Are Industry Carbon Net-Zero Alliances Cartels?

Shawn Kim*
Haas School of Business
University of California, Berkeley
shawn_kim@haas.berkeley.edu

Shirley Lu
Harvard Business School
slu@hbs.edu

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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 examine the U.S. airline industry's net-zero alliance to assess whether such alliances are collusive and whether they facilitate decarbonization. Using a difference-in-differences design comparing quarterly flight routes data, we find no evidence of collusion: net-zero alliance members do not increase ticket prices or reduce output relative to non-members. However, we also do not find evidence of meaningful environmental progress by alliance members. Firm-year carbon emissions and environmental ratings do not improve post-alliance; instead, alliance members show weakened environmental engagement. 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 team. We conclude by discussing regulatory concerns that could prevent climate alliances from being effective and other potential benefits of these alliances.

Keywords: climate alliance; collusion; competition; net-zero; decarbonization

* Corresponding author. The authors thank seminar participants at the University of California, Berkeley.

1. Introduction

With growing stakeholder concerns over climate change, firms are increasingly announcing net-zero commitments—commitments to reach net-zero carbon emissions by a specified future date. Another prominent trend is the formation of industry net-zero alliances, or groups of firms in an industry collectively committing to achieve net-zero. Examples of industry net-zero alliances include those by oil and gas companies, airlines, banks, asset managers, the shipping industry, the fashion industry, and many more.

The industry net-zero alliances come with many promises. Decarbonization is a costly transition that requires substantial investments and overhauls in operations and products. While an individual firm may not be willing to engage in costly decarbonization by itself—due to the fear of losing competitiveness against its competitors—the firm may be willing to go net-zero if its competitors are also committed to it. Firms can also collectively invest in important technology that would allow them to reach net-zero, thereby reducing the cost of decarbonization.

The collective nature of industry net-zero alliances offers more potential benefits. The net-zero commitment as an industry carries much greater credibility and weight than the net-zero commitment of an individual firm. Such an alliance can create credible future supply and demand for green products, incentivizing changes from supply chain partners. For instance, upon observing an industry-level commitment, suppliers may have greater incentives to invest in green products with the expectation that there will be a substantial growth in demand for green products. The transition of supply chain partners is often a prerequisite for achieving net zero, and industry alliances may be a more credible tool to shift partners' behaviors. The industry net-zero alliance can also help firms develop green standards for their industry and function as a nexus for policy engagement for green transition.

Despite many of these promises of industry net-zero alliances, there is a significant risk tied to them: collusion. There are serious concerns over the potential anticompetitiveness of industry net-zero alliances. Competition should be the driving force of a free market, and any anticompetitive or collusive practices that reduce consumer welfare are heavily penalized. Antitrust laws strictly prohibit firms in the same industry from colluding to make joint decisions about their prices (e.g., price fixing), future production (e.g., restricting output, reducing options for consumers), and more. Industry net-zero alliances, in which firms in an industry collaborate in sustainability-related decisions, naturally raise concerns about collusion. Industry net-zero alliances can turn into a "green cartel," which only provides green products to its customers at a higher price, eliminating the consumers' choice to purchase "brown" products at lower costs. Alliances may also decide to purchase only from green suppliers at higher costs and pass the costs on to the consumers. If industry net-zero alliances are related to such anticompetitive behaviors that reduce consumer welfare, regulators should consider regulating or dismantling these climate alliances.

Regulators around the world are responding to the antitrust concerns of this new phenomenon. The European Commission provided clearer guidelines on how its antitrust laws would apply to (or provide exemptions to) "agreements between competitors that pursue a sustainability objective" (European Commission, 2023). In the U.S., the House Judiciary Committee released an Interim Staff Report in June 2024 highlighting the concerns and risks of climate cartels in the U.S. (U.S. House Representatives Committee on the Judiciary, 2024a). The report stresses that the collaboration among firms and institutional investors to improve corporate environmental, social, and governance (ESG) performances may be collusive. The concerns about the anticompetitiveness of industry net-zero alliances are not baseless, given that firms in an

industry collaborating on decisions related to future production and investments—even if they are related to sustainability—are considered risky from an antitrust perspective. Therefore, in this paper, we ask the question of whether industry net-zero alliances act like cartels.

In addition to the potential anticompetitive behaviors of industry net-zero alliances, there is a question about whether these net-zero alliances are credible commitments. Whether firms in industry net-zero alliances are actually committed to decarbonization is somewhat independent—but equally important—to whether these alliances are collusive. In other words, firms in an industry net-zero alliance may collude by being green or by greenwashing. 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). These alliances may make good progress toward net-zero, but they are anticompetitive. On the other hand, greenwashing net-zero alliances, or industry net-zero alliances primarily serving as a marketing tool, are potentially even worse. 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 it is in order to charge higher prices or claim to be engaging in environmentally-friendly activities to justify increased prices. For these greenwashing alliances, we would expect no improvement in sustainability but reductions in consumer welfare.

Given the potential promises and perils of industry net-zero alliances, there are 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. Greenwashing cartels are collusive and are not associated with improved environmental outcomes.

Green alliances lead to improved environmental outcomes without anticompetitive behaviors. Cheap talk alliances have no effect on market competition or environmental outcomes.

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. These suggest that airline is an industry where collaboration among firms through the climate alliance is critical in achieving net-zero emissions.

We examine the anticompetitiveness of the airline industry's net-zero alliance using a difference-in-differences research design on flight-level data. We compare the change in ticket prices and quantities (passengers served) of alliance member airlines before and after the alliance's net-zero commitment to non-alliance members' changes in prices and quantities around the same time. Therefore, we are using the variation in time (before and after the alliance's net-zero commitment, which happened in March 2021) and variation in alliance membership (some airlines are members of A4A, while others are not). The U.S. Department of Transportation collects granular flight data, including ticket prices, the number of passengers, origin, destination, miles, and more. The dataset (DB1B data) covers 10% of all tickets sold. Furthermore, we examine if the alliance members' changes in prices and quantities are focused on flight routes that are more controlled by fellow alliance members. The routes with higher market share by alliance members

are where we expect the greatest anticompetitive behavior if industry net-zero alliances are indeed cartels.

After examining the anticompetitiveness of the airline industry's net-zero alliance, we test the environmental outcomes of these alliances. These tests can reveal whether the industry-level joint net-zero commitment is a credible commitment to decarbonize. We use a difference-in-differences design at the firm-year level, where environmental data are available for. We compare the change in environmental outcomes, such as carbon emissions and environmental ratings, of alliance members before and after the industry net-zero commitment to non-alliance members' changes in environmental outcomes around the same time.

