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Adrián, Nerja

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Can parallel airline alliances be welfare improving? The case of airline-airport vertical agreement.

Adrián Nerja[1*]

[1*]Fundamentos del Análisis Económico (FAE), Universidad de Alicante, Campus de Sant Vicent del Raspeig, Sant Vicent del Raspeig, 03071, Alicante, Spain.

Corresponding author(s). E-mail(s): adrian.nerja@ua.es;

Abstract

Parallel airline alliances have negative effects on consumers a priori; however, they can be counteracted if airports may modify the behavior of airlines. In particular, vertical airport-airline agreements allow the airport to influence the competition downstream market, changing the effects of parallel alliances. In this paper, we analyze the effects of parallel alliances in the context of competition between vertical airport-airline pairs competition. We show that under the influence of airports, parallel alliances are welfare improving, and the number of passengers increases, against former studies. These results offer a new brand of analyses to be considered by authorities that evaluate parallel alliances.

Keywords: airlines parallel alliances, concession revenue sharing, vertical agreements, airports competition

1 Introduction

Several reasons push airlines to sign alliances. In the most profitable years, the margins in the industry hardly ever reached 2.5-3%; very smooth in comparison with other markets, see Doganis (2005). However, despite the low returns, other strategic incentives led airlines to get allied. For instance, Zhang and Zhang (2006) reported: "strategic alliances allow firms to expand their networks, take advantage of product complementarities, realize economies of scale and scope, and improve product quality and customer service." The three major global alliance groups, Star Alliance, One World and Sky Team made up over 56.1% in revenue passenger-kilometers (RPKs) of the world market in 2018.[1] Park (1997) first distinguished between complementary and parallel alliances. Subsequently, Park, Zhang, and Zhang (2001), Zhang and Zhang (2006) and Adler and Hanany (2016) found that complementary alliances benefit the industry, whereas parallel alliances raise welfare concerns. Flores-Fillol (2009) analyzed when either type of alliance is more likely to be formed. He showed that it depends on the size of the market and the intensity of economies of traffic density. Most of the attention has focused on complementary alliances, where network effects have been considered.

Our primary goal is to analyze how a parallel airline alliance affects welfare in a scenario where airports that compete in the same catchment area share their concession revenues with airlines. The received literature has examined the effects of parallel alliances, noting their anticompetitive effects in terms of output and price, with some exceptions. For instance, Adler and Hanany (2016) found that, under certain circumstances, parallel alliances may be preferable to competitive outcomes. Similarly, Fageda, Flores-Fillol, and Theilen (2019) found that the effect of parallel alliances could be positive under the existence of strong economies of traffic density. Moreover, the existing literature on airline alliances (parallel, complementary, or hybrid) focuses on airlines' behavior in the airline market, abstracting away airports from the analysis. The novelty of the paper is the introduction of airport behavior into such an analysis. More specifically, the analysis of the effects of a parallel airline alliance using a "vertical structure" (that is, an airport is an input provider to the downstream airlines that compete or cooperate with each other in the air travel market; see Basso and Zhang (2007)). Once airport behavior is incorporated, then a natural consideration is the presence of concession revenue sharing contracts, since the growing importance of "concession revenues" (an airport's non-aeronautical service, which includes retailing, advertising, car rentals, car parking, and land rentals, which account for more than 50% of airport revenue) relative to the traditional aeronautical revenues, is a major development in the aviation sector over the last three decades. Then, we find that parallel airline alliances may be welfare improving under the existence of concession revenue sharing. Moreover, when considering private airports, parallel airline alliances may also improve consumer surplus, increasing the number of passengers in the industry. This result provides new insights for policy-makers.

Recently, vertical agreements between airlines and airports are getting attention from scholars, as D'alfonso and Nastasi (2014) note. To set up those agreements, concession revenue sharing contracts are increasingly frequent. For example, in the US, agreements between airports and airlines where concession revenue sharing is included are common. In this case, San Francisco

[1] IATA WATS (2019). Shares of RPKs were: Star Alliance (21.9%), Sky Team (18.8%), and One Wordl (15.4%).

International Airport shares 85% of the concession revenues with its signatory airlines. On the other hand, Minneapolis-St. Paul International Airport also distributes between 25-50% of some concessions, a percentage that depends on different requirements, Karanki and Lim (2020). Implicitly, other types of agreements involve the signatory airlines making a commitment in exchange for managing a terminal, which also means that the airlines appropriate the concession revenues. Zheng, Fu, Jiang, and Ge (2020) provide several examples. Terminal 2 at Munich Airport is a joint investment with Lufthansa, where the concession revenue is shared. At Sydney Airport, Qantas reached a lease agreement for 30-years to manage Terminal 3 in 1989. Terminal 5 at Kuwait International Airport is exclusively built and managed by Jazeera Airways.

