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The Contribution of Global Alliances to Airlines' Environmental Performance

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Received: 27 June 2019; Accepted: 22 August 2019; Published: 24 August 2019

Abstract: Global alliances have traditionally been related to improvements in the economic and operational performances of companies, particularly in the airline industry. However, we still do not know the effect of the participation in this kind of multilateral agreement on the environmental performance of airlines. The main aim of this work is to analyze whether the alliance membership of airlines has an effect upon their environmental performance, and if so, whether or not the characteristics of the global alliance, as well as the business model of the airline, may influence this relation to a greater or lesser extent. The results of regression and Analysis of Variance (ANOVA) in a sample of 252 airlines (58 included in one of the three global alliances: Star Alliance, Oneworld, and SkyTeam) show a strong and inverse relationship between environmental performance and belonging to an alliance. The paper also shows empirical evidence of the influence of the business model of the airline on environmental performance. These results suggest important implications for managers facing challenges regarding sustainability.

Keywords: global alliances; sustainability; environmental performance; airlines; aviation

1. Introduction

The aviation sector is the fastest-growing source of greenhouse gas emissions worldwide [1]. Many authors and corporations, such as the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA), agree that environmental sustainability may be achieved through external pressure with the imposition and accomplishment of different policies, regulations, taxations and other fiscal instruments [2–6]. As a consequence, motivated by regulatory pressures, strategic orientation and competitive threats, commercial airlines are trying to minimize their environmental impact, while improving their competitive position at the same time.

Airlines engage in alliances and inter-firm collaborations in order to get access to new knowledge and resources, achieve economies of scale, and provide better service to customers [7]. Through alliance cooperation, airlines can improve their profitability and market share, benefiting from schedule convenience, connectivity and flow improvement [8–10].

The main objective of airline global alliances is to contribute to long-term airline profitability and development, far beyond what any airline or airlines could achieve individually or bilaterally [11,12]. As explained by Dresner and Windle [13], for most airlines, the primary point of forming alliances is to serve on international routes and expand global route coverage, which otherwise would be very difficult due to legal and regulatory limitations.

Furthermore, these kind of alliance activities can help airlines to reduce the cost per passenger, taking advantage of economies of scale, scope and density across geographical boundaries due to increased traffic, joint advertising and equipment sharing, as well as accessing resources that would otherwise not be attainable [7,8,13]. Many studies have investigated the positive impact that these collaborative partnerships have on airlines' performances i.e., [14–18].

However, very little attention has been paid to the influence of alliances on the environmental results of firms. These results are partially influenced by some inherent features in the sector, such as load factor, aircraft type and engines, or the routes assigned to each aircraft, among others. Given the incessant increase in pollution generated by this sector, more solutions appear to be needed beyond those that have been given regarding technological improvements and regulations [19], in order to alleviate, or at least, to slow down the generation of pollution.

Beyond alliances, corporate strategies, as well as voluntary environmental behaviors, are critical factors that influence the environmental performance of the firm [20–22]. Firm strategies and business models are key factors that determine management and performance conditions. Particularly, in aviation, airlines usually share homogeneous business models [23,24]. Four main types of business model have been identified in the aviation sector: Net carrier, charter, regional and low-cost companies [25].

Therefore, this paper analyzes whether the alliance membership of airlines has an effect upon their environmental performance (focusing on greenhouse gas emissions and air pollution), and if so, whether the characteristics of the global alliance, as well as the business model of the airline, may influence this relation. To do so, we analyze the three global airline alliances in the industry: Star Alliance, Oneworld and Skyteam.

As has been previously studied and noticed, the main drivers of alliances are more economy-based than environmental. However, belonging to an alliance might also affect environmental performance. In this industry, operational efficiency (and subsequently, economic efficiency) is highly co-related to environmental efficiency (e.g., more efficient engines require less fuel, which saves money and reduces emissions). In this sense, the way in which this relationship occurs and the factors affecting it are of key relevance for the future sustainability of the industry.

2. Alliances and Sustainability

2.1. Global Framework

2.1.1. Global Alliances Background

Airline alliances have grown exponentially during the past decade, and have become more usual in the industry in recent years, being currently considered a defining characteristic of it [9]. Alliances consist of enduring interfirm collaborations that include governance structures [26]. There are two distinguishable forms in the sector: Global alliances (i.e., Star Alliance, Oneworld and SkyTeam) and codeshare arrangements.

Besides the deregulation process of international aviation which started in the 1970s, the entry of new actors onto the scene led to an increase in competition [27], which prompted companies to start different collaborating strategies in their growth processes, such as mergers and acquisitions, alliances and subcontracting [11]. Competition is another reason to form alliances. As stated by Yousseff and Hansen [28], their formation is a means for airlines to restrain competition, preclude rivalry and seek virtual monopoly status.

