results are again inconsistent with the claim that the airline net-zero alliance is anticompetitive.

While the previous analyses reveal no evidence of collusion by the airline industry's net-zero alliance using data from flight tickets, it is possible that alliance members collude in other dimensions to extract rent from their consumers. As an indirect test, we examine alliance members' changes in firm-year operating performance before and after A4A's net-zero commitments, relative to changes for non-member airlines. Because data is available at the firm-year level (2018-2024 firm-years for U.S. airlines), we acknowledge the limitations of a small sample, and that operating outcomes may reflect factors other than the firm's membership in net-zero alliances. To compare the operating performances of alliance members and non-members before and after A4A's net-zero commitment, we estimate:

$$FinOutcome_{ay} = \alpha + \beta_1 NZA_a \times PostNZA_y + \beta_2 NZA_a + \beta_3 PostNZA_y + \gamma Controls_{ay} + \epsilon_{ay}, \quad (3)$$

where $FinOutcome_{ay}$ is the operating outcomes for airline a in year y, and $PostNZA_y$ is an indicator that equals one for firm-year observations on and after 2021. We control for firm size (log total assets, *logAT*) and capital structure (long-term debt plus debt in current liabilities divided by total assets, *LEV*).

Table 3 reports the results. In Panel A, we find that return on assets (*ROA*, column 1), operating margin (*OPMargin*, column 2), and operating margin per ASM (*OPMarginPerASM*, column 3) are higher for net-zero alliance members after the alliance's net-zero commitment,

relative to non-alliance airlines around the same time. These findings could indicate collusive practices that increase alliance members' profitability that are not captured in higher ticket prices and reduced quantities. However, deeper analyses of airlines' operating outcomes reveal that the improvement in operating outcomes of net-zero alliance members is driven by their increased cost-efficiency, which is an example of competitive, not anticompetitive, practices. In Panel B, we separate the operating income per ASM into operating revenues per ASM (*OPRevPerASM*) and operating expenses per ASM (*OPExpPerASM*). While the changes in both variables are statistically insignificant at a 10% level, the improvement in operating income per ASM is largely driven by net-zero alliance members reducing operating expenses per ASM (i.e., improving cost efficiency). When we further divide operating expenses per ASM into operating expenses excluding fuel costs (*OpExpExclFuel*) and fuel costs per gallon (*FuelCostPerGallon*), we observe that net-zero alliances are significantly reducing operating expenses excluding fuel costs after A4A's net-zero commitment than non-alliance members. Given that the cost savings and increased efficiency of alliance members are the main drivers, the improvement in operating outcomes (ROA and operating margins) for net-zero alliance members cannot be interpreted as evidence of collusion among alliance members.

IV. Efficacy of Industry Net-Zero Alliances in Decarbonization

In the previous section, we do not find evidence that net-zero alliance in the airline industry is collusive. Yet, there is another independent but equally important question about the efficacy of industry net-zero alliances in facilitating decarbonization. While these climate alliances promise many potential benefits, it is plausible that they are empty commitments by groups of firms intended mainly as a marketing tool. Therefore, we examine whether member airlines of the net-

zero alliance significantly improve their environmental performance relative to non-member airlines. We estimate the following for firm-year observations for U.S. airlines from 2018 to 2024:

$$ESGOutcome_{ay} = \alpha + \beta_1 NZA_a \times PostNZA_y + \beta_2 NZA_a + \beta_3 PostNZA_y + \gamma Controls_{ay} + \epsilon_{ay}. \quad (4)$$

$ESGOutcome_{ay}$ is the ESG or environmental outcomes for airline a in year y. We examine three sets of firm-year outcomes: emissions (Table 4 Panel A), ESG and environmental performance (Panel B), and specific environmental activities (Panel C). We caveat that the firm-year level analyses have low power due to a small number of observations for U.S. airlines and are therefore descriptive. Also, because our sample period ends in 2024, we can only observe the short-term effects of the airline industry's net-zero alliance. To provide a more complete picture, Section 5 supplements these results by exploring additional potential benefits of the alliance that have longer-term implications.

In Table 4 Panel A, we do not observe significant changes in emissions for net-zero alliance members around the alliance's net-zero commitment relative to non-member airlines. Alliance members do not significantly reduce their emissions for both emissions intensity measures (tonnes of carbon dioxide equivalent emissions per USD 1 million revenues, *EmInt_S1/2/3*) and absolute emissions measures (the log of tonnes of carbon dioxide equivalent emissions, *logAbsEm_S1/2/3*) across all scopes of emissions.[7] The results raise questions about the efficacy and credibility of industry net-zero alliances.

[7] The GHG Protocol classifies carbon emissions into scopes based on where in the firm's value chain the emissions are generated. Scope 1 emissions are direct emissions from the firm's owned or controlled sources; Scope 2 emissions are indirect emissions related to purchased energy (electricity, heat, steam, or cooling); Scope 3 emissions include all other indirect emissions from the firm's value chain, including both upstream (suppliers) and downstream (customers) emissions. For Scope 3 emissions, we only include upstream Scope 3 emissions as downstream Scope 3 emissions are less relevant for airlines.

In Table 4 Panel B, we examine the changes in ESG and environmental scores, which are created by ESG rating agencies to summarize airlines' current and expected future ESG performance. Inconsistent with alliance members improving ESG and environmental performance, we observe significant decreases in ESG scores (column 1), environmental scores (column 2), and ESG controversy scores (reflecting more ESG controversies; column 3) for alliance members relative to non-members. Upon further examination, the negative ESG score performance relates to incidents such as Delta's class action lawsuit regarding its carbon neutrality claim (Greenfield, 2023).

Finally, we conduct analyses on specific decarbonization activities by airlines. While we observe significant increases in SAF usage after the alliance's net-zero commitment (Panel C, column 1), the average SAF usage among alliance members in the post-period (2021-2024) remains at 0.09% of their total fuel, which is far below the 10% SAF usage by 2030 ambition statement released by the World Economic Forum (World Economic Forum, 2021). Relatedly, in Table 3 Panel B column 4, we do not find a significant increase in fuel costs for net-zero alliance members after the alliance's commitment, which is consistent with low SAF adoption as SAF is estimated to be two to five times more expensive than traditional jet fuel (O'Malley et al., 2023). The absence of an increase in fuel costs and the minimal use of SAF after net-zero commitment among alliance members suggests they are not scaling up SAF use by a meaningful amount, at least in the short term. Additionally, we do not observe significant increases in environmental investment initiatives (*EnvInvestInit*) or policies related to environmentally friendly supply chains (*EnvSupplyChain*) by alliance members after the net-zero commitment (columns 2 and 3).

Overall, we do not find evidence that airlines in the industry net-zero alliance are improving their environmental performance. Alliance members do not reduce emissions, have lower ESG

and environmental scores, and have more environmental controversies following the alliance's net-zero commitment. They do not increase SAF usage to a meaningful amount nor adopt more decarbonization initiatives. These findings support concerns about the efficacy and credibility of industry net-zero alliances.