This kind of contracts have been analyzed in the literature. Theoretically, in a vertical approach formed by airport-airline pairs, Zhang, Fu, and Yang (2010), Fu and Zhang (2010), Nerja and Sanchez (2021), and Nerja (2022) analyzed concession revenue sharing agreements, that were first considered by Zhang and Zhang (1997). These studies focus on analyzing the effects of the contracts under different setups, but none of them considers parallel alliances. In this paper, the formation of parallel alliances under concession revenue sharing contracts may have beneficial effects on traffic and consumer surplus. This is because airports, by appropriately choosing the terms of the contract, can influence the downstream market through the agreement, countering the restrictive effects of parallel alliances over traffic.

Thus, the possibility of a parallel alliance also affects the vertical relationship between the airport and the airline. In particular, it is shown that the existence of alliances makes airports share more concession revenues with airlines. When the downstream market is concentrated, the number of passengers is reduced and, to neutralize this effect, airports have to increase their sharing proportions. On the other hand, the strategic relationship of airports also changes. The strategic relationship of the airports that compete in sharing proportions is determined by the strategic relationship of the airlines in the downstream market when choosing the number of passengers. By establishing an alliance, competition among airlines is reduced to the point where they behave as strategic complements. Thus, as long as the parallel alliance is strong enough, the airlines behave more like a single airline; then they behave as strategic complements instead of substitutes. This causes the change in the strategic relationship of the airports as well, because their relationship is defined by strategic relationship of airlines.

Our conclusions are of obvious applicability and can be useful for policy makers as the following example shows. One of the recent mergers between US airlines is the one of Frontier Airlines and Spirit Airlines in July 2022.[2] This merger fits closely with the model developed in this paper. Each airline operates in different airports that share catchment areas in the origin and the destination in some routes. Thus, Frontier Airlines operates from Tampa

[2]See the news release: https://ir.flyfrontier.com/news-releases/news-release-details/frontier-airlines-and-spirit-airlines-combine-creating-americas/

International Airport (TPA) to Trenton-Mercer Airport (TTN), while Spirit Airlines operates from Orlando International Airport (MCO) to Atlantic City International Airport (ACY). MCO and TPA share the catchment area, they are 92 miles apart, whereas ACY and TTN are 85 miles apart. Furthermore, each airline has a revenue sharing agreement with its respective airport, Spirit Airlines with MCO and Frontier Airlines with TPA. Our main contribution suggests that, in settings with competing airports in the same catchment area each one having a vertical agreement with one of the airlines, a parallel airline alliance can be welfare improving. The reason is that airports are capable of inducing, via the vertical agreement, changes in the airlines behavior to keep receiving passengers in their premises. That is, airport competition can be sufficient to undo the harmful effects of parallel airline alliances.

Some representative papers that study complementary alliances include Brueckner (2001) and Flores-Fillol and Moner-Colonques (2007). Brueckner (2001) analyzed a hub-and-spoke network simulating an international market with two international airports that connect with two other regional airports. Airlines ally to provide the international direct flight services splitting the market between them. This concentrates the market, causing an increase in the airfares in the inter-hub market, but favors the connection with the spokes. The net result is that consumer surplus and social welfare increase, despite the negative effect on the inter-hub connection. This result has been empirically supported by Brueckner and Singer (2019), with the novelty that they analyze a long period of time with real data. Flores-Fillol and Moner-Colonques (2007) analyzed a network of four airports with four connections, each operated by a monopolistic airline. This is a natural setting where the strategic effects of complementary alliances are analyzed. It is observed that the alliances reduce the airfares, and therefore, improve the situation of the passengers. However, Ma, Wang, Yang, and Zhang (2020) evaluated two airline mergers in China, finding that both types of mergers (complementary and parallel) result in similar pricing patterns increasing market power. Our paper contributes to the alliance literature by studying the effects of a parallel alliance by taking into account the vertical structure of the industry in the presence of concession revenue sharing contracts. Following Zhang and Zhang (2006), an equity alliance is examined because "it tends to yield greater firm values, measured in stock returns, than other types of strategic alliances," which implies airlines incorporate a fraction of their partners' profit in its decision. Some examples of equity alliances have been: Air France/KLM alliance, the Cathay Pacific/Air China Alliance, and Qantas/Air New Zealand Alliance.

The next section sets out the model and analyzes the effects on airlines, airports, and welfare. Finally, in Section 3, we conclude with some remarks and policy recommendations.

2 Effects of Parallel alliances

2.1 The model

Consider two airports, A and B sharing a common catchment area competing for passengers, that offer flights to the same destination area. Each airport operates one and a different airline, in particular, airport A operates airline i while airport B operates airline j, that is, there are two airport-airline pairs competing for passengers. Airlines provide substitute differentiated services in the eyes of passengers and compete à la Cournot, that is, each airline chooses the number of passengers that will serve. The inverse demand system is specified as:[3]

$$p_i = a - b\, q_i - d\, q_j \tag{1}$$
$$p_j = a - b\, q_j - d\, q_i \tag{2}$$

For a, b and d being positive constants. The q_i's represent the number of passengers served by airline i in a given origin-destination route, similarly for q_j. Parameters $b > d > 0$ measure the degree of substitutability between airline services. When $d = 0$ airline services are independent, while when $d = b$ both services are perfect substitutes. Finally, p_i is the airfare paid by passengers traveling with airline i, similarly for p_j.