We find no evidence of the airline industry's net-zero alliances acting as a cartel. Alliance member airlines do not increase prices or reduce output following the alliance's net-zero commitment, relative to non-member airlines. We observe improvement in alliance members' operating performance after joining the alliance, but the performance improvement is mainly attributable to increased cost efficiency, which is not an anticompetitive practice. However, we also do not find evidence to support that industry net-zero alliances are effective in facilitating decarbonization. Alliance member airlines do not reduce emissions, and have lower ESG and environmental scores after joining the alliance. Alliance members also do not increase fuel costs (to use more sustainable aviation fuel), are less likely to have environmental restoration initiatives, and have more environmental controversies after the alliance's net-zero commitment relative to non-alliance 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 discuss a paradox in climate alliances: for an alliance to not violate antitrust laws, it cannot have a bite (i.e., force members to engage or not engage in certain

activities). But, without a bite, the climate alliance cannot deliver its promise regarding decarbonization. Consistent with this paradox, we explore other potential benefits of net-zero alliances that operate through channels less subject to anticompetition concerns. We find descriptive evidence that supports that industry net-zero alliances function as a hub for policy engagement (e.g., lobbying for SAF subsidies) and help guide members' decarbonization efforts by setting industry priorities (e.g., voluntarily committing to SAF purchases).

This study contributes to the policy debate on the promises and perils of industry carbon net-zero alliances (Gasparini et al., 2024; Dolmans et al., 2023). While industry net-zero alliances could be an effective tool in facilitating firms' decarbonization, they come with risks of firms colluding to destroy consumer welfare. Regulators and commentators have increasingly raised the alarm that such alliances could be used to coordinate pricing or restrict output under the guise of sustainability goals (e.g., U.S. House Judiciary Committee, 2024a, 2024b). Given the recent increase in climate alliances and regulators' growing concerns over them, there is a need for data-driven evidence on the effects of industry net-zero alliances. Using U.S. airlines as a setting, our study contributes to the policy discussion by providing empirical evidence on the anticompetitiveness and efficacy of industry net-zero alliances. More broadly, our evidence contributes to the discussion about the relationship between competition 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. At the same time, some regulators are giving exemptions for collaboration aimed at achieving ESG goals. 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 firm 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 industry net-zero alliances can mitigate these credibility concerns by facilitating collective action. However, we highlight a structural paradox: for such alliances to meaningfully coordinate decarbonization, they require enforceable commitments among members—such as agreements on procurement activities or product offerings—that can raise antitrust risks. As a result, climate alliances may be constrained in their ability to solve the coordination problems they are designed to address.

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 & Sampson, 2004). These alliances typically enhance firms' private returns and are motivated by financial incentives. In contrast, climate alliances such as industry net-zero commitments 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.

2. Background and Hypotheses

In the 2015 United Nations Climate Change Conference, more than 190 countries agreed to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit global warming to 1.5°C (United Nations, 2015). The 2018 Special Report by the UN Intergovernmental Panel on Climate Change showed that in order to limit global warming to 1.5°C above pre-industrial levels, global net CO_2 emissions should be approximately halved by 2030 (relative to 2010 levels) and reach net zero around 2040 (IPCC, 2018). Around these events, net-zero has become an important theme in addressing climate change. Countries announced net-zero commitments, followed by regions, investors, and firms. These net-zero commitments specify an entity's promise to achieve net-zero carbon emissions by some specified future date (usually 2050 to be in line with UN IPCC's 1.5C scenario).

Another recent trend is the growth in industry net-zero alliances, in which firms in an industry jointly announce a net-zero commitment. Examples of such industry net-zero alliances include one 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), the beverage industry (REfresh Alliance), and more.

These industry net-zero alliances promise several potential benefits (Gasparini et al., 2024). The net-zero transition is costly and often requires substantial changes in operations and investments in new technology. While individual firms may not be willing to engage in such a costly activity alone, they may be willing if their competitors are also participating. Corporate decarbonization efforts suffer a "double externalities problem" (Acemoglu et al., 2012) that can be alleviated by industry alliances. Firms incur the full costs of decarbonization while the benefits of decarbonization (e.g., clean air) are shared with society. Firms incur the full cost associated with

investments in green technology, while the benefits from the green technology can spill over to other firms within and outside the industry. The double externality problem suggests that firms by themselves are unlikely to decarbonize and invest in green technology at the socially optimal levels. Industry net-zero alliances can help by reducing the burden of decarbonization for individual firms.

Industry net-zero alliances can be effective in driving changes in supplier and customer behaviors, which is often critical for an industry's net-zero transition. Industry-level net-zero commitments carry greater credibility and weight than individual firms' net-zero commitments. 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 supplier 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.

Other potential benefits of industry net-zero alliances include setting green standards for the industry. These alliances can define green practices for the industry and set priorities for decarbonization efforts. This could help firms maximize "return" on decarbonization efforts and external stakeholders to evaluate the environmental performance of firms in the industry. These alliances can also function as hubs for collective policy engagement, engaging with policymakers to facilitate net-zero transition.[1]

While industry net-zero alliances promise the aforementioned benefits, they come with a serious risk of collusion. Competition is the driving force of free and well-functioning markets,

[1] See Gasparini et al. (2024) for more discussion on the potential benefits of industry climate alliances.

and antitrust laws strictly prohibit collusive practices that artificially increase prices and reduce consumer welfare.[2] Industry net-zero alliances, through which firms in an industry collaborate on future product offerings and investments—albeit for sustainability-related purposes—are risky from the antitrust perspective. Firms may use these alliances as a means to act like a monopolist, increasing prices and reducing output. Collusive practices by industry net-zero alliances can include firms in an alliance jointly deciding to work exclusively with green suppliers who charge higher prices and pass the higher costs of their customers, or deciding to only offer green products at a higher price for their customers (i.e., eliminating the option for "brown" products at a lower price). While these activities may be beneficial for the environment (and in achieving net-zero), these are anticompetitive because they reduce consumer welfare by increased prices and fewer 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)[3]. In this guideline, the European Commission specifies the types of sustainability agreements that are unlikely to raise competition concerns. These include 1) agreements that aim solely to ensure compliance with legally binding international treaties, agreements, or conventions, 2) agreements that concern only the firms' internal corporate conduct, but not the economics activity, 3) agreements to set up a database containing information about (un)sustainable suppliers, and 4) agreements between competitors relating to the organization of industry-wide awareness

[2] 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).

[3] The Commission defines "sustainability agreements" as agreements between competitors that pursue sustainability objectives.

campaigns. While sharing information about unsustainable suppliers is allowed based on the guidelines, forbidding alliance members from purchasing from these unsustainable suppliers (or forcing members to purchase from green suppliers) would be a violation of antitrust laws.

In the U.S., there are greater concerns that climate alliances and, more broadly, the movement for ESG, are collusive. In 2024, the House Judiciary Committee released two Interim Staff Reports on how ESG-driven institutional investors, NGOs, and firms are functioning as "climate cartels" destroying American consumer welfare (U.S. House Representatives Committee on the Judiciary, 2024a; U.S. House Representatives Committee on the Judiciary, 2024b). 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 forcing their members to decarbonize. Shortly after the release of the second report in December 2024, major U.S. banks pulled out of the Net-Zero Banking Alliance (NZBA), and BlackRock withdrew from the Net-Zero Asset Managers initiative (NZAMi), indicating that the regulatory pressure on climate alliances is real.