Though global alliances from other industries tend to be temporary and linked to specific projects, global alliances in the airline industry are permanent and general in character [11,29]. Alliances have been successful, because airlines, as alliance members, can take advantage of the alliance's brand awareness to attract more passengers, and to access their partners' infrastructures [28]. This type of collaboration allows passengers to have access to better connections and a higher service quality, among other benefits [30].

The increasing prevalence of global alliances and code-sharing partnerships among airlines has led to their embeddedness into networks of multilateral "coopetitivity" [18], which is the concurrence of cooperation and competition activities among allied partners. This is because in the search of potential revenue gains or cost savings, more and more airlines have formed closer and deeper partnerships with allied partners (from the same global alliance), looking for resource sharing and joint marketing and branding. However, airlines have also maintained and developed bilateral relationships with non-allied carriers, or even with airlines from rival alliances.

2.1.2. Contribution to Airlines' Environmental Performance

As a response to the liberalized aviation marketplace stated before, airlines have developed alliances (among other strategies). In the words of Graham and Guyer [2] (p. 178), while these "are aimed at subordinating the free market to the interests of the largest airlines, there may be, perhaps, an inadvertent environmental bonus". This would be due to the alliances' natural limitation to capacity growth, which should hypothetically lead to a more efficient use of existing resources [2].

As these authors assert, free competition in this sector is "wasteful of investment and resources, including non-renewable hydrocarbons and scarce airport capacity", increasing noise and terrestrial congestion, as well atmospheric emissions. Consequently, through the formation of alliances, competition is more controlled and restricted, leading to a reduction in all of the externalities stemming from airline competition.

Resource allocation and knowledge transfer also play key roles in the development of competitive advantages and strategic assets of the firm. The more open companies are, the more exposed they are to the better practices of other firms, being able to learn from them and their procedures, and ultimately having access to their resources and capabilities [21].

Arguments for the resource-based view imply that companies can also create a competitive advantage from the resources of alliance partners [31,32]. In fact, as suggested by Park et al. [33], literature infers that, for most firms, strategic alliances are a good and popular way to obtain critical resources which otherwise would not be attainable.

Furthermore, as Forsyth [4] points out, in difficult situations, airlines on their own are likely to undertake fewer voluntary measures to reduce their emissions and enhance their environmental behaviors. Then, being an alliance member and collaborator would oblige airlines to undertake non-voluntary measures.

According to Kishna et al. [34], alliances promote social legitimacy by providing access to the sustainable technology of a partner, by developing sustainable technology in collaboration with allies, or by providing a partner's technology with access to their customers and production capacity. This sustainable technology in the airline sector would translate into the better behavior of airlines towards the environment.

The newer and the more up to date an aircraft is, the more efficient it is supposed to be, thus influencing the environmental performance of the airline [35]. In this sense, becoming a member of an established alliance would allow new entrants to access newer aircraft that would otherwise not be accessible, taking advantage of the network and resource sharing.

Furthermore, belonging to an alliance or network will legitimate its members against their competitors, since when an airline enters into an alliance, it adopts the brand, image and procedures of the alliance, which are more powerful than those of the individual airline. This isomorphism will allow and lead firms to copy environmental practices, reduce conflicts within the network, and enhance learning. The larger a company or group is, the more pressure it will be subject to for having to meet certain environmental standards and requirements.

Then, companies willing to engage in this kind of practice will adopt and implement environmental practices to ensure that they are a legitimate part of the relationship, and are able to meet the standards of performance demanded by these types of agreement. In this sense, the three global airline alliances, Star Alliance, Oneworld and SkyTeam, describe different statements and commitments towards the environment and corporate social responsibility on their webpages.

For instance, Star Alliance's site states that "every member airline from Star Alliance is dutybound to agree to its Environment Commitment Statement" [36]. There, they recognize that each carrier "operates in diverse regions of the world and faces many unique and local challenges", but they share some core principles that challenge them to reduce their "impact on the environment and maintain a healthy balance between progress and environmental sustainability".

In light of previous arguments, it might be affirmed that:

H1. *Environmental performance differs depending on whether the airline belongs to a global alliance.*

2.2. Characteristics of the Alliance and Environmental Performance

Some climate change policies and initiatives, such as carbon taxes, the Emissions Trading Scheme (ETS), and ICAO's Market-Based Mechanism (MBM) to resolve the conflicts on fees for airline emissions by non-European Union (non-EU) airlines [6], contribute to a reduction in the emissions released to the environment by this sector. However, its compliance will result in lower profitability for the airlines in the short term [4], since some types of adjustment and changes are likely to be slow, for example, the replacement of an airline's fleet.

That is to say, not all of the alliances are affected the same by stakeholder pressure and sustainability regulations, and each alliance has its own objectives, characteristics and values that may have different implications on overall performance, and in particular, upon environmental performance. This situation makes it important to analyze the characteristics of the alliance and their relation with environmental performance.