Airline i's profit function, π_i, is composed of two terms, the standard operating profits, $(\ p_i - c - w)q_i$, and profits derived from concessions, $h\ r_A q_i - f_A$. Parameter w denotes aeronautical charges per passenger paid by airlines to airports and is regulated, that is, not under airports' choice. Finally, c is the marginal cost per passenger. Regarding concessions, passengers spend money on non-aeronautical services at the airport, which generates additional revenue, hq_i, where h is the per passenger net surplus generated, and r_A is the sharing proportion of concession revenues that go to airline i awarded by airport A. Finally, f_A is the fixed payment made by the airline to the airport in exchange. The revenue sharing contract considered has been employed by Zhang et al. (2010), Fu and Zhang (2010) and Nerja and Sanchez (2021) among others, and contains two variables, (r, f). The sharing proportion, r, displays the effort of airports to pursue more passengers. In exchange, airports ask airlines for a fixed payment, which can be seen, for example, as a compromise to make any investment or to be attached to that airport for several years. We assume the two variable contract because it is consistent with situations in which airports and airlines can commit to medium/long-term cooperation. Furthermore, Zhang et al. (2010) stated that this contract "gets more traffic

[3]The inverse demand system is the result of the representative consumer maximization of $U(q_i, q_j) = a(q_i + q_j) - \frac{b}{2}(q_i^2 + q_j^2) - dq_iq_j + y$ with respect to q_i and qj, subject to the budget constraint defined as $M = y + p_iq_i + p_jq_j$, with M denoting the representative consumer's income and y the other goods used as numéraire. This system satisfies the usual properties: (i) downward-sloping demand $\frac{\partial p_i}{\partial q_i} = -b < 0$; (ii) own effects dominate cross effects $\frac{\partial p_i}{\partial q_i}\frac{\partial p_j}{\partial q_j} - \frac{\partial p_i}{\partial q_j}\frac{\partial p_j}{\partial q_i} = b^2 - d^2 > 0$.

volume and social welfare" than the contract with just one variable. Therefore, airline i and j profits are, respectively:

$$\pi_i = (p_i - c - w + hr_A)q_i - f_A \tag{3}$$
$$\pi_j = (p_j - c - w + hr_B)q_j - f_B \tag{4}$$

Besides, airports using concession revenue sharing agreements also have two sources of revenue. For instance, airport A gets wq_i from aeronautical activities. Remind that w cannot be changed by the airport unilaterally since it is regulated by the airport authority. The other source is composed of the share of concession revenues it keeps, $(1 - r_A)hq_i$ plus the fixed fee, f_A; similarly for airport B. The simple representation of the net concession revenue, h, where it is strictly complementary to passenger volume, has been used by Zhang et al. (2010), Fu and Zhang (2010), Yang, Zhang, and Fu (2015) and Nerja and Sanchez (2021), among others. Finally, τ is the marginal aeronautical costs, while we normalized fixed costs to zero. Therefore, these are the airport profits:

$$\Upsilon_A = (w - \tau)q_i + (1 - r_A)hq_i + f_A \tag{5}$$
$$\Upsilon_B = (w - \tau)q_j + (1 - r_B)hq_j + f_B \tag{6}$$

Agents make decisions in two stages. In the first stage, each airport decides simultaneously and independently over the concession revenue sharing contract (r_A, f_A) and (r_B, f_B) to maximize profits, and given that, each airline accepts or reject the corresponding offer. In the second stage, airlines compete for the number of passengers served, given the sharing proportions. The next subsections characterize the subgame perfect Nash equilibrium of the game, which is solved in the standard backward way.

2.2 Downstream airline competition

This paper considers the effect of a parallel alliance in the downstream market on airports' behavior. For many reasons, airlines get allied to survive and to gain access to other markets; consequently, many alliances with several motivating forces are spread worldwide. Park (1997) formally distinguished between complementary and parallel alliances. Increased airport rivalry implies that the chance to find parallel airline alliances increases. The purpose of this section is to analyze how parallel alliances affect sharing proportions, airport competition, and social welfare.