Based on the potential benefits and antitrust risks of industry net-zero alliances, our first hypothesis is whether industry net-zero alliances are collusive. We aim to provide empirical evidence on the anticompetitiveness of industry net-zero alliances that can inform policy discussions on whether and how to regulate climate alliances. We examine if firms in net-zero alliances engage in anticompetitive practices.

An equally important—and somewhat independent—question is about the effectiveness of industry net-zero alliances in decarbonization. It is an empirical question whether industry net-zero alliances can deliver on their promises of facilitating firms' net-zero transition. Therefore, our second hypothesis examines whether net-zero alliances improve member firms' environmental performance.

We note that industry net-zero alliances can be collusive for effective and ineffective alliances. Net-zero alliances can jointly restrict product offerings to only green products at higher prices or purchase only from green suppliers at higher costs. This is an example of a green alliance that is collusive. Even worse, alliance members can collude to use sustainability and climate as excuses to increase prices or restrict output. This would be a greenwashing alliance that is collusive.

Our tests on the two hypotheses allow us to characterize industry net-zero alliances in four ways based on their anticompetitiveness and efficacy in reducing emissions: 1) green cartels, 2) greenwashing cartels, 3) green alliances, and 4) cheap talk alliances. Green cartels are alliances that are collusive but effective in facilitating decarbonization. Greenwashing cartels are collusive and are ineffective in reducing emissions. Green alliances are not collusive and effective in decarbonization. Cheap talk alliances are not collusive but do not facilitate member firms' decarbonization.

3. Sample, Data, and Measurement

We use U.S. airlines' industry 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.[4] The airline industry provides an apt setting to study the anticompetitiveness and effectiveness of industry net-zero alliances, which require substantial investment and technological development to achieve net-zero. The net-zero transition of airlines requires sustainable aviation fuel (SAF) available at scale (and at prices similar to conventional aviation fuel) and update in fleets to fuel-efficient aircrafts (e.g., American Airlines, 2024). Not only net-zero transition high in cost, it requires investment and innovation from airlines' fuel and aircraft suppliers. Such aspects suggest that the potential value of industry net-zero alliances is higher in the airline industry. Second, the airline industry has high anticompetition concerns, with frequent regulatory blocks in mergers and joint ventures (e.g., Azar et al., 2018; Bilotkach, 2019; Dennis et al., 2022). Recently, in 2024, the U.S. Court of Appeals for the First Circuit upheld the district court ruling to block the joint venture by American Airlines and JetBlue Airways (Northeast Alliance, NEA) based on its anticompetitive effects.[5] Therefore, the risk of climate alliance acting as a cartel, or being used as a cover for a cartel is particularly high in the airline industry.

Our primary data is from the Airline Origin and Destination Survey (DB1B). This data represents a 10% random sample of airline tickets collected by the Office of Airline Information of the Bureau of Transportation Statistics. This quarterly 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. That is, a ticket from Airport A to Airport B is an observation, regardless of the number of stops in between. The dataset records a roundtrip from Airport A to Airport B and then back to

[4] https://www.airlines.org/airlines-fly-green/
[5] United States v. American Airlines Group Inc., No. 23-1802 (1st Cir. 2024).

Airport A as two observations (A to B and B to A). 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 quarter-airline-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 (*City Market ID*), allowing us to aggregate airports that serve the same geographic market. We aggregate by taking average ticket prices (*MktFare*), miles flown (*MktMilesFlown*), and number of passengers (*Passengers*) for tickets 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 price 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 an indicator for industry net-zero alliance members. The indicator (*NZA*) equals one for Airlines for America (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 Airlines for America members collectively committed to carbon net-zero 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.

We use the Air Carrier Statistics (Form 41 Traffic; T-100 Domestic Market Data) 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 flights of all flights flown

in and out of U.S. airports.[6] 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. Using this information, we calculate the Herfindahl-Hirschman Index (HHI) for each route-month, where the HHI for route *r* in month *m* is $HHI_{mr} = \sum_{a=1}^{n} s_{mra}$. 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 at the route-quarter-level (by taking averages) and merged into the main quarter-airline-route data. To focus on flights around the introduction of the A4A net-zero alliance, we restrict our sample to quarter-airline-routes from 2018Q1 to 2024Q2.

We also conduct airline-year-level analyses to compare operating performance and environmental outcomes before and after industry net-zero alliances. We collect operating performance data from Compustat and LSEG, emissions data from Trucost, and ESG data from LSEG. The operating performances of airlines are measured using return on assets (ROA), operating margin, and operating income per available seat miles (ASM). We also examine the effect of industry 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 various environmental initiatives. We also use Lu et al. (2024) measure that captures firms' activities related to climate solutions and sustainable aviation fuel using their financial statements (10K Item 1 business descriptions). For additional analyses, we collect airlines' sustainability reports and press relases to measure their discussions on policy engagement and SAF.

[6] The unit of observation for T-100 data is flight (or flight number), while the unit of observation for DB1B data is ticket. We exclude flights with less than 200 passengers per month and distance less than 100 miles from the T-100 Domestic Market Data.

4. Industry Net-Zero Alliances and Collusion

Regulators are most concerned about firms' collusive behavior that reduces consumer welfare. Competitors colluding to charge artificially high prices to consumers (price fixing) and to restrict output are some notable examples of such anticompetitive practices. Therefore, we first test if alliance members charge higher prices after joining the net-zero alliance, relative to non-alliance members. We estimate:

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

$logTicketFare_{art}$ is the average log ticket prices of flight tickets by airline *a* in route *r* in quarter *t*. NZA_a is an indicator for net-zero alliance members, and $PostNZA_t$ is an indicator for quarters after Airline for America's net-zero commitment (March 2021). We control for the average log 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 other (airline-specific, time-specific, and route-specific) factors that can explain the variation in prices and quantities.

Table 2 reports the estimated results. Across different fixed effects structures, we find no evidence of price increases by alliance members after the alliance's net-zero commitment, compared to non-member airlines. In column 1, after controlling for average distance flown, market HHI, time effect, and route effect, 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 the time effect and airline effect 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 effect and airline effect. 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 (different flights by Delta). Overall, our results are not consistent with the claim that firms collude via industry climate alliances to increase prices.

While we do not find an increase in ticket prices 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 allows us to compare routes controlled by net-zero alliance members (greater market share held by net-zero alliance members collectively) 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 by alliance members is concentrated in alliance-controlled routes:

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

Table 2 Panel B reports the results. Across all three fixed effects structures (controlling for time and route effects, controlling for time and airline effects, and controlling for route-time and airline effects), we do not find evidence that net-zero alliance members increase ticket prices following their joint net-zero commitment, even in markets controlled by net-zero alliance

members. This evidence is again inconsistent with the claim that industry net-zero alliances are anticompetitive.

Next, we examine if net-zero alliance members engage in other anticompetitive practices to reduce consumer welfare: output restriction. It is possible the net-zero alliance members collude to reduce quantities and/or limit product offerings to increase prices artificially. Therefore we estimate:

$$logPassengers_{art} = \alpha + \beta_1 NZA_a \times PostNZA_t + \beta_2 NZA_a + \beta_3 logMilesFlown_{art} + \beta_4 MarketHHI_{rt} + Fixed\ Effects + \epsilon_{art}, \quad (3)$$

where $logPassengers_{art}$ is the log number of passengers served by an airline in a quarter for a route. Negative and significant β_1 will suggest that net-zero alliance members reduce quantities following the alliance's net-zero commitment compared to non-member airlines.