Following this idea, after reviewing and analyzing the composition and the data made available by global alliances, we observed some alliances' characteristics or attributes that can affect the environmental performance of their members in different ways. In fact, Castiglioni et al. [37] (p. 28) argued that "both the features of the individual firm and the characteristics of the alliance network impact on the performance that a company can get from its integration in this type of cooperation".

Thus, besides the shared objectives of alliance's members, each partner may pursue a specific or individual interest that is not necessarily aligned with that of the group [38]. Table 1 summarizes the main variables that can affect airlines' environmental sustainability, and different arguments related to their impacts on the environmental performance of firms.

Table 1. Variables of alliances and their impacts on airline environmental performance.

Variable	Positive Impacts on Environmental Performance	Negative Impacts on Environmental Performance
Number of airlines	• Greater likelihood of sharing flights for customers. • Greater availability of airplanes from which the most efficient is selected. • Greater R&D expenses allowed in the network for technological changes.	• Companies' regulatory rigidity towards incremental improvements in emissions. • Greater rigidity and lower flexibility towards better sustainable behavior. • Greater divergence in objectives.
Alliance age	• Greater confidence among members to cooperate in the medium term. • Lower likelihood of defining long-term objectives for environmental concerns.	• Lack of room to redefine the usually economic goals of the alliance.
Average airline membership age	• Lower likelihood of considering new green ideas.	• Greater difficulty in environmentally orientating already established objectives.
Average number of destinations	• Greater probability of using shared flights, filling the plane with more passengers.	• Greater number of take-offs and landings. • Less flight diversity, and lower capacity/load aircraft adaptation.
Average number of countries served	• Higher learning effect from specific regulations from each country. • Higher need for flight sharing.	• Less flexibility to adapt to regulations. • Less possibility of sharing flights.
Average number of aircraft	• Greater flexibility to choose the more convenient aircraft.	• Greater potential lag in the capacity/load ratio.
Average aircraft age	• Greater likelihood of needing airplane renewal.	• Greater likelihood of being old and less efficient.

Source: Our own elaboration.

The *number of airlines* that comprise each alliance would influence their environmental performance, since the higher this number is, the greater the likelihood of customers sharing flights is, and the greater the availability of airplanes is, due to the higher number of accessible airlines. This would allow airlines to select the most efficient aircraft (that emanate fewer emissions) and, for instance, to keep the newest airplanes for trips shared among members of the alliance. This greater number of airlines would also lead to access to greater R&D expenses, which are allowed in the network for technological changes (shared or not) that enhance the reduction of fuel consumption and emissions [39].

However, the regulatory rigidity of some companies may lead to changes in the operation of other companies of the same alliance, and therefore affect incremental improvements in emissions. Besides, the greater the alliance is and the more companies it integrates, the greater the rigidity is and the lower the flexibility in making changes towards a more sustainable behavior is, due to the greater objectives' divergence to reach non-economic objectives.

Regarding the *alliance age*, as it grows, the greater the confidence among member airlines, the greater the likelihood of medium-term cooperation to deal with non-economic problems, such as those regarding emissions. On the other hand, the younger the alliance, the greater the likelihood that the definition of long-term objectives will be affected by environmental concerns and contexts, and that a commitment to emissions would be generated.

Nevertheless, the higher is the age of the alliance, the greater the likelihood that new members will lack room to redefine the goals of the alliance, usually with economic profile in the short term.

The *average age of airline membership* would also improve environmental performance. The younger the membership age of the airline, the greater the likelihood that the alliance will consider new green ideas brought by the new members. On the other side, the higher the age is, the greater the difficulty in environmentally orienting already established objectives in the global alliance.

On the other hand, the older the airline is, the greater the likelihood is of having old airplanes that have poor environmental performance in terms of emissions. Besides, young airlines can have lower financial solvency that makes their operations dependent upon airplane subcontracting (no availability of their own aircraft), so they are unable to choose the least-polluting ones.

Considering the *average number of destinations* of the alliance, as this number gets higher, the probability of using shared flights with other alliance members increases, thus generating some degree of efficiency by filling the plane with more passengers [39].

In contrast, a higher number of destinations also entails a greater number of take-offs and landings, and therefore, a greater number of emissions, since those are the operations with the greatest effect upon pollution. Additionally, fewer destinations would imply lower flight diversity and lower capacity/load aircraft adaptation, which has a detrimental effect on emissions.

Something similar happens with the *average number of countries served*. The more dispersed the network, the higher the number of countries served, and the higher the need for sharing flights is, thus contributing to a reduction in emissions [39]. Besides, as the number of countries grows, the learning effects of the specific regulations of each country that reduces emissions increases, and these measures could be applied to all airlines, or to the alliance as a whole.

Nevertheless, this greater number of countries in which the airline operates would imply less flexibility to adapt to regulations regarding refueling, fuel reserve, take-offs and routes, among others, which would lead to greater emissions. In addition, the fewer countries served, the smaller the need to share flights, leading to less energetic efficiency (more emissions).