We conduct two sets of robustness tests to address the challenges of our setting. A caveat of our setting is that the largest passenger airlines are all members of the alliance. In the above analyses, we address the concern through various fixed effects structures and cross-sectional analyses exploiting the within-airline variation in routes' market share by alliance members (Eq. (2)). Columns 3 and 6 in Table 2 include airline fixed effects and route-time fixed effects. Cross-sectional analyses in Table 3 compare pricing (and output) by an alliance airline across routes that are more and less controlled by the alliance members, therefore, the results are less prone to the bias coming from differences in alliance airlines and non-member airlines. To further alleviate the concern, we implement the synthetic difference-in-differences approach to the firm-year analyses examining the effect of net-zero alliance on financial and environmental outcomes (Tables 3 and 4). The synthetic difference-in-differences approach allows us to achieve a more parallel pre-trend between treated and control firms by assigning different weights to control firms and years in the pre-period (Arkhangelsky et al., 2021). For this analysis, we adjust our sample period to include a longer pre-period (starting from 2016) and exclude 2024 due to missing observations for some airlines. The results using synthetic DiD, tabulated in Supplementary Appendix A, are consistent with our results in Tables 3 and 4. We observe a significant increase in firm-year operating margins, but this is largely driven by improved cost efficiency. We do not find evidence to suggest that net-zero alliance members reduce emissions or engage in more environmental activities after the alliance's net-zero commitment. Instead, similar to what we document in Table 4, ESG scores and

ESG controversy scores are lower for alliance members following the alliance's net-zero commitment relative to non-alliance members. The consistent synthetic DiD results alleviate concerns that our results are driven by systematic differences between alliance member airlines and non-member airlines.

Another limitation of our setting is that the sample period coincided with the COVID-19 pandemic, which severely affected international travel and the airline industry. To address this, we re-estimate our tests excluding COVID-19 affected periods. For airline-quarter-route level analyses (Tables 2), we exclude the period from 2020 Q2 to 2021 Q1. These four quarters experienced significant declines in the number of flights, as indicated by the Bureau of Transportation Statistics' T-100 data. For firm-year level analyses (Tables 3 and 4) on the operating and environmental outcomes of the alliance, we exclude observations from the year 2020 and instead include those from 2017 to maintain the same number of pre-period years. Across all tests, our results are robust to excluding periods affected by COVID-19 (results tabulated in Supplementary Appendix A, Tables SA2-SA4), confirming that any disruption in airlines during COVID-19 is not driving our results.

V. Paradox of Industry Net-Zero Alliances and Other Benefits

Collectively, our results using U.S. airlines as a setting support the hypothesis that industry net-zero alliances are "cheap talk alliances." These alliances do not appear to be collusive, but also seem ineffective in facilitating the industries' decarbonization in the near term. Our findings can be explained by the paradox of climate alliances: to abide by the antitrust laws, climate alliances cannot restrain what their member firms can or cannot do. For example, climate alliances cannot require firms to retire carbon-intensive products or prevent them from working with brown

suppliers. This means that under the current regulatory landscape, industry net-zero alliances cannot have a "bite". Then, it becomes unclear how an alliance without bite can deliver its initial promises for decarbonization. It is possible that industries form net-zero alliances with the goal of creating green alliances—to effectively facilitate decarbonization without collusion—but end up with a cheap talk alliance due to legal considerations.

Moreover, the absence of clear regulatory guidance on permissible forms of collaboration among competitors for sustainability-related objectives may discourage firms from fully engaging with climate alliances. In the face of such ambiguity, firms may err on the side of caution and adopt a passive or narrowly constrained approach to alliance participation. In addition, antitrust cases in the United States are predominantly adjudicated under the Rule of Reason framework, in which courts weigh the anticompetitive harms against the procompetitive benefits of a defendant's conduct (Newman, 2019).[8] However, it remains unclear to what extent environmental benefits are recognized as "procompetitive benefits" within this framework. Given that U.S. antitrust law prioritizes consumer welfare and market competition over broader public interest goals, it is unlikely that environmental benefits alone would be deemed sufficient justification for potentially anticompetitive conduct. Therefore, providing clear antitrust guidance on sustainability-related collaborations may be a crucial first step toward resolving the paradox and enabling climate alliances to fulfill their intended role in advancing decarbonization.

Given this trade-off between climate cooperation and competition, we explore two other potential benefits of climate alliances that are less subject to competition concerns. First, industry net-zero alliances can function as a nexus for coordinated policy engagement, strengthening firms' collective influence in advocating for regulatory and policy changes needed to achieve net-zero

[8] The other framework used in antitrust cases is per se. Certain agreements, with obvious anticompetitive harms and no significant procompetitive benefits, are challenged as per se illegal.

emissions.[9] Second, these alliances can articulate and consolidate industry-wide decarbonization priorities—most notably the development and scaling of sustainable aviation fuel in the airline sector—thereby steering firms' individual climate efforts toward common strategic goals.

To evaluate the industry net-zero alliance's role in coordinating policy engagement, we examine airlines' lobbying activities on environmental issues. We use two measures: the count of airlines' environmental lobbying activities (*EnvLobbyCount*) and airlines' discussion of policy engagement in their sustainability reports (*LobbySentenceCount*). For the first measure, we count the annual number of lobbying activities on environmental issues (Energy & Nuclear Power, Fuel, Gas & Oil, Environment & Superfund) by airlines during 2018-2024 using data from OpenSecrets (OpenSecrets, 2016-2024). For our second measure, we collect airlines' annual sustainability reports via web search and count the number of sentences that include at least one policy engagement keyword.[10]

Figure 1 Panels A and B show the policy engagement activities of alliance members and non-members before and after the alliance's net-zero commitment. Descriptively, there is a larger increase in environmental lobbying activities and policy engagement discussions by A4A members after its net-zero commitment. The difference in slopes of the two lines is not statistically significant using a difference-in-differences design with controls as in Eq. (4). Overall, these figures provide modest support that industry net-zero alliances function as a hub for member firms' policy engagement.

[9] Joint policy engagement can be anticompetitive, if it aims at raising costs for all firm in the industry (e.g., through lobbying for stricter regulations) instead of lowering costs of decarbonization for the industry. Stricter regulations can be used as a mechanism to drive out competition (Salop and Scheffman, 1983).

[10] The keywords used to identify policy engagement discussions are "public policy," "policy engagement," "policy advocacy," "policy participation," "policy contribution," "political party," "political action," "policy maker," "policymaker," "US policy," "government," "regulatory environment," "regulation," "congress," "federal agency," "lobby," "lobbying," "political activity," and "policy priority."