In order to model a parallel alliance, we follow Zhang and Zhang (2006), who stated that "an equity alliance tends to yield greater firm values, measured in stock returns, than other types of strategic alliances." Therefore, in the second stage, every airline chooses the number of passengers to be served to maximize the following expressions:

$$\underset{q_i}{Max} \quad \Pi_i = \pi_i + \alpha\, \pi_j \tag{7}$$
$$\underset{q_j}{Max} \quad \Pi_j = \pi_j + \alpha\, \pi_i \tag{8}$$

When airlines form alliances, their objective function changes, and they maximize their profit plus a weight on their partner's profit. Parameter $\alpha \in [0, 1)$ denotes the degree of cooperation; $\alpha = 0$ represents the Cournot case that appears in previous works, whereas $\alpha = 1$ corresponds to that case of a single airline, which is ruled out in this analysis. The degree of cooperation, α, is assumed equal for both airlines involved and given.

Despite forming an alliance, each airline chooses the number of passengers independently to maximize its objective function. In this case, given the degree of cooperation and the terms of the revenue sharing contracts, the number of passengers per airline and the total number of passengers in the industry would be the following:

$$q_i^* = \frac{(a-c-w)(2b-(1+\alpha)d) + h(2b\, r_A - (1+\alpha)d\, r_B)}{4\, b^2 - \ (1+\alpha)^2\ d^2} \tag{9}$$
$$q_j^* = \frac{(a-c-w)(2b-(1+\alpha)d) + h(2b\, r_B - (1+\alpha)d\, r_A)}{4\, b^2 - \ (1+\alpha)^2\ d^2} \tag{10}$$

$$Q^* = \ q_i^* + \ q_j^* = \frac{2(a-c-w) + h(\ r_A + \ r_B)}{2b + (1+\alpha)d}, \tag{11}$$

Then, the following result can be established.

Proposition 1 *Parallel alliances reduce total traffic, i.e.* $\frac{\partial\ Q^*}{\partial \alpha} = -\frac{d\ Q^*}{2b+(1+\alpha)d} < 0.$

This was expected because the concentration in the downstream market reduces total traffic. Nevertheless, and even though the loss of passengers occurs, the effects at the different airports depend on the sharing proportion of each one. Therefore, we must pay attention to these variables. If both airports behave symmetrically, that is, the sharing proportion is equal, $r_A = r_B$, there is a loss of passengers on both airlines, $\frac{\partial\ q_i^*}{\partial \alpha} < 0 \quad \forall \quad i, j$. When there is asymmetry, that is, an airport distributes more sharing than the other, the airport with less sharing always reduces its traffic, as expected due to the effect of market concentration. On the other hand, the higher sharing airport can see its traffic increase if the sharing proportion is large enough and smaller than one. This is due to the substitution effect that exists between airports when establishing alliances. The airline that operates at the airport with the lowest sharing proportion transfers passengers to the other airport since in this way, they obtain greater profit.

With these results, parallel alliances produce a negative effect in terms of traffic level. Park et al. (2001) found empirical evidence where a parallel alliance decreases total traffic by an average of 11-15 %. The degree of cooperation, that is, the value of α, will determine if the scenario seems more like a Cournot, or a monopoly case, although we do not consider the latter scenario. As the degree of cooperation increases, other things equal, airlines can increase airfares, which is why they have incentives to cooperate since they obtain greater profits. For this effect, parallel alliances are expected to be harmful. However, upstream market behavior can mitigate this effect. In this case, as argued through the paper, airports can influence the outcome in the downstream market through vertical agreements such as concession revenue sharing contracts.

2.3 Airports answer to parallel alliances

Earlier results in the literature do not consider the possibility of a formal vertical relationship between airports and airlines so that the effect of any market concentration downstream inevitably leads to a reduction in the number of passengers. However, when considering concession revenue sharing contracts, there are situations in which traffic increases due to the ability of airports to influence the equilibrium in the downstream market. Then, once the results and the implications of parallel alliances on the second stage equilibrium have been established, we move up to characterize the first stage equilibrium.

Consider now two private airports competing to attract passengers by choosing the terms of the concession revenue sharing contracts offered to their corresponding airline. That is, each airport A and B, decides simultaneously and independently about the $\{f_A, r_A\}$ and $\{f_B, r_B\}$ pairs to maximize profits. Having observed the terms of the contract, each corresponding airline unilaterally and independently accepts or rejects the deal.

To compute the terms of the contracts, each airport chooses the corresponding sharing proportion that maximizes its profits subject to the corresponding participation constraint for the signatory airline. To do so, we will first calculate the largest fixed payment that satisfies each participation constraint, that is, the one that leaves the signatory airline indifferent between accepting or rejecting the contract; next, each fixed payment is plugged into airport profits and finally, each airport's profits are maximized with respect to the sharing proportion. That is, for airport A, the r_A is obtained from $\underset{r_A}{Max} \quad \Upsilon_A$, subject to $\pi_i \geq \pi_i^0$; where π_i^0 is denoting the profits airline i's will have if she rejects the offer from airport A. Similarly, for airport B the r_B is obtained from $\underset{r_B}{Max} \quad \Upsilon_B$, subject to $\pi_j \geq \pi_j^0$. Note that airports profits are increasing in their respective fixed fees which implies that the constraint is binding, therefore, for the case of airport A, $f_A = (p_i^* - c - w + hr_A)q_i^* - (p_i^{i0} - c - w)q_i^{i0}$; where q_i^{i0} is equilibrium quantity in (9) for $r_A = 0$ and p_i^{i0} is the price once equilibrium quantities in (9) and (10) for $r_A = 0$ have been substituted in