In Table 3, Panel A, we find no evidence to suggest that net-zero alliance members restrict outputs. In fact, except for Panel A column 1, we observe significant increases in the number of passengers served by net-zero alliance members following their joint 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 columns 3, we account for route-time effect and airline effect on 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.

Next, we test if we observe anticompetitive practices (regarding reduced outputs) in routes controlled by net-zero alliance members. These routes are where we would expect to observe more anticompetitive practices if airlines are colluding through the climate alliance. Similar to the ticket price analyses above, we interact $NZA_a \times PostNZA_t$ with an indicator for routes with above-

median market share by net-zero alliance members ($HighNZAShare_{rt}$). In Table 3, Panel B, 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 based on the route's market share by alliance members. 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. This result is again inconsistent with the claim that industry net-zero alliances are anticompetitive.

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

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

where $FinOutcome_{ay}$ is the operating outcomes for airline a in year y.

Table 4 reports the results. In Panel A, we find that return on assets (column 1), operating margin (column 2), and operating income per available seat miles (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 suggest that net-zero alliance members may be engaging in

collusive practices that are not captured in higher ticket prices and reduced quantities to increase their profitability.

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 Table 4 Panel B, we divide the operating income per available seat miles (ASM) into operating revenues per ASM and operating expenses per ASM, and examine their change around net-zero alliance separately. While the change in operating revenues per ASM and the change in operating expenses per ASM (columns 1 and 2) are both statistically insignificant at a 10% level, we observe that the improvement in operating income per ASM is largely driven more 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 more around the alliance'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 read as evidence of collusion among alliance members.

5. Efficacy of Industry Net-Zero Alliances in Decarbonization

In the previous section, we do not find evidence to support that industry net-zero alliances, at least the one in the airline industry, are 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 if member airlines of the net-zero alliance significantly improve their environmental performance relative to non-member airlines. The results can reveal whether industry net-zero alliances are green alliances or cheap talk alliances. We estimate the following:

$$ESGOutcome_{ay} = \alpha + \beta_1 NZA_a \times PostNZA_y + \beta_2 NZA_a + \beta_3 PostNZA_y + \gamma Controls_{ay} + \epsilon_{ay}. \quad (5)$$

$ESGOutcome_{ay}$ is the ESG (or environmental) outcomes for airline *a* in year *y*. We examine three sets of ESG and environmental outcomes. We report results using firm-year emissions (Table 5 Panel A), ESG scores by ESG rating agencies (Panel B), and environmental activities and controversies (Panel C). Again, we caveat that the firm-year level analyses suffer low power due to a small number of observations (2018-2024 firm-year observations for U.S. airlines). Also, because our sample period ends in 2024, our analyses are limited to the short-term effect of the airline industry's net-zero alliance.

In Table 5 Panel A, we do not observe a significant change 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 (carbon emissions scaled by total revenues) and absolute emissions measures (the log of carbon emissions in metric tons). We examine the net-zero alliance's effect on different scopes of emissions. 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. Across all scopes (direct and indirect), we do not observe reductions in emissions from net-zero alliance members, raising questions about the efficacy and credibility of industry net-zero alliances.

Relatedly, in Table 4 Panel B column 4, we document that there is no significant increase in fuel costs for net-zero alliance members after the alliance's commitment. Fuel cost is particularly important as the use of sustainable aviation fuel (which is currently costlier than traditional aviation fuel) is one of the main means of achieving net-zero carbon emissions for airlines. No increase in fuel cost per gallon by alliance members suggests that the alliance members are not increasing the use of sustainable aviation fuel, at least in the short term.

In Table 5 Panel B, we compare the changes in ESG and environmental scores of net-zero alliance members around the alliance's net-zero commitment relative to changes in scores of non-alliance members. These scores by ESG rating agencies can summarize and reflect airlines' current ESG performance and expected future ESG performance. Inconsistent with net-zero alliance members improving ESG and environmental performance, we observe decreases in ESG scores (column 1), ESG controversy scores (reflecting more ESG controversies; column 2), and environmental scores (column 3) for alliance members relative to non-members.

Finally, we conduct analyses on more specific environmental activities by airlines. We test if alliance members are more likely to have environmental restoration initiatives and environmental investment initiatives following the alliance's net-zero commitment. Next, using a disclosure-based measure, we test whether net-zero alliance members increase investments in climate solutions. Lu et al. (2024) finetune a GPT 3.5 model to identify sentences related to climate solutions from companies' 10-K Item 1 business descriptions. Their measure (*GPTClimateRatio*), defined as the percentage of sentences from 10-K Item 1 that are classified as a climate solutions

sentence, captures a firm's focus on climate solutions in their products and services. Lastly, we examine the change in their policy regarding environmentally friendly supply chains and incidents of environmental controversies.

The results on these specific environmental activities further support the hypothesis that the airline industry's net-zero alliance is a cheap talk alliance (Table 5 Panel C). Net-zero alliance members are less likely to have environment restoration initiatives and have more environmental controversies following the alliance's net-zero commitment, compared to non-member airlines. We do not observe increases in alliance members' investments in climate solutions at least in the short run. We observe no effect of net-zero alliances on airlines' environmental investment initiatives and environmental supply chain policies.

Overall, we do not find evidence of airlines in the industry net-zero alliance improving their environmental performance after joining the alliance. Alliance members do not reduce emissions, have lower ESG and environmental scores, have fewer environmental restoration initiatives, and have more environmental controversies after joining the alliance. These findings support concerns about the efficacy and credibility of industry net-zero alliances.

6. 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 seem collusive, but also appear to be ineffective in facilitating the industries' decarbonization in the near term. Analyses using ticket-level data reveal that airline net-zero alliance members do not seem to increase ticket prices or reduce outputs after joining the alliance. We do not observe collusive behaviors of net-zero alliance members, even in routes controlled by alliance members. We fail to find evidence that

net-zero alliance members significantly reduce emissions or improve their environmental performances. In fact, net-zero alliance members have lower environmental scores and more environmental controversies following the alliance's net-zero commitment.

Our findings can be explained by the paradox of climate alliances: to abide by the antitrust laws, climate alliances cannot restrict what their member firms can or cannot do (to reduce emissions). This means that under the current regulatory landscape, industry net-zero alliances cannot have a bite. Then, it becomes unclear how an alliance without any bite can deliver its initial promises for decarbonization. It is possible that industries form net-zero alliances with the goal of creating green alliances—that effectively facilitate decarbonization without collusion—but end up with a cheap talk alliance due to legal considerations.

Given this paradox, we explore two other potential benefits of net-zero alliances that are less subject to competition concerns. First, Industry net-zero alliances can function as a nexus for policy engagement for firms in the industry, increasing their bargaining power and voice to facilitate policy changes required for the industry's net-zero transition. Second, industry net-zero alliances can identify industry priorities to guide individual firms' decarbonization efforts.