Innovation and scaled-up production of SAF is one of the most important requirements for airlines' net-zero transition. While we do not observe significant use of SAF as of 2024, industry net-zero alliance can help focus member firms' decarbonization efforts by identifying priorities such that these airlines commit to future activities related to SAF. We investigate this channel using three approaches. First, we use the percentage of sentences in Form 10-K Item 1 related to SAF (*SAF_10K*) from Lu et al. (2024). Second, we count the number of sentences containing "SAF" or "sustainable aviation fuel" in airlines' sustainability reports (*SAFSentenceCount*). In Panels A and B of Figure 2, we observe that alliance members increase SAF discussion in their financial statements and sustainability reports more than non-members around the alliance's net-zero commitment (the difference in the slopes of the lines is statistically significant only for Panel B). Third, we manually collect press releases related to SAF for all U.S. airlines by searching for keywords related to sustainable aviation fuel on each airline's website. Figure 2, Panel C shows the frequencies of SAF press releases by year and by A4A membership. All eight A4A members released SAF press releases on and after 2021 (the year of the alliance's net-zero commitment). Such press releases were exceedingly rare prior to 2020; however, their frequency increased markedly from 2021 onward for A4A members. In contrast, among the ten non-alliance airlines, only two made SAF press releases.

Because current SAF adoption of airlines remains limited, we systematically search for SAF-related initiatives that could reflect future SAF adoption. We search for such initiatives in airline's sustainability reports as of 2025. As shown in Figure 2 Panel D, we only observe initiatives for alliance members, and we summarize them in a heatmap across four categories: SAF customer engagement, SAF offtake agreements, SAF coalitions, and SAF investments. Three observations emerge. First, cost remains a central barrier, as shown by customer engagement

programs designed to offset the SAF "green premium" through corporate and passenger contributions. Second, supply is constrained, reflected in the large number of SAF coalitions and investment initiatives seeking to scale production. Airlines often engage in different SAF coalitions, potentially reflecting efforts to strengthen local production ecosystems (e.g., Alaska's involvement in the Cascadia Accelerator and Delta's in the Minnesota SAF Hub), or to avoid the appearance of direct coordination that could raise antitrust concerns. Third, many airlines disclose offtake agreements are in place to secure future SAF volumes and signal credible, long-term demand to producers. We include the full list of such disclosures in Supplementary Appendix Tables SA5.

While descriptive, this finding is consistent with the idea that the alliance helps guide and coordinate member firms' decarbonization efforts toward the industry's key priority—sustainable aviation fuel (SAF) for airlines. Overall, although we do not observe significant near-term environmental benefits from the climate alliance, our results provide descriptive evidence of longer-term benefits that pose fewer antitrust concerns: functioning as a hub for collective policy engagement and focusing members' decarbonization efforts on shared industry priorities. That said, because these potential benefits are captured through disclosures and forward-looking initiatives, questions remain as to whether they reflect credible commitments or merely cheap talk.

VI. Conclusion

Using the U.S. airline industry as a setting, we investigate whether industry net-zero alliances are collusive and whether these alliances deliver their promises for decarbonization. We find no evidence of anticompetitive practices by net-zero alliance airlines (higher prices or reduced output) compared to non-alliance airlines after the alliance's net-zero commitment. However, we

also do not find significant improvement in the environmental performance of alliance airlines following the alliance's net-zero commitment in the near term. Our results collectively suggest that industry net-zero alliances are likely to be "cheap talk alliances," which are neither collusive nor effective in decarbonization. Our empirical evidence on the anticompetitive risks and effectiveness of industry net-zero alliances offers important insights for regulators and policymakers considering how to oversee climate alliances. It also speaks directly to recent regulatory actions and lawsuits around climate alliances (e.g., Office of the Attorney General of Texas, 2024; State of Iowa Office of the Attorney General, 2025).

We discuss the paradox of industry net-zero alliances as potential explanations for our results. To comply with antitrust laws, industry net-zero alliances cannot have a bite (i.e., they cannot force their members to engage in or restrain them from engaging in certain activities). However, without a bite, net-zero alliances cannot deliver their promises of facilitating decarbonization. Moreover, the absence of clear guidelines on permissible climate-related collaboration among competitors and on how environmental benefits are considered in antitrust courts may have led to the constrained utilization of climate alliances. Based on this, we examine other potential benefits of industry net-zero alliances with less antitrust risks—functioning as a hub for members' policy engagement and setting industry priorities to guide members' decarbonization efforts—and find descriptive evidence in support of these benefits.

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Appendix A. Variable Definitions

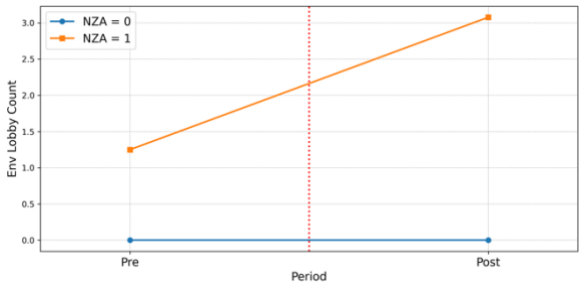
Variable	Definition
Variables for the airline-route-quarter level analyses:	
logTicketFare	The natural logarithm of the average ticket prices for tickets sold by the airline for the route in the calendar quarter. Ticket price data (*MktFare*) is from the Airline Origin and Destination Survey (DB1B Market data) by the Bureau of Transportation Statistics. The data contains detailed ticket-level information for a random 10% sample of all tickets in a given quarter. Route is defined as an origin city market and destination city market pair. The U.S. Department of Transportation assigns airports the serve the same geographic market to a city market (*City Market ID*). This variables in winsorized at 1% and 99%. Source: DB1B Market data.
logPassengers	The natural logarithm of the number of passengers served by the airline for the route in the calendar quarter. We calculate the number of passengers served by adding the number of passengers (*PASSENGERS*) from all tickets for the airline-route-quarter from the DB1B Market data. We then multiply this by 10 as the DB1B data represent 10% random sample for all tickets in a given quarter. Source: DB1B Market data.
NZA	An indicator that equals one for airline-route-quarter observations for Airlines for America (A4A) members. The alliance members are Alaska, American, Delta, Hawaiian, JetBlue, Southwest, United, Atlas Air, FedEx, and UPS.
PostNZA	An indicator that equals one for airline-route-quarter observations after Airlines for America's (A4A) net-zero commitment on March 30, 2021. This indicator equals one for observations on and after 2021 Q2.
logMilesFlown	The natural logarithm of the average miles flown (*MktMilesFlown*) for tickets sold by the airline for the route in the calendar quarter. This variables in winsorized at 1% and 99%. Source: DB1B Market data.
MarketHHI	The average Herfindahl-Hirschman Index (HHI) for the route-quarter. We use Air Carrier Statistics (Form 41 Traffic; T-100 Domestic Market Data) by the Bureau of Transportation Statistics to calculate market share by different airlines for each route-month. The HHI for route *r* in month *m* is $HHI_{mr} = \sum_{a=1}^{n} s_{mra}^2 . s_{mra}$ is the market share of airline *a* in route *r* in month *m*, and *n* is the number of airlines serving route *r* in month *m.* We aggregate the route-month HHIs to route-quarter by taking the average to merge with DB1B market data, which is quarterly. Source: T-100 Domestic Market Data.
HighNZAShare	An indicator that equals one for route-quarters with above-median market share by net-zero alliance (A4A) members. Using T-100 Domestic Market Data, we calculate the market share by net-zero alliance members for each route-month. Then, we aggregate it to route-quarter by taking the average to merge with quarterly DB1B market data. Source: T-100 Domestic Market Data.
Variables for the firm-year level analyses:	
ROA	Net income before extraordinary items scaled by total assets. Source: Compustat.
OPMargin	Operating income before depreciation divided by total revenues. Source: Compustat.
OPMarginPerASM	Operating revenue per available seat miles minus operating expense per available seat miles. Source: LSEG.
OPRevPerASM	Operating revenue per available seat miles. Source: LSEG
OPExpPerASM	Operating expense per available seat miles. Source: LSEG
OPExpExclFuel	Operating expense excluding fuel per available seat miles. Source: LSEG
FuelCostPerGallon	Fuel cost per gallon. Source: LSEG
NZA	An indicator for firm-year observations net-zero alliance (A4A) members. The Airlines for America members are Alaska, American, Delta, Hawaiian, JetBlue, Southwest, United, Atlas Air, FedEx, and UPS.
PostNZA	An indicator for firm-year observations on and after 2021. The A4A's net-zero commitment was in March 30, 2021.