(1). Similarly for f_B. These expressions of fees are plugged in Υ_A and Υ_B, and finally, two first order conditions, defined as $\frac{\partial \Upsilon_A}{\partial r_A} = 0$ and $\frac{\partial \Upsilon_B}{\partial r_B} = 0$ are solved simultaneously to obtain the symmetric equilibrium sharing proportion, $r_A^* = r_B^* = r^*$ given by,[4]

$$r^* = \begin{cases} \frac{d(a-c)(2\alpha b+(1+\alpha)d)+2b(h-\tau)(2b+(1+\alpha)d)}{h(2b(2b+d)-(1+\alpha)d^2)} + \frac{w}{h} & \text{if} \quad max\{0, w^+\} < w < w^* \\ 1 & w^* \leq w \end{cases} \tag{12}$$

There is a condition ensuring that $r^* > 0$, which is when $w > w^+ \equiv -\frac{d(a-c)(2\alpha b+(1+\alpha)d)+2b(2b+(1+\alpha)d)(h-\tau)}{2b(2b+d)-(1+\alpha)d^2}$. At the same time, there is a condition ensuring that $r^* < 1$, that is, when $w < w^* \equiv \frac{2b(2b+(1+\alpha)d)\tau - d(a-c+h)(2\alpha b+(1+\alpha)d)}{2b(2b+d)-(1+\alpha)d^2}$. Then, $0 < r^* < 1$ as long as $max\{0, w^{*+}\} < w < w^*$. Once the equilibrium sharing proportion is obtained, the equilibrium fixed fees are also symmetric and given by,[5]

$$\begin{cases} f^* = \frac{4b^2(b+\alpha d)(a-c+h-\tau)^2}{(4b^2+2bd-(1+\alpha)d^2)^2} - \pi^0 & \text{if } max\{0, w^+\} < w < w^* \\ \overline{f^*} = \frac{(b+\alpha d)(a-c+h-w)^2}{(2b+(1+\alpha)d)^2} - \overline{\pi^0} & w^* \leq w \end{cases} \tag{13}$$

When airports distribute all the concession revenue, i.e., $r^* = 1$ (or $w^* \leq w$), there is always a reduction in traffic due to parallel alliances. This happens because airports cannot increase the sharing proportion any further to modify the behavior of airlines. But if the sharing proportion is not fully shared, we find cases where alliances increase traffic. From a regulatory perspective, this shows how in situations where there are private airports, authorities can set a sufficiently small aeronautical charge to guarantee that the sharing proportion is less than one and, therefore, there is scope for airports to further increase the sharing proportion finally leading parallel airline alliances to generate a traffic increase.

Proposition 2 *As a response to airline cooperation, airports increase the concession revenue sharing proportion, i.e.* $\frac{\partial r^*}{\partial \alpha} = \frac{8b^2 d(b+d)(a-c+h-\tau)}{h(4b^2+2bd-(1+\alpha)d^2)^2} > 0$.

When an airline parallel alliance is established, the airport responds by increasing the sharing proportion to offset the decrease in passenger traffic. As showed by Proposition 1, there is a generalized loss of traffic, which would be higher if there was no a positive sharing proportion, $Q^*(r) > Q^*(0)$.

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[4]Several papers in the previous literature assumed that it is in both firms' interest, when competing with the other vertical pair, to capture the largest proportion of passengers from the total pool and this is achieved just by choosing the revenue-sharing parameter to maximize a profit sum of the vertical pair, see Fu and Zhang (2010), Barbot (2011) and D'Alfonso and Nastasi (2012). In this case, each airport-airline pair maximizes its aggregate profit when choosing the sharing proportion r_A, $\underset{r_A}{Max}\ \Upsilon_A + \pi_i$; r_B, $\underset{r_B}{Max}\ \Upsilon_B + \pi_j$. We have checked that our main results hold under this alternative specification.

[5]Where, $\pi^0 = \frac{((b+d\alpha)(2b-d(1+\alpha))(a-c-w)-(1-\alpha)bdhr^*)((2b-d(1+\alpha))(a-c-w)-(1+\alpha)dhr^*}{(4b^2-d^2(1+\alpha)^2)^2}$ and $\overline{\pi^0} = \frac{((b+d\alpha)(2b-d(1+\alpha)))(a-c-w)-(1-\alpha)bdh)((2b-d(1+\alpha))(a-c-w)-(1+\alpha)dh}{(4b^2-d^2(1+\alpha)^2)^2}$.