To evaluate the industry net-zero alliance's role in coordinating policy engagement, we examine airlines' lobbying activities on environmental issues. We use the count of airlines' lobbying activities in environmental issues and their discussion on policy engagement in sustainability reports to proxy for their policy engagement. We collect information on airlines' lobbying activities during 2018-2024 from OpenSecrets. We count the annual number of lobbying activities on environmental issues (Energy & Nuclear Power, Fuel, Gas & Oil, Environment & Superfund) for airlines. Figure 1 Panel A shows the environmental lobbying activities for alliance members and non-members before and after the alliance's net-zero commitment. Descriptively,

there is a larger increase in environmental lobbying activities by A4A members after its net-zero commitment. The difference in slope of the two lines (connecting pre and post-periods for alliance members and non-members) is not statistically different using a difference-in-differences design with controls as in Eq. (5). We also note that we do not find any lobbying activities on environmental issues by non-alliance member airlines in both pre and post periods.

Next, we examine the change in airlines' discussion on policy engagement in their sustainability reports around A4A's net-zero commitment. After collecting airlines' annual sustainability reports via web search, we look for discussions on policy engagements in the reports. We measure airlines' policy engagement by the number of sentences that include at least one policy engagement keyword.[7] In Figure 1 Panel B, we descriptively find a larger increase in policy engagement discussion by alliance member airlines following the alliance's net-zero commitment. However, the difference in the slopes of the line (estimated through a difference-in-differences design) is not statistically different from zero. Overall, these evidence provides weak support that industry net-zero alliances function as a hub for member firms' policy engagement.

Innovation and scaled-up production of sustainable aviation fuel (SAF) is one of the most important requirements for airlines' net-zero transition. To investigate the role of industry net-zero alliance in focusing member firms' decarbonization efforts by identifying priorities, we examine U.S. airlines' activities related to SAF. We capture U.S. airlines' use and investment in SAF through their disclosure in financial statements, sustainability reports, and press releases. Using a finetuned GPT model, Lu et al. (2024) capture sentences related to sustainable aviation fuel in firms' 10-K Item 1 business descriptions. The percentage of sentences in 10-K Item 1 related to

[7] 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 (*SAF_10K*) captures how an airline's operations and investments are geared toward SAF. In Figure 2 Panel A, we show descriptive evidence that the increase in SAF discussion in 10-K business descriptions is larger for net-zero alliance members, suggesting their greater use and investment in SAF following the alliance's net-zero commitment. The slopes of the two lines are not statistically significantly different when compared using a difference-in-differences design with control variables.

Next, using the sustainability reports collected for U.S. airlines, we examine how their discussion on SAF changed around A4A's net-zero commitment. Figure 2 Panel B shows a larger increase in the number of sentences containing "SAF" or "sustainable aviation fuel" for alliance members after the alliance's net-zero commitment. Again, the difference-in-differences design does not yield statistically significant differences across the two groups. Finally, we examine airlines' press releases on SAF to capture their intention to invest more in SAF. We hand-collect press releases related to SAF for all U.S. airlines by searching for keywords related to sustainable aviation fuel from each airline's websites. Table 6 shows the distribution of SAF press releases by year and by A4A membership. All eight A4A released SAF press releases after 2021. Such announcements were almost non-existent prior to 2020, and in 2021, the year of alliance introduction, total SAF press releases increased from 3 in 2020 to 22 in 2021. In contrast, among the ten non-alliance airlines, only two airlines made SAF press releases. While descriptive, this finding is consistent with the alliance guiding and coordinating member firms' decarbonization effort to address industry priority, which is SAF for airlines. Moreover, this analysis suggests that climate alliances may be effective in the long run by driving collective investment into costly technology that is required for all firms in the industry to achieve net zero by mitigating the externalities problem.

7. **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 environmental performances of alliance airlines following the alliance's net-zero commitment. Our results collectively suggest that industry net-zero alliances are likely to be "cheap talk alliances," which are not collusive but also not effective in decarbonization. Our empirical evidence on the anticompetitiveness and efficacy of industry net-zero alliances contributes to the ongoing debate on whether and how to regulate climate alliances.

We discuss the paradox of industry net-zero alliances as potential explanations for our results. To abide by the antitrust laws, industry net-zero alliances cannot have a bite (i.e., be able to force its members to engage in or forbid its members from engaging in certain activities). However, without a bite, net-zero alliances cannot deliver their promises of facilitating decarbonization. Based on this, we examine other potential benefits of industry net-zero alliances that may have lower anticompetition risks: functioning as a hub for members' policy engagement and setting industry priorities to guide members' decarbonization efforts. We find descriptive evidence for these benefits: industry net-zero alliance members increase environmental policy engagements and invest more in sustainable aviation fuel following the alliance's net-zero commitment (statistically insignificant).

There are several limitations to this study. Our sample period (2018-2024) overlaps with COVID-19, which had a large impact on airlines. However, in untabulated analyses, we confirm that our results are robust if we remove the COVID-19-affected period from our sample.[8] While our outcome measures (for collusive behavior, operating outcomes, and environmental performance) are comprehensive, it is incomplete. Net-zero alliance members may be colluding and/or improving environmental performance in dimensions not captured in our outcome measures. Our empirical analyses are limited to the effect of net-zero alliances in one industry. However, the airline is an important industry to study the effect of climate alliances as the potential value of these alliances is larger (due to the hard-to-abate nature of the industry), and anticompetition concerns are high.

[8] For this robustness tests, we exclude observations from 2020 Q2 to 2021 Q1 for flight level analyses. For firm-year level analyses, we exclude 2020 observations and include 2017 observations instead.

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Appendix A. Variable Definitions