Lastly, the number and age of the aircraft also affects the environmental performance of these airlines. The greater the *average number of aircraft* is, the greater the flexibility to choose a more efficient aircraft for each destination is. In addition, a higher number of aircraft implies greater pollution due to a potential lag in the capacity/load ratio.

The higher the *average age of their airplanes* is, the greater would be the likelihood of a need for airplanes' renewal, changing to aircraft with lower emissions. However, this would also imply a higher likelihood of being old, and therefore less efficient in emissions.

2.3. Alliance, Business Model, and Environmental Performance

The individual corporate strategies of airlines have been found to play fundamental roles in their development and survival, even in the alliance context. Simple participation in a global alliance does not guarantee an airline's success, as shown by the closure of Malev in 2012, and the absorption of Austrian Airlines in 2009 [11]. As these authors assert, the strategy plays a key role in ensuring an airline's development, and leveraging the opportunities arising from its participation in global alliances. Therefore, the general strategy and specific mission of the company can reveal important differences between airlines [24].

As González-Benito and González-Benito [40] have expressed, companies within international groups can benefit from a greater availability of resources and suffer higher pressure from the social and economic environment, leading to firms improving their environmental behaviors. However, the incorporation of the environmental variable into corporate strategies has largely depended upon the level of corporate proactiveness [41,42], not only of the firm, but also of the global alliance as a whole. This proactivity refers to the adoption of environmental protection strategies that do more than comply with legislation or meet industry standards [43], but rather, voluntarily take measures to reduce the environmental impact of the firm [21,40,44].

The airline industry is quite varied in terms of business models. They are usually characterized into four main categories: Net carrier, regional, charter and low-cost, e.g., [25,45]. The business model of each company will determine the company behavior, which, in turn, will probably determine its environmental performance, given differences in the route and network design, occupancy rate, weight carried and age of the fleet (and therefore the use of more efficient aircraft), among other factors [46].

Net carriers or full-service carriers traditionally represented the majority of the industry. Air China, British Airways or Delta Airlines are examples of these. They focus on providing a broad variety of services, which include hundreds of destinations via a hub-and-spoke model, which is eventually complemented by a network of direct flights that are mainly focused on the home country. To do so, they use different aircraft models, from small, regional to wide-body aircraft. These are configured in 2–4 passenger classes, and offer a wide variety of amenities to customers, including loyalty programs [47].

Regional airlines are mainly focused in more rural areas [48] and usually provide feeding services for net carriers, to which they might be associated, or not. They usually have more efficient operations and costs than net carriers, and employ a fleet of regional aircraft ranging in capacity from 30 to 90 seats [47].

Charter airline is a broad definition used for carriers that specialize in the transport of tourists. Nowadays, they usually operate on schedules, although this highly depends upon the seasonal demand [49]. They typically offer point-to-point flights, concentrated at a few times per week, by employing a homogeneous fleet of medium-sized and large aircraft.

Finally, low-cost carriers are airlines which offer simple, no-frills services based upon simple operations and a simple point-to-point network with no connections. They usually employ a quite homogeneous and young, medium-sized fleet, which helps to maintain the low-cost structure (both maintenance and capital costs). They proactively stimulate demand by offering low fares and serving destinations that were not previously covered to maximize the occupation and utilization of their fleet [45,49].

All these differential characteristics led us to propose the following hypothesis:

H2. *Environmental performance differs depending of the business model of the airline (with or without alliance) (net carrier, regional, charter and low-cost).*

3. Sample Data and Methods

3.1. Sample Description and Data Source

In this research, we used secondary data sources. Thus, we built a database based upon information from public reports on environmental efficiency indicators (Atmosfair, for example) and other official websites that provide general company information, i.e., Capital IQ or Statista, as well as airline-specific information, such as the global alliance webpages Innovata (Flight Global) and AeroTransport Data Bank (ATDB), and corporate annual reports when needed.

The initial sample of this study comprised all airlines appearing in the Atmosfair Airline Index (AAI) from the years 2012 to 2018. As this index uses data from two years before the publication, the real data used was from the start of this decade until the last data available in the index (2010–2016). This time range gave companies room to show the results of any actions taken towards improvements in their environmental behaviors, rather than just giving data for one isolated moment in time (a good indicator could be caused by accidental factors).

Through this index, Atmosfair provided a complete and independent environmental rank for commercial airlines considering their CO_2 emissions, which we used to measure the environmental performance of the airlines. To create the index, Atmosfair calculates the emissions considering all city pairs of an airline, and the aircraft type, engine, seat and cargo capacity and load factor, among others. [6,50]

This index has been recognized as a "labeling system that ranks airlines according to their efficiency" [51] (p. 42) and a performance indicator based on more objective data [52], being considered to provide "the best data set currently available for evaluating the environmental friendliness of airlines" [6] (p. 38). For this reason, not only in academia, but also in industry, this index has been frequently used and referred to, "as a tool to demonstrate environmental performance and credibility" [53] (p. 84).