It is also worth mentioning the strategic relationship of airports. This relationship is preceded by the strategic relationship that exists between the airlines in the downstream market. When an alliance is established, if it is strong enough, the strategies of the airlines are aligned, so they stop behaving as strategic substitutes. This causes airports, which use the sharing proportion as a rivalry tool, to change their behavior.

Proposition 3 *Airports' strategic relation changes from substitutes to complements for a large enough degree of cooperation among airlines, that is for* $\alpha \in (\hat{\alpha}, 1]$, *where* $\hat{\alpha} = (\frac{2b^2-d^2-2b\sqrt{b^2-d^2}}{d^2})$.

For a better understanding, suppose airlines merge and form a monopoly. The single airline will prefer the airport with the highest sharing proportion to increase its profit; i.e., the airline can transfer passengers between airports for the sake of its benefit. Aware of that, airports behave as strategic complements in the sharing proportions to avoid passenger transference between them; i.e., if one airport increases its sharing, the rival increases it too.

2.4 Welfare analysis

When considering a parallel alliance in the downstream market, it is worth looking at how it affects social welfare. The expressions for welfare (given by the sum of consumer surplus, airport profits and airline profits) and consumer surplus are the following:

$$SW^* = \begin{cases} \frac{4b(3b^2+bd-(1+\alpha)d^2)(a-c+h-\tau)^2}{(4b^2+2bd-(1+\alpha)d^2)^2} & if \quad max\{0, w^+\} < w < w^* \\ \frac{(a-c+h-w)((3b+(1+2\alpha)d)(a-c+h-\tau)+(w-\tau)(b+d)}{(2b+(1+\alpha)d)^2} & if \quad w^* \leq w \end{cases} \tag{14}$$

$$CS^* = \begin{cases} \frac{4b^2(b+d)(a-c+h-\tau)^2}{(4b^2+2bd-(1+\alpha)d^2)^2} & if \quad max\{0, w^+\} < w < w^* \\ \frac{(b+d)(a-c+h-w)^2}{(2b+(1+\alpha)d)^2} & if \quad w^* \leq w \end{cases} \tag{15}$$

Proposition 4 *If the sharing proportions are smaller than one, i.e.* $max\{0, w^+\} < w < w^*$, *parallel alliances are welfare and consumer surplus improving for any degree of cooperation, i.e.* $\frac{\partial SW^*}{\partial \alpha}, \frac{\partial CS^*}{\partial \alpha} > 0$. *Instead, when the sharing proportions are equal to one, social welfare and consumer surplus decrease with the degree of cooperation.*

If $w^* < w$ then $r^* = 1$, and airports cannot influence the downstream market more than they actually do. Therefore, any increase in the degree of cooperation reduces welfare, because the airport cannot respond to it. Thus, if the degree of cooperation increases, the only effect that arises over the traffic level is the negative effect because of the downstream market concentration.

However, when $r^* < 1$ (i.e., $max\{0, w^+\} < w < w^*$) parallel airline alliances are welfare improving.

On the other hand, parallel alliances also increase consumer surplus. In this case, the increase in social welfare is preceded by the increase in consumer surplus and the profits of airlines to the detriment of airport profits, which is the part affected. That is, in a setting with private airports and concession revenue sharing, if a sufficiently small aeronautical charge is guaranteed that makes $r^* < 1$, and the airline services are sufficiently differentiated, airlines will form a parallel alliance and this type of alliances are welfare improving, and they also increase consumer surplus. In times of crisis, as with the COVID-19 pandemic, airports and institutions tend to suspend the increase on, or even reduce, aeronautical charges. This fact makes it easier that airports sharing proportion fall bellow 1, then supporting the results found under certain conditions.

Proposition 4 holds for private airports, however, despite the airport privatization process, there are public airports still. Consider now a setting with two public airports where social welfare is maximized. What happens is that the airport serves as a regulator mechanism transferring economic profits from airlines to consumers. Then, consumer surplus reaches its maximum as long as the sharing proportions are less than one. Thus, airlines parallel alliances have no effect in a setting with public airports with the existence of a vertical agreement. For a more detailed analysis see Appendix B.

To conclude, although it can be difficult that a parallel alliance between dominant carriers be cleared by competition authorities, the novel result regarding the chance of a welfare increase following the alliance merits to be emphasized. Our analysis identifies conditions such that the anticompetitive well-known effects of this type of alliance can be overridden by the response of the airports in choosing the sharing proportions. These conditions are basically that airports use concession sharing contracts and that the airports have room to increase the sharing proportion as a reaction to the alliance. This is the case for sufficiently low regulated aeronautical charges as shown in Proposition 4. In other words, when airports have not shared all the concession revenues. In case of public airports that maximize social welfare, the use of concession sharing contracts allows to undo the negative effect of parallel alliances in any case. This should hopefully be useful for informed policy analysis.