logTA	The natural logarithm of one plus total assets. Source: Compustat.
LEV	Total long-term debt plus debt in current liabilities divided by total assets. Source: Compustat.
EmInt_S1/2/3	Scope 1/2/3 greenhouse gas emissions scaled by total revenues (tCO_2e/USD million revenue). For Scope 3 emissions, we only include upstream Scope 3 emissions as downstream Scope 3 emissions are less relevant for airlines. Source: Trucost.
logAbsEm_S1/2/3	The natural logarithm of Scope 1/2/3 absolute greenhouse gas emissions (in tCO_2e). For Scope 3 emissions, we only include upstream Scope 3 emissions as downstream Scope 3 emissions are less relevant for airlines. Source: Trucost.
ESGscore	ESG Scores by LSEG. The score ranges from 0 (D-) to 11 (A+). Source: LSEG.
ESGControversyScore	ESG Controversy Scores by LSEG. The score ranges from 0 (D-) to 11 (A+). Higher scores indicate less controversies. Source: LSEG.
Escore	Environmental Pillar Scores by LSEG. The score ranges from 0 (D-) to 11 (A+). Source: LSEG.
EnvInvestInit	An indicator that equals one if the firm-year had environmental investments initiatives. Source: LSEG.
EnvSupplyChain	An indicator that equals one if the firm-year had policies for environmental supply chain. Source: LSEG.
EnvControversies	An indicator that equals one if the firm-year had environmental controversies. Source: LSEG.
EnvLobbyCount	The number of lobbying activities for the firm-year on environmental issues. We count the lobbying activities on 'Energy & Nuclear Power,' 'Fuel, Gas & Oil,' and 'Environment & Superfund' issues based on OpenSecrets' classifications. Source: OpenSecrets.
LobbySentenceCount	The number of sentences containing policy engagement keywords in the firm-year's sustainability report. The keywords used to identify policy engagement discussions are "public policy," "policy engagement," "policy advocacy," "policy participation," "policy contribution," "political party," "political action," "policy maker," "policymaker," "US policy," "government," "regulatory environment," "regulation," "congress," "federal agency," "lobby," "lobbying," "political activity," and "policy priority."
SAF_10K	A subscore from the Climate Solution measure from Lu et al. (2024). This is the percentage of sentences from 10-K Item 1 that is classified as related to sustainable aviation fuel using a finetuned GPT model. Source: Lu et al. (2024).
SAFusage	The percentage of total jet fuel that comes from sustainable aviation fuel in a firm-year. Source: Hand collected
SAFSentenceCount	The number of sentences containing "sustainable aviation fuel" or "SAF" in the firm-year's sustainability report.

Figure 1. Potential Benefits of Industry Net-Zero Alliance: Policy Engagement

The figures illustrate the change in policy engagement by net-zero alliance member airlines (*NZA* = 1) and non-member airlines (*NZA* = 0) around the alliance's net-zero commitment. Panel A shows the changes in the number of environmental lobbying activities (*EnvLobbyCount*) using data from OpenSecrets. Panel B shows the changes in the number of policy engagement sentences in airlines' sustainability reports (*LobbySentenceCount*). The keywords used to identify policy engagement sentences are "public policy," "policy engagement," "policy advocacy," "policy participation," "policy contribution," "political party," "political action," "policy maker," "policymaker," "US policy," "government," "regulatory environment," "regulation," "congress," "federal agency," "lobby," "lobbying," "political activity," and "policy priority." For detailed variable definitions, see Appendix A.

Panel A. Environmental lobbying activities



Panel B. Policy engagement discussions in sustainability reports

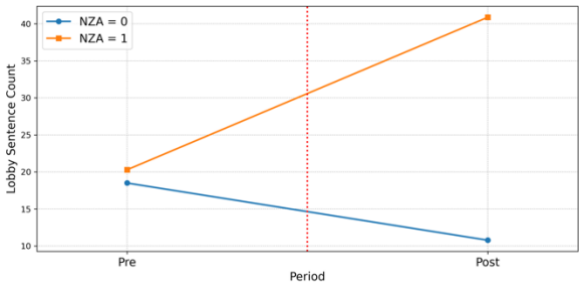
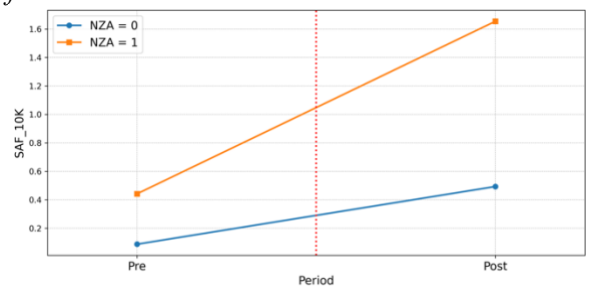


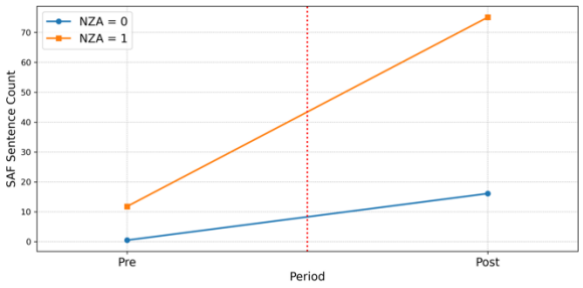
Figure 2. Potential Benefits of Industry Net-Zero Alliance: Industry Priority - Sustainable Aviation Fuel

The figures illustrate the change in sustainable aviation fuel activities by net-zero alliance member airlines (*NZA* = 1) and non-member airlines (*NZA* = 0) around the alliance's net-zero commitment. Panel A shows changes in airlines' SAF use and investment using the disclosure-based measure from Lu et al., 2025 (*SAF_10K*). Panel B shows changes in the number of SAF-related sentences in airlines' sustainability reports (*SAFSentenceCount*). Panel C reports the number of press releases related to sustainable aviation fuel by all U.S. airlines. The shaded years (2021-2024) represent the post-period (the period after the alliance's net-zero commitment). Panel D reports the number of sustainable aviation fuel initiatives reported in airlines' sustainability reports as of fiscal year 2024. For detailed variable definitions, see Appendix A.