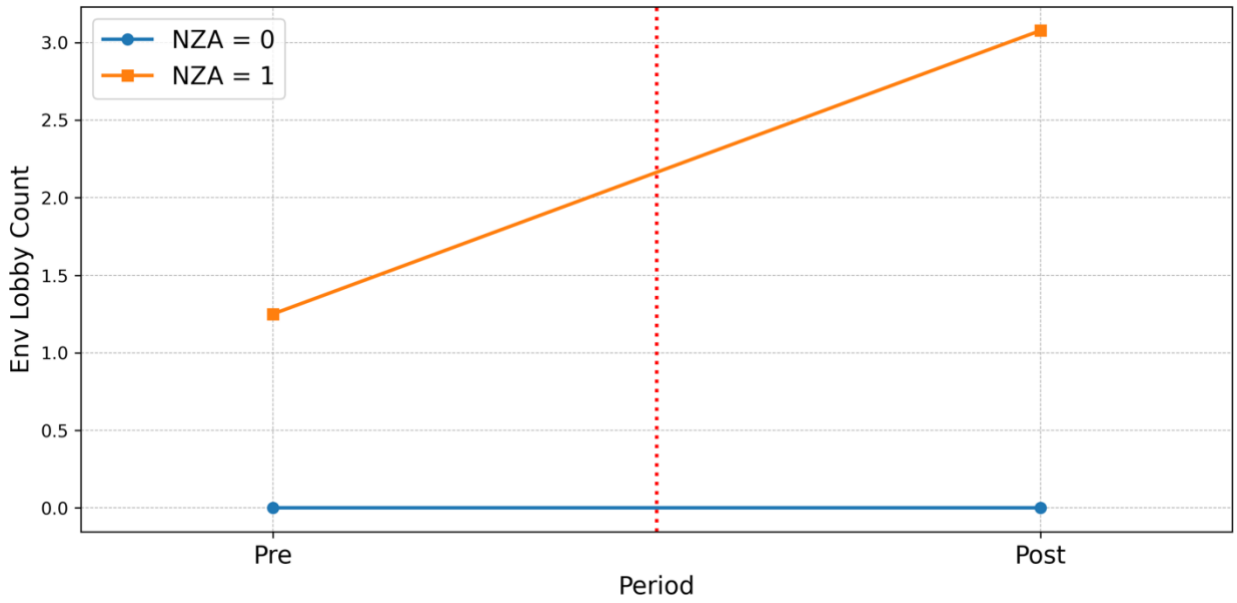
Variable	Definition
Variables for the airline-route-quarter level analyses:	
logTicketFare	The natural logarithm of the average ticket prices for tickets sold by the airline for the route in the calendar quarter. Ticket price data (*MktFare*) is from the Airline Origin and Destination Survey (DB1B Market data) by the Bureau of Transporation 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 Transporation 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 passenges (*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 Traffie; 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 $HHI_{mr} = \sum_{a=1}^{n} s_{mra} \cdot s_{mra}$ 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.
OPIncomePerASM	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.
EmissionInt_S1/2/3	Scope 1/2/3 greenhouse gas emissions scaled by total revenues. Source: Trucost.
logAbsEmission_S1/2/3	The natural logarithm of Scope 1/2/3 absolute greenhouse gas emissions. 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+). Source: LSEG.
Escore	Environmental Pillar Scores by LSEG. The score ranges from 0 (D-) to 11 (A+). Source: LSEG.
EmissionScore	Emissions Scores by LSEG. The score ranges from 0 (D-) to 11 (A+). Source: LSEG.
EnvInvestInitiative	An indicator that equals one if the firm-year had environmental investments initiatives. Source: LSEG.
EnvRestoreInitiative	An indicator that equals one if the firm-year had environmental restoration initiatives. Source: LSEG.
GPTClimateRatio	The Climate Solution measure from Lu et al. (2024) that captures the firm's focus on climate solutions in their products and services. Lu et al. (2024) uses a finetuned GPT 3.5 model to identify sentences related to climate solutions from the company's 10-K Item 1 business descriptions. The measure is the percentage of sentences from 10-K Item 1 that is classified as climate solutions sentences. Source: Lu et al. (2024).
EnvSupplyChainPolicy	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.
Env Lobby Count	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 OpenSecret's classifications. Source: OpenSecrets.
Lobby Sentence Count	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).
SAF Sentence Count	The number of sentences containing "sustainable aviation fuel" or "SAF" in the firm-year's sustainability report.

Figure 1. Industry Net-Zero Alliance and 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 (*Env Lobby Count*) using data from OpenSecrets. Panel B shows the changes in the number of policy engagement sentences in airlines' sustainability reports (*Lobby Sentence Count*). For detailed variable definitions, see Appendix A.

Panel A. Environmental lobbying activities



Panel B. Policy engagement discussions in sustainability reports

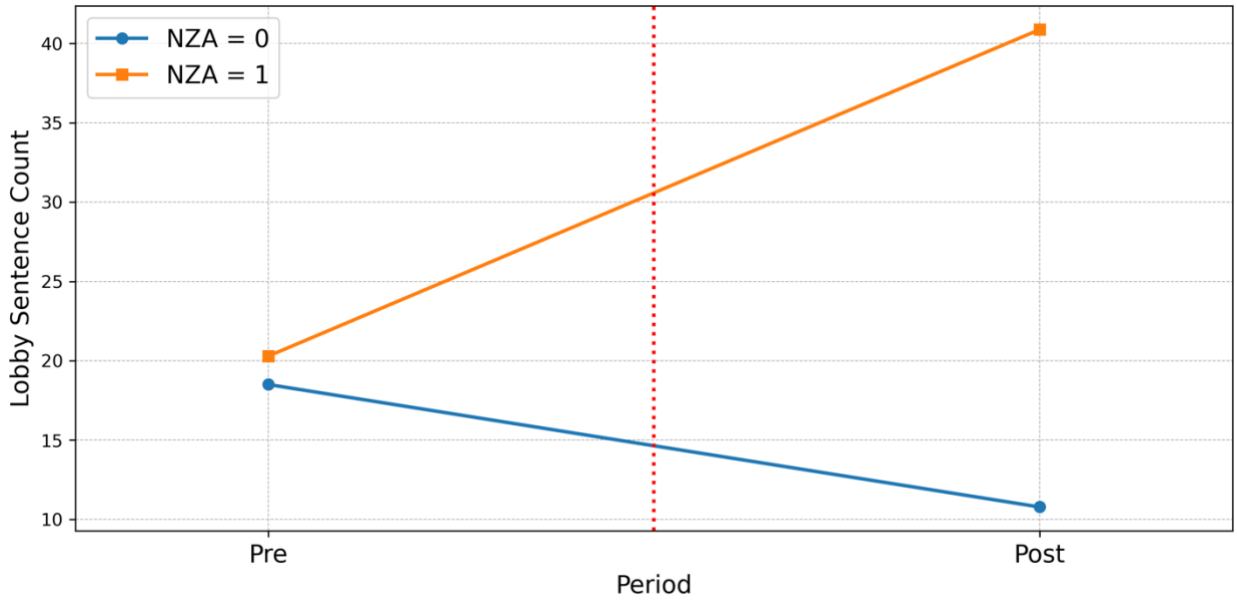
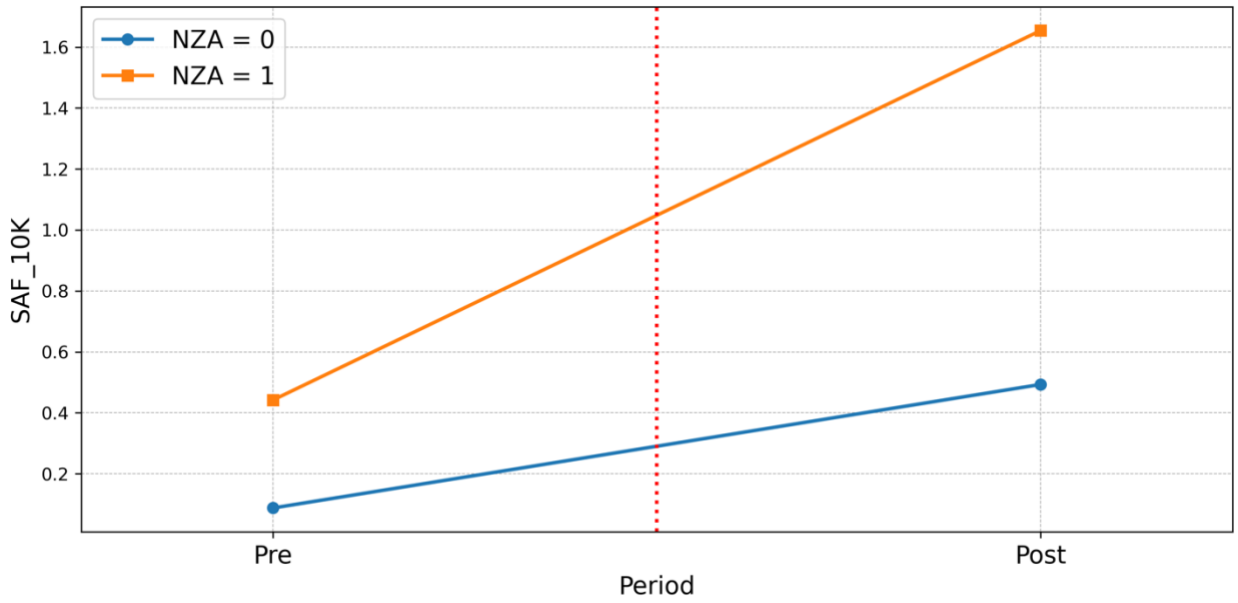