3 Concluding remarks

We have found novel results when parallel alliances are analyzed following a vertical structure approach and under concession revenue sharing contracts. We find that parallel alliances reduce total traffic by concentrating the downstream market as compared to the no alliance case. However, anticipating this, airports may increase the sharing proportion to ease that loss of passengers and make it smoother. Besides, it is also found that, under certain conditions, social welfare increases as well as consumer surplus and total traffic, which emphasizes the need for further study of this type of alliance in different contexts.

Even indirectly, alliances bring positive effects to the economy. Parallel alliances have been avoided because they concentrate the air transport market. However, they allow for knowledge transfer between airlines and improve productivity, which also benefits passengers. Furthermore, under a setting where airlines sign agreements with airports, the adverse effects may be reverted through the proper actions of airports. In any case, many interactions arise when two or more firms get allied, so more insights are needed to give an accurate verdict.

Otherwise, concession revenue sharing contracts allow airlines to appropriate an externality they generate, bringing passengers from one airport to another. Both airports and airlines have incentives to sign this kind of agreement because they give them balance and allow them to plan in advance and make strategic decisions in the medium and long run. Vertical agreements also allow airlines to achieve a competitive advantage if they position as leaders in a market or airport. Thus, institutions may allow this kind of agreement to ensure the future of the air transport market and permanent growth in the industry.

Regarding parallel alliances and concession revenue sharing contracts there remains much to research. For instance, we just considered two competing airports to illustrate the role of airports considering parallel alliances. Then, the consideration of airline competition within an airport, the kind of competition and cooperation among the end-point airports, or the empirical study of airlines networks, are interesting extensions for further research.

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Appendix A - Proofs

Throughout the paper, there are some restrictions on the value of the relevant parameters, which are used in the proofs that follow:

1. $b > d > 0$
2. $a, c, \tau, h, w > 0$
3. $a > c + \tau$
4. $\alpha \in [0, 1)$

Second order conditions in the first stage of the game

1. Concavity
   $\frac{\partial^2 \Upsilon_A}{\partial \mathrm{r}_A^2} = \frac{\partial^2 \Upsilon_B}{\partial \mathrm{r}_B^2} = -\frac{4b\left(2b^2-(1+\alpha)d^2\right)h^2}{(4b^2-(1+\alpha)^2 d^2)^2} < 0$
2. Strategic relationship
   $\frac{\partial^2 \Upsilon_A}{\partial r_A \partial r_B} = \frac{\partial^2 \Upsilon_B}{\partial r_A \partial r_B} = -\frac{dh^2\left(-4\alpha b^2+(1+\alpha)^2 d^2\right)}{(4b^2-(1+\alpha)^2 d^2)^2}$
3. Stability condition
   $\frac{\partial^2 \Upsilon_A}{\partial r_A^2}\frac{\partial^2 \Upsilon_B}{\partial r_B^2} - \frac{\partial^2 \Upsilon_A}{\partial r_A \partial r_B}\frac{\partial^2 \Upsilon_B}{\partial r_B \partial r_A} = \frac{h^4\left(64b^6-16(2+\alpha)^2 b^4 d^2+8(1+\alpha)^2(2+\alpha)b^2 d^4-(1+\alpha)^4 d^6\right)}{(4b^2-(1+\alpha)^2 d^2)^2} > 0$

Equilibrium values

In this subsection the results in equilibrium are gathered:
If $r^* < 1$ (that is, if $max\{0, w^+\} < w < w^*$)

$$q_i^* = q_j^* = \frac{2b(a-c+h-\tau)}{4b^2+2bd-d^2(1+\alpha)}$$

$$p_i^* = p_j^* = \frac{a(2b^2-d^2(1+\alpha))+2b(b+d)(c-h+\tau)}{4b^2+2bd-d^2(1+\alpha)}$$

$$\pi_i^* = \pi_j^* = \frac{4b^2(b+d\alpha)(a-c+h-\tau)^2}{(4b^2+2bd-d^2(1+\alpha))^2} - f^*$$

$$\Upsilon_A^* = \Upsilon_B^* = \frac{-2bd(2b\alpha+d(1+\alpha))(a-c+h-\tau)^2}{(4b^2+2bd-d^2(1+\alpha))^2} + f^*$$

If $r^* = 1$ (that is, if $w^* \leq w$)

$$q_i^* = q_j^* = \frac{a-c+h-w)}{2b+d(1+\alpha)}$$

$$p_i^* = p_j^* = \frac{a(b+d\alpha)+(b+d)(c-h+w)}{2b+d(1+\alpha)}$$

$$\pi_i^* = \pi_j^* = \frac{(a-c+h-w)^2(b+d\alpha)}{(2b+d(1+\alpha))^2} - \overline{f^*}$$

$$\Upsilon_A^* = \Upsilon_B^* = \frac{(a-c+h-w)(w-\tau)}{2b+d(1+\alpha)} + \overline{f^*}$$

Proofs

Proof of Proposition 2

$\frac{\partial\ r^*}{\partial\alpha} = \frac{8b^2 d(b+d)(a-c+h-\tau)}{h(4b^2+2bd-(1+\alpha)d^2)^2} > 0$

The partial derivative is always positive because all terms in the derivative are.