Panel A. Sustainable aviation fuel discussion in financial statements



Panel B. Sustainable aviation fuel discussions in sustainability reports



Panel C. Press releases on sustainable aviation fuel

Year	*A4A members*	*Non-A4A members*	*Total*
2018	0	0	0
2019	0	0	0
2020	3	0	3
2021	22	0	22
2022	22	2	24
2023	20	3	23
2024	15	1	16
Total	82	6	88

Panel D. Sustainable aviation fuel initiatives in sustainability reports

	SAF Customer engagement	*SAF Offtake agreements*	*SAF coalition*	*SAF investment*
Alaska Airlines Inc.	2	2	4	
American Airlines Inc.		1	3	1
Atlas Air Inc.			1	
Delta Air Lines Inc.	1	2	4	
JetBlue Airways	2		3	
Southwest Airlines Co.	1	3	1	1
United Air Lines Inc.	2	1	2	2

Table 1. Summary Statistics

This table reports the summary statistics of the variables used in the analyses. Variables are defined in Appendix A.

	Mean	*Std.Dev.*	*25%*	*Median*	*75%*	*N*
Variables for the airline-route-quarter level analyses:						
logTicketFare	5.297	0.610	5.089	5.393	5.643	971333
logPassengers	5.577	2.258	3.689	5.347	7.244	971333
NZA	0.397	0.489	0.000	0.000	1.000	971333
PostNZA	0.535	0.499	0.000	1.000	1.000	971333
logMilesFlown	6.919	0.643	6.548	6.975	7.367	971333
MarketHHI	0.714	0.276	0.465	0.741	1.000	971333
HighNZAShare	0.500	0.500	0.000	0.000	1.000	971333
Variables for the firm-year level analyses:						
ROA	0.003	0.059	-0.026	0.016	0.046	84
OPMargin	0.053	0.198	-0.001	0.125	0.171	84
OPMarginPerASM	0.001	0.023	0.000	0.010	0.010	60
OPRevPerASM	0.126	0.041	0.090	0.130	0.150	60
OPExpPerASM	0.125	0.041	0.100	0.120	0.150	60
OPExpExclFuel	0.096	0.031	0.070	0.100	0.120	59
FuelCostPerGallon	2.378	0.779	2.020	2.200	2.943	62
NZA	0.595	0.494	0.000	1.000	1.000	84
PostNZA	0.524	0.502	0.000	1.000	1.000	84
logTA	9.250	1.320	8.328	9.044	10.480	84
LEV	0.446	0.138	0.349	0.470	0.542	84
EmInt_S1	1093.0	404.4	902.2	1093.7	1160.0	75
EmInt_S2	3.661	2.672	2.162	2.885	4.109	75
EmInt_S3	122.71	29.92	99.33	122.30	137.89	75
logAbsEm_S1	15.528	1.401	14.57	15.52	16.72	75
logAbsEm_S2	9.695	1.575	8.865	9.310	10.662	75
logAbsEm_S3	13.388	1.434	12.42	13.04	14.66	75
ESGscore	4.950	2.375	2.750	5.500	7.000	60
Escore	4.130	3.096	1.000	4.500	6.750	54
ESGControversyScore	7.000	4.190	3.000	9.000	11.000	60
EnvControversies	0.033	0.181	0.000	0.000	0.000	60
SAFusage	0.030	0.110	0.000	0.000	0.003	84
EnvInvestInitiative	0.183	0.390	0.000	0.000	0.000	60
EnvSupplyChainPolicy	0.400	0.494	0.000	0.000	1.000	60
Env Lobby Count	1.310	3.945	0.000	0.000	0.000	84
Lobby Sentence Count	25.79	22.72	11.50	18.00	36.50	43
SAF_10K	0.688	1.090	0.000	0.383	0.827	64
SAF Sentence Count	35.19	40.86	2.000	21.00	49.00	43

Table 2. Industry Net-Zero Alliance and Competition

The tables report the OLS coefficient estimates and (in parentheses) standard errors from regressions of average ticket prices for the airline-quarter-route (*logTicketFare*) and the average log number of passengers for the airline-quarter-route (*logPassengers*) on the indicator for net-zero alliance membership (*NZA*) and the indicator for quarters after the alliance's net-zero commitment (*PostNZA*). Panel A reports the changes in ticket prices and the number of passengers by alliance member airlines following the alliance's net-zero commitment, relative to changes in ticket prices by non-alliance member airlines. Panel B reports how the changes in ticket prices and the number of passengers by alliance member airlines following the alliance's net-zero commitment differ for routes with greater alliance member market shares. For detailed variable definitions, see Appendix A. We assess statistical significance based on robust standard errors clustered by firm and indicate significance at the 1%, 5%, and 10% levels (two-tailed) with ***, **, and *.

Panel A. Industry net-zero alliances and airline ticket prices and number of passengers

	(1)	(2)	(3)	(4)	(5)	(6)
		logTicketFare			*logPassengers*	
NZA×PostNZA	0.013	-0.004	-0.009	0.164	0.169**	0.157**
	(0.020)	(0.020)	(0.019)	(0.112)	(0.066)	(0.068)
NZA	0.105	-	-	1.592***	-	-
	(0.080)	-	-	(0.311)	-	-
logMilesFlown	0.167*	0.268***	0.121***	-4.443***	-0.252	-4.232***
	(0.086)	(0.020)	(0.034)	(0.413)	(0.212)	(0.319)
MarketHHI	0.041**	0.049***	-	-0.565***	-1.827***	-
	(0.018)	(0.015)	-	(0.095)	(0.246)	-
Year-Quarter fixed effects	Yes	Yes	No	Yes	Yes	No
Route FEs	Yes	No	No	Yes	No	No
Route-Year-Quarter FEs	No	No	Yes	No	No	Yes
Airline FEs	No	Yes	Yes	No	Yes	Yes
N	971,333	971,333	971,333	971,333	971,333	971,333
R-squared	0.204	0.314	0.442	0.390	0.333	0.527