The Atmosfair Airline Index provides rates for each year for 150 commercial airlines, which gave a sample composed of 252 airlines collected from the rankings available in the Index from 2010 to 2016, after eliminating duplicities (from one year to another) and taking the name changes and absorptions that occurred in this timeframe into account.

In this sample, the airlines were classified into types (net carrier, regional, charter and low-cost) based on their business model, and we included airlines from all groups. The average values of the variables were chosen as representative values for the entire period. Within this group, 58 airlines were involved in a global alliance, either Oneworld, Star Alliance or Skyteam. We used this subsample to analyze whether there were any differences in the environmental performance influences of alliances on their member airlines.

It must be noted that during the period of study, some airlines became members of the alliances, as it is the case of (among others) Saudi Arabian Airlines, Qatar Airways or Air India, members since 2012, 2013 and 2014, respectively. Consequently, all the airlines appearing as members of one global alliance by 2016 have been treated as belonging to the alliance in the study. To show this period characteristic or time lags, some variables related with the airline membership age (*Member_below5, Member_5—10, Member_above10*) have been created to incorporate the length of the alliance membership in the model.

In addition, the subsidiary airlines of the alliance members have been also treated as alliance members, since they are affiliates of the main airline, as the global alliance and the airlines themselves declare so.

3.2. Methods and Variables of Study

In order to see the direct effect that belonging to a global alliance has upon the environmental performance of airlines, we conducted a multiple regression analysis per blocks to see the improvement in the model when introducing our principal study variable.

As a second part of the data analyses, we used the one-way Analysis of Variance (ANOVA) test to investigate the differences among the three global alliances and the decisive characteristics that affect, to a greater or lesser extent, the company's environmental performance—either positively or negatively. This methodology and all the analyses were carried out using IBM SPSS Statistics software. Table 2 shows all the variables used in the empirical analysis.

Table 2. Description of variables.

	Variable	Description	Source
Environmental performance	Efficiency Class (*EC*)	Classification of airlines from the Atmosfair Airline Index (AAI), where they receive a punctuation (efficiency points) in the ranking, and are then assigned to seven efficiency classes from A to G (similar to the European Union (EU) energy efficiency label), transformed to a scale from 7 to 1. It takes the average value of all values from the period [1].	Atmosfair
Alliance belonging	*Alliance*	Dummy equal to 1 if the airline is member of one of the three global alliances (Oneworld, Star Alliance, and Skyteam), and equal to 0 if not.	Global alliance webpages
Airline membership age	*Member_below5*	Dummy equal to 1 if the duration of the airline as a member of the global alliance is below 5 years, and equal to 0 if not.	Global alliance webpages
	Member_5—10	Dummy equal to 1 if the duration of the airline as a member of the global alliance is between 5 and 10 years, and equal to 0 if not.	Global alliance webpages
	Member_above10	Dummy equal to 1 if the duration of the airline as a member of the global alliance is above 10 years, and equal to 0 if not.	Global alliance webpages
Airline control indicators	Airline Age (*Age*)	Age of the airline.	Capital IQ
	Total Flights (*Total_flights*)	Number of total flights carried by the airline. It takes the average value of all values from the period.	Flightglobal
	GDP per capita (*GDPpc*)	GDP per capita of the airline home country as an indicator of economic development. It takes the average value of all values from the period.	The World Bank databank
Alliance characteristics	Number of airlines (*n_airlines*)	Number of airline members per global alliance.	Global alliance webpages
	Alliance age (*Alliance_age*)	Age of the global alliance.	Global alliance webpages
	Airlines average membership age (*Av_age*)	Average age of airline membership per global alliance.	Global alliance webpages
	Average destinations (*Av_destin*)	Average number of destinations of member airlines per global alliance.	Global alliance webpages
	Average countries served (*Av_countries*)	Average number of countries served by the airline per global alliance.	Global alliance webpages
	Average fleet (*Av_fleet*)	Average number of aircraft that each airline member has per global alliance.	Global alliance webpages/AeroTransport Data Bank (ATDB)-aero
	Average fleet age (*Av_fleet_age*)	Average age of the aircraft of airline members per global alliance.	(ATDB)-aero
	Average sales revenue (*Av_sales_rev*)	Average sales revenue of the airline members per global alliance.	Global alliance webpages/Statista/Corporate annual reports
	Average members employees (*Employees*)	Average number of employees in airline members per global alliance.	Global alliances webpages/Corporate annual reports
	Alliance revenue aggregated (*Revenue_aggregated*)	Aggregated revenue of each global alliance.	Statista
	Alliance market share (*Market_share*)	Market share of each global Alliance.	Statista
	Alliance operating profit (*Op_profit*)	Operating profit of each global alliance.	Statista
Business Model/Strategy	*NetCarrier*	Dummy equal to 1 if the airline is a net carrier, and 0 if not.	Atmosfair
	Regional	Dummy equal to 1 if the airline is regional, and 0 if not.	Atmosfair
	Charter	Dummy equal to 1 if the airline is a charter, and 0 if not.	Atmosfair
	LowCost	Dummy equal to 1 if the airline is low-cost, and 0 if not.	Atmosfair

[1] Since only 150 airlines appear for each-year index, not all the airlines had a score for all years. Consequently, we took an average value of their scores. The methodology used by Atmosfair to calculate EP and assign the EC for every airline can be found in the Atmosfair Airline Index itself [50].