Figure 2. Industry Net-Zero Alliance and Sustainable Aviation Fuel Activities
The figures illustrate the change in airlines' activities related to sustainable aviation fuel (SAF) by net-zero alliance member airlines (*NZA* = 1) and non-member airlines (*NZA* = 0) around the alliance's net-zero commitment. Panel A shows the changes in the airlines' SAF use and investment using the disclosure-based measure from Lu et al., 2024 (*SAF_10K*). Panel B shows the changes in the number of SAF-related sentences in airlines' sustainability reports (*SAF Sentence Count*). For detailed variable definitions, see Appendix A.

Panel A. Sustainable aviation fuel use and investment



Panel B. Sustainable aviation fuel discussions in sustainability reports

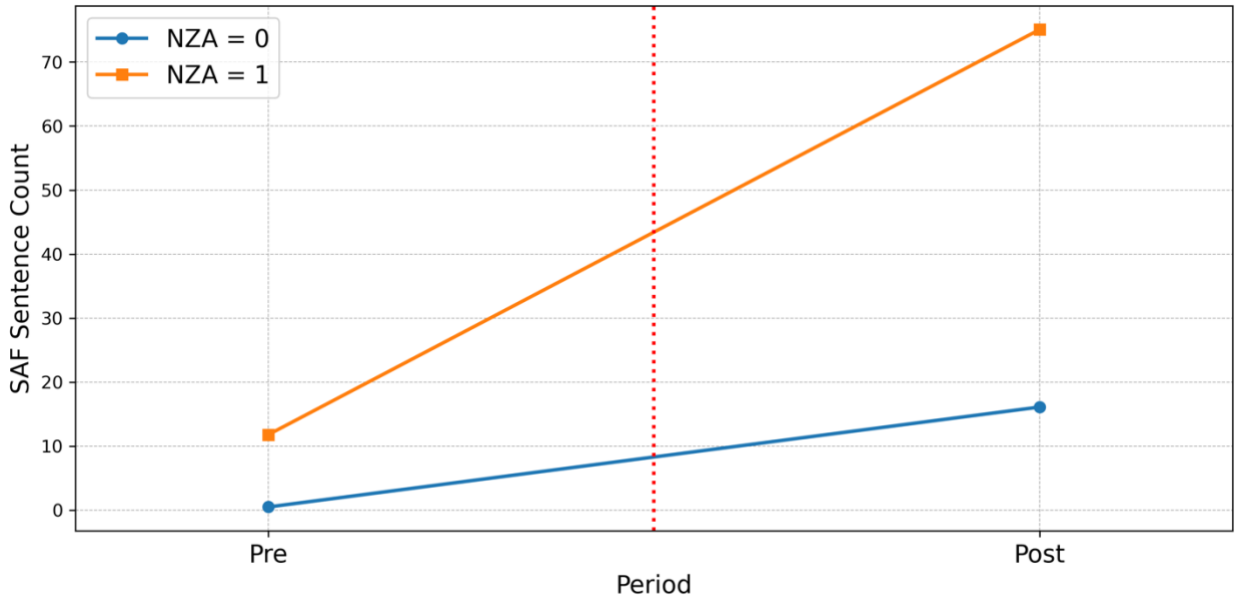


Table 1. Summary Statistics
This table reports the summary statistics of the variables used in the analyses. Variables are defined in Appendix A.

	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
OPIncomePerASM	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
EmissionInt_S1	1093.0	404.4	902.2	1093.7	1160.0	75
EmissionInt_S2	3.661	2.672	2.162	2.885	4.109	75
EmissionInt_S3	122.71	29.92	99.33	122.30	137.89	75
logAbsEmission_S1	15.528	1.401	14.57	15.52	16.72	75
logAbsEmission_S2	9.695	1.575	8.865	9.310	10.662	75
logAbsEmission_S3	13.388	1.434	12.42	13.04	14.66	75
ESGscore	4.950	2.375	2.750	5.500	7.000	60
ESGControversyScore	7.000	4.190	3.000	9.000	11.000	60
Escore	4.130	3.096	1.000	4.500	6.750	54
EmissionScore	5.296	4.064	1.000	6.500	8.750	54
EnvInvestInitiative	0.183	0.390	0.000	0.000	0.000	60
EnvRestoreInitiative	0.367	0.486	0.000	0.000	1.000	60
GPTClimateRatio	1.705	1.821	0.421	1.244	2.344	64
EnvSupplyChainPolicy	0.400	0.494	0.000	0.000	1.000	60
EnvControversies	0.033	0.181	0.000	0.000	0.000	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	35.186	40.859	2.000	21.00	49.00	43

Table 2. Industry Net-Zero Alliance and Prices

The tables report the OLS coefficient estimates and (in parentheses) *t*-statistics from regressions of average ticket prices for the airline-route-quarter (*logTicketFare*) 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 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 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

	(1) *logTicketFare*	(2) *logTicketFare*	(3) *logTicketFare*
NZA×PostNZA	0.0133	-0.0037	-0.009
	(0.6787)	(-0.1843)	(-0.4747)
NZA	0.1054	-	-
	(1.3125)	-	-
logMilesFlown	0.1665*	0.2683***	0.1207***
	(1.9348)	(13.642)	(3.5655)
MarketHHI	0.0408**	0.0492***	-
	(2.3363)	(3.3526)	-
Fixed Effects	Year-Quarter, Route	Year-Quarter, Airline	Route-Year-Quarter, Airline
N	971,333	971,333	971,333
R-squared	0.204	0.314	0.442