Panel B. The moderating effect of alliance member market share

	(1)	(2)	(3)	(4)	(5)	(6)
		logTicketFare			*logPassengers*	
NZA×PostNZA×HighNZAShare	-0.027	-0.028	-0.027	0.017	0.024	0.071
	(0.025)	(0.020)	(0.020)	(0.106)	(0.114)	(0.117)
NZA×PostNZA	0.024	0.006	0.003	0.117	0.110	0.070
	(0.022)	(0.016)	(0.014)	(0.118)	(0.088)	(0.089)
NZA×HighNZAShare	0.119**	0.113***	0.102***	1.966***	2.102***	2.011***
	(0.049)	(0.017)	(0.019)	(0.176)	(0.141)	(0.159)
PostNZA×HighNZAShare	0.031	0.045***	-	-0.020	-0.119*	-
	(0.020)	(0.017)	-	(0.085)	(0.063)	-
HighNZAShare	-0.071***	-0.087***	-	-0.828***	-0.427***	-
	(0.026)	(0.015)	-	(0.204)	(0.114)	-
NZA	0.046	-	-	0.599**	-	-
	(0.071)	-	-	(0.285)	-	-
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter fixed effects	Yes	Yes	No	Yes	Yes	No
Route FEs	Yes	No	No	Yes	No	No
Route-Year-Quarter FEs	No	No	Yes	No	No	Yes
Airline FEs	No	Yes	Yes	No	Yes	Yes
N	971,333	971,333	971,333	971,333	971,333	971,333
R-squared	0.206	0.316	0.443	0.434	0.389	0.571

Table 3. Industry Net-Zero Alliance and Operating Performance

The tables report the OLS coefficient estimates and (in parentheses) standard errors from regressions of the firm-year operating performance measures on the indicator for net-zero alliance membership (*NZA*) and the indicator for quarters after the alliance's net-zero commitment (*PostNZA*). For detailed variable definitions, see Appendix A. We assess statistical significance based on robust standard errors clustered by firm and indicate significance at the 1%, 5%, and 10% levels (two-tailed) with ***, **, and *.

Panel A. Industry net-zero alliance and operating performance

	(1) *ROA*	(2) *OPMargin*	(3) *OPMarginPerASM*
NZA×PostNZA	0.057***	0.153***	0.030***
	(0.021)	(0.058)	(0.008)
NZA	-0.089***	-0.295**	-0.061***
	(0.031)	(0.137)	(0.012)
PostNZA	-0.037*	-0.036	-0.009
	(0.019)	(0.043)	(0.006)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	84	84	60
R-squared	0.349	0.300	0.378

Panel B. Industry net-zero alliance and operating performance (cont.)

	(1) *OPRevPerASM*	(2) *OPExpPerASM*	(3) *OpExpExclFuel*	(4) *FuelCostPerGallon*
NZA×PostNZA	0.008	-0.023	-0.017*	-0.163
	(0.013)	(0.014)	(0.009)	(0.222)
NZA	-0.041	0.020	0.038**	-1.084***
	(0.031)	(0.023)	(0.017)	(0.380)
PostNZA	0.012	0.021*	0.009	0.804***
	(0.009)	(0.012)	(0.006)	(0.076)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	60	60	59	62
R-squared	0.593	0.590	0.6497	0.292

Table 4. Industry Net-Zero Alliances and Environmental Outcomes

The tables report the OLS coefficient estimates and (in parentheses) standard errors from regressions of the firm-year environmental (and ESG) outcome measures on the indicator for net-zero alliance membership (*NZA*) and the indicator for quarters after the alliance's net-zero commitment (*PostNZA*). For detailed variable definitions, see Appendix A. We assess statistical significance based on robust standard errors clustered by firm and indicate significance at the 1%, 5%, and 10% levels (two-tailed) with ***, **, and *.

Panel A. Industry net-zero alliance and emissions

	(1)	(2)	(3)	(4)	(5)	(6)
	EmInt_S1	*EmInt_S2*	*EmInt_S3*	*logAbsEm_S1*	*logAbsEm_S2*	*logAbsEm_S3*
NZA×PostNZA	26.33	0.452	9.157	-0.154	0.458	0.136
	(352.0)	(1.208)	(7.216)	(0.404)	(0.520)	(0.102)
NZA	-173.7	1.180	-7.278	0.051	0.186	-0.124
	(171.5)	(1.510)	(8.196)	(0.375)	(0.363)	(0.124)
PostNZA	-10.18	-1.757*	-22.54***	0.361	-0.560	-0.053
	(312.6)	(1.050)	(5.171)	(0.376)	(0.515)	(0.090)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	75	75	75	75	75	75
R-squared	0.044	0.142	0.172	0.889	0.831	0.952

Panel B. Industry net-zero alliance and ESG (and environmental) performance

	(1)	(2)	(3)	(4)
	ESGscore	*Escore*	*ESGControversyScore*	*EnvControversies*
NZA×PostNZA	-0.738**	-0.615**	-2.394*	0.145*
	(0.350)	(0.306)	(1.241)	(0.081)
NZA	2.291***	0.624	-0.958	-0.082
	(0.847)	(1.249)	(2.296)	(0.091)
PostNZA	0.869***	0.615**	-1.537**	-0.004
	(0.254)	(0.238)	(0.667)	(0.010)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	60	54	60	60
R-squared	0.893	0.879	0.567	0.117

Panel C. Industry net-zero alliance and specific environmental activities

	(1)	(2)	(3)
	SAFusage	*EnvInvestInit*	*EnvSupplyChain*
NZA×PostNZA	0.092**	-0.111	0.142
	(0.038)	(0.208)	(0.192)
NZA	-0.030	0.444	-0.407
	(0.026)	(0.470)	(0.459)
PostNZA	-0.001	0.063	0.135
	(0.003)	(0.081)	(0.131)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	84	60	60
R-squared	0.158	0.164	0.371

Supplementary Appendix for
"Are Industry Climate Alliances Cartels?"

By Shawn Kim and Shirley Lu

Supplementary Appendix A. Robustness Tests

We conduct two sets of additional analyses to address the challenges of our setting. We address concerns that 1) all three largest passenger carriers are members of the industry net-zero alliance (A4A) and 2) our sample periods include periods affected by COVID-19. The robustness tests, using synthetic difference-in-differences and samples excluding COVID-19 affected periods, support the robustness of our results presented in the paper.

B.1. Synthetic difference-in-differences (SDID) approach

A caveat of our setting is that the largest passenger airlines are all members of the net-zero alliance. In Table 2, we address this concern through various fixed effects structures and cross-sectional analyses exploiting the within-airline variation in routes' market share by alliance members (Eq. (2)). To further alleviate the concern, we implement the synthetic difference-in-differences approach to the firm-year analyses examining the effect of net-zero alliance on operating and environmental outcomes (Tables 3 and 4). The synthetic difference-in-differences approach allows us to achieve a more parallel pre-trend between treated and control firms by assigning different weights to control firms and years in the pre-period (Arkhangelsky et al., 2021). For this analysis, we adjust our sample period to include a longer pre-period (starting from 2016) for better matching and exclude 2024 due to missing observations for some airlines. We apply linear interpolation and forward/backward filling to address missing data.

Table SA1 summarizes the estimated results using the synthetic difference-in-difference approach. Across both operating and environmental outcomes, the SDID estimates are consistent

with our main DID results shown in Tables 3 and 4.[1] We observe a significant increase in firm-year operating margins, but this is largely driven by improved cost efficiency (instead of higher revenues per ASM). We do not find evidence to suggest that net-zero alliance members reduce emissions or engage in more environmental activities after the alliance's net-zero commitment. Instead, similar to what we document in Table 4, ESG scores and ESG controversy scores are lower for alliance members following the alliance's net-zero commitment relative to non-alliance members. The consistent SDID results alleviate concerns that our results are driven by some systematic difference (e.g., size) between alliance member airlines and non-member airlines.