3.3. Sample Validity

Before the multiple regression analysis, the assumptions of homoscedasticity, normality and non-multicollinearity were tested to determine the appropriateness of using this method for the sample. The variances in the residuals were found to be uniform, indicating homoscedasticity in the model. The residuals also followed a normal distribution.

Finally, to check for multicollinearity, we used tolerance and variance inflation factors (VIFs) as indicators. The tolerances of the variables had values near 1 (higher than the 0.2 required), and the VIFs were found to be less than 1.5 for all variables, considerably below the rule-of-thumb cut-off of 10, and even under the four-point limit established in Hair et al. [54], so we were able to largely assume the absence of multicollinearity. All this indicates that the sample matched the requirements to do the regressions [55].

4. Results and Discussion

Table 3 presents the results of the hierarchical regression analysis with two blocks of variables. The dependent variable was the Efficiency Class (*EC*), the independent variables were *Alliance*, *Member_below5*, *Member_5-10* and *Member_above10*, and the control variables were *Age*, *Total_flights* and *GDPpc*. Log values were used to increase the homogeneity of the measures. After deleting the outliers and missing values, the final sample included data from 199 airlines.

Table 3. Multiple regression results.

	Descriptive Statistics		***Regression***			
			Model 1		**Model 2**	
Variables	**Mean**	**SD**	**β**	**p**	**β**	**p**
EC	4.2799	0.8529				
Constant			4.673	0.000	4.136	0.000
Log_Age	3.4783	0.6691	−0.198	0.014	−0.050	0.545
Log_Total_Flights	8.4273	1.1695	0.039	0.452	0.092	0.069
Log_GDPpc	9.7787	1.1421	−0.009	0.867	−0.024	0.636
Alliance	0.33	0.472			−0.894	0.000
Member_below5	0.07	0.260			0.391	0.136
Member_5—10 (entered)						
Member_above10	0.16	0.363			0.251	0.262
R^2			0.030		0.166	
ΔR^2					0.136	0.000

Model 2 shows that belonging to an alliance and the environmental performance of an airline are negatively and significantly related ($\beta = -0.894$, $p < 0.001$), and the model fit improved significantly when our independent variables were introduced ($\Delta R^2 = 0.136$, $p < 0.001$). This would translate as a negative effect of alliance membership towards the environmental performance of the firms that belong to the alliance, in spite of all the benefits that a priori collaborating in a multi-partner alliance would have upon the environmental sustainability of firms. Therefore, we can conclude that Hypothesis 1 is supported. In addition, these results suggest a disconnection between alliance objectives and the environmental concerns of airlines.

Since belonging to an alliance does not appear to benefit the environmental performance of firms by itself, we wanted to check whether or not there were any global alliance characteristics that lead to differences among them, and make one have better effect on its airlines' EC than the others.

One-way ANOVA was used to investigate whether there are differences between the three groups (Star Alliance, Oneworld and Skyteam). Table 4 includes the results of this analysis for the explored characteristics (including environmental performance). Alliance was depicted as a categorical variable ranging from 1 to 3, depending on the group. The results indicate that EC is not affected by the alliance (*p* value = 0.717). Consequently, no alliance by itself appears to have a better impact on the environmental performance of its airline members.

Table 4. One-way Analysis of Variance (ANOVA) by Alliances.

	Sum of Squares	d.f.	Mean Square	F	p
EC	0.240	2	0.120	0.335	0.717
Age	40.709	2	20.355	0.031	0.969
Total_flights	69990263.459	2	34995131.730	0.178	0.838
n_airlines	1867.655	2	933.828	.	.
Av_age	82.651	2	41.326	1.016	0.000
Airline_age	73.262	2	36.631	1.145	0.326
Alliance_age	68.897	2	34.448	.	.
Av_destin	9308.075	2	4654.037	1.332	0.000
Av_countries	399.241	2	199.620	5.140	0.000
Av_fleet	10671.458	2	5335.729	7.411	0.000
Fleet_age	18.036	2	9.018	0.964	0.388
Av_fleet_age	9.184	2	4.592	1.704	0.000
Av_sales_rev	74.939	2	37.469	7.734	0.000
Employees	2635762849.047	2	1317881424.524	1.220	0.000
Revenue_aggregated	37686.414	2	18843.207	.	.
Market_share	491.631	2	245.816	7.817	0.000
Op_profit	165.383	2	82.691	1.530	0.000

Although we did not find significant differences in environmental performance among the different global alliances, our results show that the three alliances analyzed do differ in some characteristics, such as the number of destinations and countries served, or the size and age of the fleet used, among others.