Panel B. The moderating effect of alliance member market share

	(1) *logTicketFare*	(2) *logTicketFare*	(3) *logTicketFare*
NZA×PostNZA×HighNZAShare	-0.027	-0.0281	-0.0267
	(-1.0716)	(-1.4238)	(-1.3205)
NZA×PostNZA	0.0238	0.0056	0.0026
	(1.0984)	(0.3398)	(0.1947)
NZA×HighNZAShare	0.1192**	0.1126***	0.102***
	(2.4585)	(6.5259)	(5.4663)
PostNZA×HighNZAShare	0.0311	0.0453***	-
	(1.524)	(2.6138)	-
HighNZAShare	-0.0708***	-0.0866***	-
	(-2.7491)	(-5.6557)	-
NZA	0.0459	-	-
	(0.6461)	-	-
logMilesFlown	0.1743**	0.275***	0.1262***
	(2.0589)	(15.138)	(3.7663)
MarketHHI	0.0447***	0.0418***	-
	(2.7128)	(3.0166)	-
Fixed Effects	Year-Quarter, Route	Year-Quarter, Airline	Route-Year-Quarter, Airline
N	971,333	971,333	971,333
R-squared	0.206	0.316	0.443

Table 3. Industry Net-Zero Alliance and Quantities

The tables report the OLS coefficient estimates and (in parentheses) *t*-statistics from regressions of the average log number of passengers for the airline-route-quarter (*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 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 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 number of passengers

	(1)	(2)	(3)
	logPassengers	*logPassengers*	*logPassengers*
NZA×PostNZA	0.1642	0.1685**	0.157**
	(1.4676)	(2.556)	(2.3002)
NZA	1.5917***	-	-
	(5.1199)	-	-
logMilesFlown	-4.4427***	-0.2519	-4.232***
	(-10.768)	(-1.1866)	(-13.26)
MarketHHI	-0.5646***	-1.8269***	-
	(-5.9701)	(-7.4414)	-
Fixed Effects	Year-Quarter, Route	Year-Quarter, Airline	Route-Year-Quarter, Airline
N	971,333	971,333	971,333
R-squared	0.390	0.333	0.527

Panel B. The moderating effect of alliance member market share

	(1)	(2)	(3)
	logPassengers	*logPassengers*	*logPassengers*
NZA×PostNZA×HighNZAShare	0.0167	0.0238	0.0714
	(0.1581)	(0.2092)	(0.6098)
NZA×PostNZA	0.1171	0.1098	0.0696
	(0.9889)	(1.2551)	(0.7833)
NZA×HighNZAShare	1.9658***	2.1021***	2.011***
	(11.142)	(14.966)	(12.623)
PostNZA×HighNZAShare	-0.0198	-0.1193*	-
	(-0.2321)	(-1.8837)	-
HighNZAShare	-0.8277***	-0.4271***	-
	(-4.0676)	(-3.7332)	-
NZA	0.5987**	-	-
	(2.0981)	-	-
logMilesFlown	-4.299***	-0.3371**	-4.1055***
	(-11.196)	(-2.0571)	(-13.407)
MarketHHI	-0.5522***	-1.7661***	-
	(-7.5357)	(-8.6036)	-
Fixed Effects	Year-Quarter, Route	Year-Quarter, Airline	Route-Year-Quarter, Airline
N	971,333	971,333	971,333
R-squared	0.434	0.389	0.571

Table 4. Industry Net-Zero Alliance and Operating Performance

The tables report the OLS coefficient estimates and (in parentheses) *t*-statistics 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)	(2)	(3)
	ROA	*OPMargin*	*OPIncomePerASM*
NZA×*PostNZA*	0.0572***	0.1529***	0.0305***
	(2.7713)	(2.6441)	(4.004)
NZA	-0.0889***	-0.2948**	-0.061***
	(-2.8654)	(-2.1556)	(-5.262)
PostNZA	-0.0365*	-0.0361	-0.0087
	(-1.9639)	(-0.85)	(-1.5804)
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)	(2)	(3)	(4)
	OPRevPerASM	*OPExpPerASM*	*OpExpExclFuel*	*FuelCostPerGallon*
NZA×*PostNZA*	0.0078	-0.0227	-0.017*	-0.1627
	(0.581)	(-1.6391)	(-1.8555)	(-0.7329)
NZA	-0.0414	0.0196	0.0379**	-1.0843***
	(-1.3202)	(0.8656)	(2.2048)	(-2.8533)
PostNZA	0.0122	0.0208*	0.009	0.8036***
	(1.3395)	(1.8183)	(1.4339)	(10.574)
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 5. Industry Net-Zero Alliances and Environmental Outcomes

The tables report the OLS coefficient estimates and (in parentheses) *t*-statistics 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)
	EmissionInt_S1	*EmissionInt_S2*	*EmissionInt_S3*	*logAbsEmission_S1*	*logAbsEmission_S2*	*logAbsEmission_S3*
NZA×PostNZA	26.333	0.4517	9.1574	-0.1536	0.4582	0.1362
	(0.0748)	(0.3738)	(1.2691)	(-0.3803)	(0.8813)	(1.3322)
NZA	-173.67	1.1797	-7.2784	0.0511	0.1858	-0.1235
	(-1.0129)	(0.7815)	(-0.888)	(0.1364)	(0.5112)	(-0.9968)
PostNZA	-10.182	-1.7572*	-22.544***	0.3613	-0.5604	-0.0533
	(-0.0326)	(-1.6742)	(-4.3594)	(0.9619)	(-1.0875)	(-0.5957)
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 environment) scores

	(1)	(2)	(3)	(4)
	ESGscore	*ESGControversyScore*	*Escore*	*EmissionScore*
NZA×PostNZA	-0.7375**	-2.3941*	-0.6152**	-0.3525
	(-2.1095)	(-1.9299)	(-2.0134)	(-0.6677)
NZA	2.2909***	-0.9577	0.6244	2.9344***
	(2.7058)	(-0.4171)	(0.4997)	(2.6881)
PostNZA	0.8695***	-1.5367**	0.6145**	0.1963
	(3.4213)	(-2.3038)	(2.5808)	(0.8338)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	60	60	54	54
R-squared	0.893	0.567	0.880	0.918

Panel C. Industry net-zero alliance and environmental initiatives and controversies

	(1)	(2)	(3)	(4)	(5)
	EnvInvestInitiative	*EnvRestoreInitiative*	*GPTClimateRatio*	*EnvSupplyChainPolicy*	*EnvControversies*
NZA×PostNZA	-0.1114	-0.2685**	0.4201	0.1423	0.1449*
	(-0.535)	(-2.1621)	(0.4353)	(0.7398)	(1.788)
NZA	0.4445	0.193	0.3541	-0.4068	-0.0819
	(0.9463)	(0.5583)	(0.5097)	(-0.8863)	(-0.8957)
PostNZA	0.0633	0.0335	1.3931**	0.1352	-0.0042
	(0.7775)	(0.4347)	(2.5868)	(1.0304)	(-0.4008)
Controls	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*	*logTA, LEV*
N	60	60	64	60	60
R-squared	0.164	0.688	0.341	0.371	0.117

Table 6. Press Releases on Sustainable Aviation Fuel by Industry Net Zero Alliance Members
The table reports the number of press releases related to sustainable aviation fuel by all U.S. airlines. The table shows the yearly number of such press releases by industry net-zero alliance (A4A) membership. The shaded years (2021-2024) represent the post-period (the period after the alliance's net-zero commitment).

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