Table SA1. Industry net-zero alliance and firm-year outcomes: Synthetic difference-in-differences

The tables report the synthetic difference-in-differences (SDID) estimates of the effect of joining the industry net-zero alliance on various firm-year level outcomes. The coefficient on the interaction term *NZA×PostNZA* reflects the estimated treatment effect, with standard errors reported in the next column. For detailed variable definitions, see Supplementary Appendix A. Significance levels: ***p < 0.01, **p < 0.05, *p < 0.10.

Outcome Variables	SDID estimate (*NZA×PostNZA*)		Standard Error	N
Operating Outcomes				
ROA	0.016		0.020	112
OPMargin	0.078	***	0.023	112
OPMarginPerASM	0.008		0.006	88
OPRevPerASM	-0.002		0.013	88
OPExpPerASM	-0.012		0.010	88
OpExpExclFuel	0.001		0.008	88
FuelCostPerGallon	-0.464		0.301	80
Environmental Outcomes				
EmInt_S1	-7.371		270.4	128
EmInt_S2	12.18		14.12	128
EmInt_S3	1.071		7.190	128
logAbsEm_S1	0.325		0.242	128
logAbsEm_S2	1.591		1.213	128
logAbsEm_S3	0.314	**	0.159	128
ESGscore	-0.850	*	0.504	96
Escore	-0.700		0.470	96
ESGControversyScore	-3.603	**	1.600	96
EnvSupplyChain	0.056		0.211	96

[1] For some outcome variables in Table 4, the synthetic difference-in-differences estimator could not be implemented because the pre-period values for the control group were constant (equal to zero). These outcomes (*EnvControversies*, *SAFusage*, and *EnvInvestInit*) are therefore excluded from the reported estimates.

B.2. Excluding COVID-19 affected periods

Another challenge of our setting is that the sample period coincided with the COVID-19 pandemic, which had a severe impact on international travel and the airline industry. To address this, we re-estimate our tests excluding COVID-19 affected periods. For airline-quarter-route level analyses showing the effect of alliance on market competition (Table 2), we exclude the flights from Q2 2020 to Q1 2021. These four quarters experienced significant declines in the number of flights, as indicated by the Bureau of Transportation Statistics' T-100 data.

Table SA2 shows the effect of the airline industry's net-zero alliance on market competition, excluding periods severely affected by COVID-19. The results are consistent with those shown in Table 2. We do not observe net-zero alliance members increasing ticket prices or reducing output after joining the alliance relative to non-member airlines (Panel A). Even in routes controlled by net-zero alliance members, we do not observe any anticompetitive effects of the alliance (Panel B).

For firm-year level analyses (Tables 3 and 4) on the operating and environmental outcomes of the industry net-zero alliance, we exclude observations from 2020 and instead include those from 2017 to maintain the same number of pre-period years. Again, our results are robust after removing periods affected by COVID-19. In Table SA3, consistent with the results in Table 3, we observe significantly higher operating performance for net-zero alliance members after the alliance's net-zero commitment. Similar to the main results, from Panel B, we observe that much of the improvement in operating performance by alliance members is driven by airlines improving cost efficiency, which is not an anticompetitive behavior. In Table SA4, we again find that alliance members do not reduce emissions more than non-members following the alliance's net-zero commitment. Consistent with the results in Table 4, in Table SA4 Panels B and C, we observe that

alliance members have lower ESG scores and more environmental controversies after the alliance's net-zero commitment, relative to non-member airlines. While we observe a significant increase in SAF usage by alliance members following the alliance's net-zero commitment, the SAF usage by alliance members in the post-period is still very minimal (less than 0.1% of the total fuel on average) to lead to meaningful decarbonization. Alliance members also do not increase the adoption of environmental investment initiatives or environmental supply chain policies following the net-zero commitment. These results suggest that industry net-zero alliances have little environmental impact in the near term, at least in the airline industry. Overall, our results are robust to excluding periods affected by COVID-19, confirming that any disruption in airlines during COVID-19 is not driving our results.

Table SA2. Industry net-zero alliance and competition: Excluding COVID-19 affected periods

The tables report the OLS coefficient estimates and (in parentheses) standard errors from regressions of average ticket prices for the airline-quarter-route (*logTicketFare*) and the average log number of passengers for the airline-quarter-route (*logPassengers*) on the indicator for net-zero alliance membership (*NZA*) and the indicator for quarters after the alliance's net-zero commitment (*PostNZA*). We exclude COVID-affected periods (Q2 2020-Q1 2021) from the estimation. Panel A reports the changes in ticket prices and the number of passengers by alliance member airlines following the alliance's net-zero commitment, relative to changes in ticket prices by non-alliance member airlines. Panel B reports how the changes in ticket prices and the number of passengers by alliance member airlines following the alliance's net-zero commitment differ for routes with greater alliance member market shares. For detailed variable definitions, see Supplementary Appendix A. We assess statistical significance based on robust standard errors clustered by firm and indicate significance at the 1%, 5%, and 10% levels (two-tailed) with ***, **, and *.

Panel A. Industry net-zero alliances and airline ticket prices and number of passengers

	(1)	(2)	(3)	(4)	(5)	(6)
	logTicketFare			*logPassengers*		
NZA×PostNZA	0.032	0.009	0.002	0.023	0.063	0.029
	(0.023)	(0.022)	(0.020)	(0.129)	(0.079)	(0.082)
NZA	0.087	-	-	1.738***	-	-
	(0.075)	-	-	(0.312)	-	-
logMilesFlown	0.172**	0.273***	0.131***	-4.512***	-0.260	-4.296***
	(0.085)	(0.019)	(0.035)	(0.423)	(0.216)	(0.330)
MarketHHI	0.032	0.042***	-	-0.554***	-1.835***	-
	(0.021)	(0.015)	-	(0.108)	(0.246)	-
Year-Quarter fixed effects	Yes	Yes	No	Yes	Yes	No
Route FEs	Yes	No	No	Yes	No	No
Route-Year-Quarter FEs	No	No	Yes	No	No	Yes
Airline FEs	No	Yes	Yes	No	Yes	Yes
N	862,808	862,808	862,808	862,808	862,808	862,808
R-squared	0.177	0.286	0.416	0.394	0.335	0.529