After these results, we checked the effect of the business model on EC, considering (or not) the alliance that the airline belongs to, using another ANOVA analysis on the business models of the 252 airlines (net carrier, regional, charter and low-cost) [25] (see descriptive statistics on Table 5). Significant differences were found in the EC of each business model (F = 38.627, $p < 0.001$), thereby supporting Hypothesis 2. This implies that, as inferred by the literature, the individual strategy of each firm has an effect on its performance, and in this case, also on its environmental sustainability.

Table 5. Descriptive statistics of used variables (ANOVA).

	N	Mean	SD	Min.	Max.
NetCarrier	124	4.1326	0.6250	2.75	6
Regional	57	3.5918	1.0616	1.00	6
Charter	18	5.2050	0.4043	4.50	6
LowCost	53	4.8856	0.6723	3.00	6
Total	252	4.2452	0.8963	1.00	6

Based on these results, and considering that low-cost and charter airlines do not engage in global alliances [11], it might be thought that this situation may have conditioned previous results. Therefore, we applied a regression analysis (explained above) on a reduced sample (just including net carriers and regional airlines). After removing low-cost and charter carriers, the final sample included 140 cases (without including outliers and missing values). The percentage of airlines in an alliance was 48.39% for net carriers and 40.35% for regional airlines. Table 6 shows the results.

The results show that even taking into account just net carriers and regional airlines, which are the ones that enter into these collaborative forms, our variable *Alliance* maintained a significant negative association with the environmental performance of airlines ($\beta = -0.534$, $p < 0.01$), although with less importance than in the first regression. Model 2 significantly improved (although very slightly) the model fit ($\Delta R^2 = 0.061$, $p < 0.05$).

This indicates that the inclusion of business models not engaging in an alliance were not disturbing the main findings of our model, that is, the negative impact that engaging in a global alliance has on the environmental sustainability of the airline members.

Table 6. Second multiple regression results.

	Descriptive Statistics		*Regression*			
			MOD. 1		MOD. 2	
Variables	**Mean**	**SD**	**β**	**p**	**β**	**p**
EC	3.9830	0.7730				
Constant			4.191	0.000	3.925	0.000
Log_Age	3.6202	0.6597	−0.037	0.684	0.014	0.887
Log_Total_Flights	8.4783	1.1350	0.057	0.341	0.089	0.144
Log_GDPpc	9.6727	1.1431	−0.060	0.306	−0.061	0.313
Alliance	0.47	0.501			−0.534	0.003
Member_below5	0.10	0.304			0.370	0.144
Member_5—10 (entered)						
Member_above10	0.22	0.414			0.244	0.270
R^2			0.012		0.073	
ΔR^2					0.061	0.029

Finally, in order to corroborate the evidence found, Table 7; Table 8 show the average *EC* values and standard deviations for each group of airlines, classified by the business model and alliance membership, and the correlations matrix of these variables, respectively. It must be remembered that when looking in Table 7 for the group, 0 means not belonging to the alliance or category, and 1 means belonging to it.

Table 7. Mean Efficiency Category per group.

				EC	
				Mean	**SD**
NetCarrier	0	Alliance	0	4.6138	0.0914
			1	3.1699	0.1979
	1	Alliance	0	4.2307	0.0801
			1	4.0279	0.0767
Regional	0	Alliance	0	4.6177	0.0630
			1	4.0279	0.0767
	1	Alliance	0	3.8772	0.1801
			1	3.1699	0.1979
Charter	0	Alliance	0	4.3810	0.0695
			1	3.7902	0.0881
	1	Alliance	0	5.2050	0.0953
LowCost	0	Alliance	0	4.2783	0.0803
			1	3.7902	0.0881
	1	Alliance	0	4.8856	0.0923

Table 7 shows how among the net carriers, for instance, those that do not belong to an alliance have a greater *EC* than those that do engage in this collaborative form. The same can be seen for regional carriers. These airlines have 0.7073 more *EC* points, on average, then when they do not take part in alliances. On the contrary, low-cost carriers and charters, as they do not engage in global alliances, have the highest mean values of all possibilities, confirming the main findings of this study.

Finally, Table 8 displays the correlations matrix of the main variables in our study: *EC, Alliance, NetCarrier, Regional, Charter* and *LowCost*, to see how they relate and affect each other.

Table 8. Correlations Matrix.