Proof of Proposition 3

To analyze the strategic relationship between airports, we have to know the sign of

$\frac{\partial^2\Upsilon_A}{\partial\ r_A \partial\ r_B} = \frac{\partial^2\Upsilon_B}{\partial\ r_A \partial\ r_B} = \frac{dh^2(4b^2\alpha-(1+\alpha)^2 d^2)}{(4b^2-(1+\alpha)^2 d^2)^2}$

This sign is determined by the sign of $4\alpha b^2 - (\alpha+1)^2 d^2$. Solving this term to obtain the roots, we get $\alpha^- = (2b^2 - d^2 - 2b\sqrt{b^2-d^2})/d^2$, and $\alpha^+ = (2b^2 - d^2 + 2b\sqrt{b^2-d^2})/d^2$, where the term is positive for $\alpha^- < \alpha < \alpha^+$ with $\alpha^+ > 1$ and $0 < \alpha^- < 1$.

Then, airports are strategic substitutes if $\alpha^- < \alpha < 1$, and they are strategic complements as long as $0 < \alpha < \alpha^-$.

Proof of Proposition 4

First note that CS and SW are defined by,

$$CS = U - p_i q_i - p_j q_j = \frac{1}{2} b\left(q_i^2 + q_j^2\right) + dq_i q_j$$

$$SW = CS + \Upsilon_A + \Upsilon_B + \pi_i + \pi_j = (a-c+h-\tau)(q_i+q_j) - \frac{1}{2} b\left(q_i^2 + q_j^2\right) - dq_i q_j$$

1. In the case that $r^* < 1$, by inspection:
   - $\frac{\partial SW^*}{\partial\alpha} = \frac{4bd^2\left(2b^2-(\alpha+1)d^2\right)(a-c+h-\tau)^2}{(4b^2+2bd-(\alpha+1)d^2)^3} > 0$
   - $\frac{\partial CS^*}{\partial\alpha} = \frac{8b^2 d^2(b+d)(a-c+h-\tau)^2}{(4b^2+2bd-(1+\alpha)d^2)^3} > 0$
2. When $r^* = 1$:
   - $\frac{\partial SW^*}{\partial\alpha} = -\frac{2d(a-c+h-w)((a-c+h)(b+\alpha d)-\tau(2b+(\alpha+1)d)+w(b+d))}{(2b+\alpha d+d)^3}$.

     In order to have $\frac{\partial SW^*}{\partial\alpha} > 0$, it is required $w < \frac{-(a-c+h)(b+\alpha d)+\tau(2b+(1+\alpha)d)}{b+d}$. This value of w is smaller than w^*. The value that makes $r^* = 1$ is w^*, then $\frac{\partial SW}{\partial\alpha} < 0$ for every possible value of $w \geq w^*$.
   - $\frac{\partial CS^*}{\partial\alpha} = -\frac{2b(b+d)(a-c+h-w)^2}{(2b+(1+\alpha)d)^3} < 0$

Appendix B - Effects of parallel alliances with public airports

The results previously found are considering private airports in the setting. The privatization of major airports began in the UK in 1987. Since then, more and more airports have been privatized around the world; however, many airports are still publicly owned with welfare maximization as one of their important considerations. Thus, in this appendix, we are going to consider public airports in order to compare the effects with the private setting.

The stage 2 where airlines compete in the downstream market remains. Changes are made in the stage 1, where airports, instead of maximizing profits, maximize social welfare to obtain the sharing proportion, $\underset{r_A,\ r_B}{Max}\ SW$. Then, once airports maximize jointly SW they obtain the following sharing proportions:

$$r^* = r_A^* = r_B^* = \frac{(a-c)(b+\alpha d) + w(b+d) + (h-\tau)(2b+(1+\alpha)d)}{(b+d)h}$$

In this case, with public airports, Proposition 2 holds, where airports increase the concession revenue sharing proportion as a response to airline cooperation, i.e. $\frac{\partial r_*}{\partial \alpha} = \frac{d(a-c+h-\tau)}{(b+d)h} > 0$.

In this point, we are able to compute social welfare and consumer surplus, which in this case are the same.

$$SW = CS = \frac{(a-c+h-\tau)^2}{b+d}$$

In a setting with public airports, we find that the consumer surplus is maximized, which means that airports extract the rents from airlines. Then, airports transfer the whole economic profits to consumers, that is, $\Upsilon_i = \pi_i = 0$. Thus, as can be seen in the previous equation, a parallel alliance in the downstream market does not affect welfare in a setting with public airports. In this case, public airports serve as a mechanism to regulate the market, and they do so through the concession revenue sharing contract.

Observe that this result sustains as long as the sharing proportions are fewer than 1. Beyond that point, the increase in the degree of cooperation will diminish social welfare and consumer surplus.