Panel B. The moderating effect of alliance member market share

	(1)	(2)	(3)	(4)	(5)	(6)
	logTicketFare			*logPassengers*		
NZA×PostNZA×HighNZAShare	-0.003	-0.006	-0.008	-0.021	-0.018	0.047
	(0.029)	(0.018)	(0.019)	(0.120)	(0.131)	(0.134)
NZA×PostNZA	0.032	0.008	0.005	0.015	0.044	-0.029
	(0.026)	(0.020)	(0.017)	(0.143)	(0.111)	(0.112)
NZA×HighNZAShare	0.097**	0.094***	0.086***	2.000***	2.149***	2.040***
	(0.042)	(0.018)	(0.019)	(0.181)	(0.144)	(0.164)
PostNZA×HighNZAShare	0.017	0.035**	-	0.011	-0.112	-
	(0.024)	(0.015)	-	(0.097)	(0.078)	-
HighNZAShare	-0.061**	-0.081***	-	-0.845***	-0.433***	-
	(0.024)	(0.016)	-	(0.207)	(0.119)	-
NZA	0.037	-	-	0.708**	-	-
	(0.067)	-	-	(0.289)	-	-
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter fixed effects	Yes	Yes	No	Yes	Yes	No
Route FEs	Yes	No	No	Yes	No	No
Route-Year-Quarter FEs	No	No	Yes	No	No	Yes
Airline FEs	No	Yes	Yes	No	Yes	Yes
N	862,808	862,808	862,808	862,808	862,808	862,808
R-squared	0.179	0.288	0.417	0.438	0.390	0.573

Table SA3. Industry net-zero alliance and operating performance: Excluding COVID-19 affected periods

The tables report the OLS coefficient estimates and (in parentheses) standard errors from regressions of the firm-year operating performance measures on the indicator for net-zero alliance membership (*NZA*) and the indicator for quarters after the alliance's net-zero commitment (*PostNZA*). We exclude observations from 2020 (COVID-affected period) from the estimation and instead add 2017 observations to the pre-period. For detailed variable definitions, see Supplementary Appendix A. We assess statistical significance based on robust standard errors clustered by firm and indicate significance at the 1%, 5%, and 10% levels (two-tailed) with ***, **, and *.

Panel A. Industry net-zero alliance and operating performance

	(1) *ROA*	(2) *OPMargin*	(3) *OPMarginPerASM*
NZA×PostNZA	0.038**	0.064*	0.011***
	(0.018)	(0.033)	(0.004)
NZA	-0.060***	-0.135**	-0.019**
	(0.015)	(0.052)	(0.008)
PostNZA	-0.068***	-0.142***	-0.014***
	(0.015)	(0.027)	(0.002)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	82	82	60
R-squared	0.587	0.556	0.433

Panel B. Industry net-zero alliance and operating performance (cont.)

	(1) *OPRevPerASM*	(2) *OPExpPerASM*	(3) *OpExpExclFuel*	(4) *FuelCostPerGallon*
NZA×PostNZA	0.004	-0.007	0.001	-0.273
	(0.015)	(0.013)	(0.008)	(0.213)
NZA	-0.023	-0.004	0.002	-0.692
	(0.034)	(0.026)	(0.021)	(0.522)
PostNZA	0.006	0.020*	0.008	0.822***
	(0.010)	(0.010)	(0.006)	(0.073)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	60	60	59	61
R-squared	0.600	0.603	0.705	0.242

Table SA4. Industry net-zero alliances and environmental outcomes: Excluding COVID-19 affected periods

The tables report the OLS coefficient estimates and (in parentheses) standard errors from regressions of the firm-year environmental (and ESG) outcome measures on the indicator for net-zero alliance membership (*NZA*) and the indicator for quarters after the alliance's net-zero commitment (*PostNZA*). We exclude observations from 2020 (COVID-affected period) from the estimation and instead add 2017 observations to the pre-period. For detailed variable definitions, see Supplementary Appendix A. We assess statistical significance based on robust standard errors clustered by firm and indicate significance at the 1%, 5%, and 10% levels (two-tailed) with ***, **, and *.

Panel A. Industry net-zero alliance and emissions

	(1)	(2)	(3)	(4)	(5)	(6)
	EmInt_S1	*EmInt_S2*	*EmInt_S3*	*logAbsEm_S1*	*logAbsEm_S2*	*logAbsEm_S3*
NZA×PostNZA	-178.9	0.720	13.43*	-0.430	0.415	0.085
	(399.9)	(1.435)	(7.788)	(0.581)	(0.498)	(0.146)
NZA	41.77	1.082	-13.90	0.407	0.294	-0.021
	(232.2)	(1.951)	(9.285)	(0.603)	(0.269)	(0.206)
PostNZA	284.2	-1.880*	-30.03***	0.386	-0.856	-0.361***
	(363.3)	(1.059)	(4.357)	(0.518)	(0.527)	(0.071)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	72	72	72	72	72	72
R-squared	0.089	0.132	0.207	0.890	0.851	0.978

Panel B. Industry net-zero alliance and ESG (and environment) performance

	(1)	(2)	(3)	(4)
	ESGscore	*Escore*	*ESGControveryScore*	*EnvControversies*
NZA×PostNZA	-1.256**	-0.689	-2.779**	0.161*
	(0.484)	(0.682)	(1.066)	(0.092)
NZA	3.325***	0.131	-0.499	-0.118
	(1.004)	(1.943)	(2.459)	(0.117)
PostNZA	1.079***	0.876	-1.501***	0.008
	(0.320)	(0.577)	(0.439)	(0.019)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	58	51	58	58
R-squared	0.913	0.887	0.565	0.122

Panel C. Industry net-zero alliance and specific environmental activities

	(1)	(2)	(3)
	SAFusage	*EnvInvestInit*	*EnvSupplyChain*
NZA×PostNZA	0.099**	-0.073	0.164
	(0.043)	(0.201)	(0.235)
NZA	-0.036	0.357	-0.460
	(0.030)	(0.478)	(0.546)
PostNZA	0.000	0.087	0.276
	(0.005)	(0.089)	(0.208)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	82	57	57
R-squared	0.160	0.167	0.408

Table SA5. Sustainable aviation fuel offtake agreements

The table lists sustainable aviation fuel offtake agreements disclosed in airlines' sustainability reports as of 2025.

Company name	*Year of commitment*	*Partner name*	*Size of supply (gallons)*
Alaska Airlines Inc.	2018	Neste	Not specified
Alaska Airlines Inc.	2022	Twelve	Not specified
Alaska Airlines Inc.	2023	Shell Aviation	Up to 10,000,000
American Airlines Inc.	2021	Aemetis	280,000,000
American Airlines Inc.	2023	Infinium	Not specified
American Airlines Inc.	2025	Valero	Up to 10,000,000
Delta Air Lines Inc.	2019	Gevo	10,000,000 per year
Delta Air Lines Inc.	2021	Neste	Not specified
Delta Air Lines Inc.	2022	DG Fuels	385,000,000
Delta Air Lines Inc.	2023	Shell Aviation	Up to 10,000,000
Southwest Airlines Co.	2024	Neste	Not specified
Southwest Airlines Co.	2024	Valero	Minimum 3,600,000 (option up to 25,000,000)
Southwest Airlines Co.	2025	Prime energy	1,700,000 per year (5-year)
United Air Lines Inc.	2023	Cemvita	up to 50,000,000 per year
United Air Lines Inc.	2024	Phillips 66	3,000,000