	EC	*Alliance*	*NetCarrier*	*Regional*	*Charter*	*LowCost*
EC	1					
Alliance	−0.357 ***	1				
NetCarrier	−0.124 *	0.324 ***	1			
Regional	−0.395 ***	0.085	−0.532 ***	1		
Charter	0.298 ***	−0.194 **	−0.273 ***	−0.150 *	1	
LowCost	0.369 ***	−0.362 ***	−0.508 ***	−0.279 ***	−0.143 *	1

* Significant at 0.05; ** Significant at 0.01; *** Significant at 0.001.

If we center our attention on the variable *EC*, which is the dependent variable of our model, it is significantly related to all the other variables, with four of them being significant at $p < 0.001$. Besides, its relationships are negative for *Alliance*, *NetCarrier* and *Regional*, and positive for *Charter* and *LowCost* carriers, as expected and inferred by our research.

5. Conclusions and Implications

This study has addressed the relationship between sustainability and a key strategic component in the aviation industry: Global Alliances. More specifically, the paper tackled the influence of belonging to an airline alliance on a firm's environmental performance using theoretical and empirical approaches, considering the global effect of the alliances as well as their characteristics. This relationship was also associated with the business models that determine the management of airlines.

5.1. Theoretical Contributions

From a theoretical point of view, this work contributes to the environmental management field by providing a new approach that allows the relations between global alliances in the airline industry and environmental sustainability to be connected and explored, focusing upon the environmental performance of the airlines.

The paper contributes to a revision of the theoretical arguments, with both sector and firm focuses, of whether alliances favor or damage a firm's environmental performance. In particular, we identify a potential divergence between the objectives of global alliances, as well as those of the firms, and environmental concerns.

Likewise, the paper highlights the effect of corporate strategy (business model) and alliance, which appear to be key factors in environmental performance. We also explore and propose the different characteristics of alliances that can influence the sustainability of their members in one way or another.

5.2. Practical Contributions

In addition to its theoretical implications, this study also has important practical contributions. First, we found that alliances, as they are defined at the moment, have a negative impact on the environmental performance of the airlines. In this sense, among the Net Carrier airlines, for instance, the ones with better environmental results are those that do not belong to any of the three global alliances in the sector. This could be a result of the main focus of the alliances (and airlines themselves) on economic and operational objectives, leaving environmental concerns aside.

Although alliances take environmental issues into consideration and include different statements and commitments towards the environment and corporate social responsibility, such as the Environment

Commitment Statement of Star Alliance [36], on their webpages, in fact, these values are not transferred to environmental performance.

This situation reinforces the argument of the divergence between alliance and firm objectives and environmental issues, showing the need for more proactive environmental behavior in the sector (at both alliance and firm levels). This could be achieved for instance, with the development of capabilities related to clean environmental management, at a general level [21,40,42], and in the aviation sector in particular [56], as suggested by other works.

5.3. Limitations

The main limitations of this study are related to the sample size and the use of a partial measure for the environmental performance of airlines. However, the sample included all airlines that engage in global alliances, and also secondary data collected at different moments in time, not being based on managerial perceptions, were considered, so a social desirability bias was not present. In addition, the environmental performance data used were produced by recognized organizations in the sector, and therefore gave independent evaluations of the airlines.

We also acknowledge the limitations of using average values within a time frame, when a time series approach could be more appropriate to capture some time-related elements, such as the effects of the entrance to an alliance. Although we consider that our theoretical and empirical contributions are supported by a coherent and solid database, we recognize the need to further study our conclusions using other measures of environmental performance and new samples of companies in the sector, as well as using managerial perception, which refers to the development of management capabilities associated with sustainability.

5.4. Implications for Industry

Consequently, one of the main implications of our paper is the necessary redefinition of the alliances' objectives in the future. Law and Breznik [24] identified six content dimensions of mission statements among the top airlines in the world according to their mission definitions. These six content dimensions are "service", "customer", "concern for stakeholders", "concern for strategy", "competitive advantage" and "development". "Concern for stakeholders" may indicate that the importance of sustainability in the company is conditioned to stakeholder pressure.

This situation reinforces our empirical results, and may explain the differences in environmental performance among companies according to their strategies. Besides, our study found significant evidence about the misalignment of alliance objectives with sustainability. So, if sustainability is a challenge to be faced, it is necessary that firms, both individually and within global alliances, start to include sustainability and environmental performance as drivers of their own objectives in the future.

Author Contributions: The three authors have equally contributed to this paper (conceptualization, methodology, formal analysis and writing). All authors have revised and approved the final manuscript.

Funding: We acknowledge financial support from the Spanish Ministry of Economy, Industry and Competitiveness, the Agencia Nacional de Investigación-AEI, the European Regional Development Fund-ERDF/Fondo Europeo de Desarrollo Regional-FEDER/European Union (EU) (R&D project ECO2015-66504), as well as Excellence project of Junta de Andalucía (reference SEJ-7085).

Conflicts of Interest: The authors declare no conflict of interest.

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