Exclusivity in concession revenue sharing contracts

Nerja, Adrian

August 2021

Exclusivity in concession revenue sharing contracts

Adrián Nerja*

*Department of Economic Analysis and ERI-CES, University of Valencia, Campus dels Tarongers, E-46022 Valencia, Spain
adrian.nerja@uv.es

Abstract

This paper studies the effects of concession revenue sharing contracts by endogenizing the choice of the signatory airline(s). It is shown that an airport finds it profitable to share concession revenues with airlines and this increases both consumer surplus and social welfare. The airport prefers an exclusive agreement when the net per passenger revenue generated on non-aeronautical services at the airport is sufficiently low; it extracts higher payments by exploiting the competition between airlines to become the sole signatory. The level of aeronautical charges, that are regulated, influences the airport's decision and, consequently, the intensity of airline competition. Welfare is higher under a non-exclusive arrangement, which may be in conflict with the airport's decision. The incentive to use these contracts remains under airport competition and revenue sharing increases. With an airline alliance, revenue sharing increases traffic for a large enough degree of cooperation between airlines.

This paper is the Submitted Version of a published paper in the Journal of Air Transport Management with
DOI - https://doi.org/10.1016/j.jairtraman.2021.102158
Please cite as: Nerja, A. (2022). Exclusivity in concession revenue sharing contracts. Journal of Air Transport Management, 99, 102158.

1 Intro duction

Airports are fundamental players in the air transport industry as public infrastructures serving the needs of airlines and passengers. However, in recent times airports have been under pressure to become more financially self-sufficient and leave off relying on public funds. Since aeronautical services are often regulated, airports have turned their looks at non-aeronautical activities, which have become an increasing source of revenues. The ACI (2018) discloses that 39.4% of airport revenues are non-aeronautical, although there are airports such as Hong Kong (HKG) or Tampa (TPA) that obtain more than 70% of their revenues from non-aeronautical activities according to ATRS (2017). With the growth of concession revenues, a more competitive environment has pushed up the use of revenue sharing contracts, whereby an airport shares its commercial revenues with airlines. Agreements may be signed with just one (possibly dominant) airline while others embrace several airlines (Fu and Zhang, 2010). Our paper contributes to the literature that studies the effects of concession revenue sharing contracts by endogenizing the choice of the signatory airline(s). We shall investigate the consequences on competition and the welfare implications of having either an exclusive or a non-exclusive contract.

In practice, revenue sharing is becoming popular. For example, Tampa International Airport has been sharing revenue with airlines since 2000. In 2006, it shared 20% of its net revenue with its signatory airlines. The Greater Orlando Aviation Authority (2010) has been also implementing similar revenue sharing arrangements along the period 2009-2013 with 30% (25%) allocated to signatory airlines and 70%(75%) allocated to the airport authority over the period 2009-2010 (2011-2013). The signatory airline share is distributed among the airlines based on each airline's share of enplaned passengers. In 2002, the Frankfurt Airport signed a five-year agreement with Lufthansa and other airlines showing a non-exclusive concession behavior.

The regulation of aeronautical charges has been preceded from the consideration of airports as natural monopolies. However, several features such as the airline market structure, the extent of competition among airports or the vertical relationship between airports and airlines affect airports' decisions. More precisely, there are studies that support the theory that the presence of non-aeronautical income prevents airports from increasing their aeronautical charges (Starkie (2001); Zhang and Zhang (2003)). Therefore, the positive externality stemming from the demand for aviation services on the demand for commercial services reduces an airport's incentive to exploit its market power and to set higher aeronautical charges (Oum and Fu (2008)), yet this need not be so in the case of foresighted passengers (Czerny (2006), Flores-Fillol et al. (2018)).

Airports and airlines have incentives to establish agreements since both provide perfectly complementary services. Airports provide a necessary input for the air transport industry and airlines bring in passengers who use airport commercial facilities and contribute to their profitability. By signing those agreements, airports ensure a portion of future traffic and profits, and signatory airlines participate in the commercial revenue associated with more traffic while possibly establishing a dominant position at the airport thus gaining a competitive advantage over other airlines. Several types of vertical agreements are found in the literature. Fu et al. (2011) point out five types: signatory airlines of airports, airline ownership or control of airport facilities, long-term use contracts, airport issuance of revenue bonds to airlines, and concession revenue sharing between airports and airlines. Differently, Barbot (2011) and D'Alfonso and Nastasi (2012) analyzed three types of vertical agreements in a situation with and without competition. Their results mainly point out anti-competitive concerns about vertical agreements, since signatory airlines benefit from their position inside the airport. Furthermore, Barbot and D'Alfonso (2014) find that price rebate contracts, where airports ensure a level of traffic in exchange for a discount in airlines charges, are not sustainable.

Concession revenue sharing contracts certainly allow airports and airlines to internalize the externalities that arise in their vertical relationships. These arrangements, which are the object of our analysis, may increase traffic volumes as well as joint profit. However, there are strategic effects at play that may give rise to undesirable consumer surplus and welfare consequences, hence the opportunity of our contribution.

In the literature, Zhang and Zhang (1997) were the first to introduce this kind of contracts following a traditional approach, that is, without formally modeling the downstream airline market and assuming that an airport's demand is directly a function of an airport's own decisions. Our paper is closely related to several recent studies under the vertical structure approach, where the downstream market is modeled, and airports and airlines are vertically related. Fu and Zhang (2010) focused on the effects of revenue sharing contracts. They found that concession revenue sharing increases welfare, but it can have negative effects on airline competition, due to the fact that it increases the market power of signatory airlines. Their analysis though does not discuss whether an airport prefers equal revenue sharing among all airlines or exclusive revenue sharing. Moreover, Zhang et al. (2010) analyzes how the sharing varies depending on the structure of the downstream market. In a fairly rich analysis, these authors emphasize the relevance of how airlines' services are related to each other in establishing the degree of revenue sharing; they also suggest that airport competition strengthens vertical cooperation but the welfare consequences are ambiguous. Saraswati and Hanaoka (2014) consider several airports and several airlines in a network model. Users value flight duration, schedule delay and connection times, so that airlines sequentially decide on airfares and flight frequencies. The authors propose a three-step game in which airports extract all profit from airlines. Their numerical analysis unveils that an airport will find it profitable to share its commercial revenues with the dominant carrier, and may also share with non-dominant carriers. We extend their analysis by also endogenizing the cooperating parties in the agreement under alternative assumptions while for- mally characterizing the airports' contract choice. Besides, we provide conditions on the per passenger aeronautical charges and the per passenger net revenue from non-aeronautical services that determine an airport's choice between exclusive and non-exclusive revenue sharing contracts. We further discuss the welfare effects of either contract type and examine the effects brought by airport competition and airline alliances.

Our analysis confirms and complements earlier findings in the literature. Thus, we show that indeed the airport is willing to sign a concession revenue sharing contract. Although the airport gives away part of its non-aeronautical revenues, it can positively influence the downstream market by increasing traffic, which also raises revenues. Besides, our research discloses that, whenever per passenger net surplus from commercial services is large enough, the airport prefers to sign a non-exclusive sharing agreement. On the other hand, with relatively small values of per passenger net surplus, the airport prefers to make an exclusive revenue sharing offer to generate a greater impact through a single airline. Our model describes a new important role played by institutions, they can also influence the decision of the airport to opt for a certain type of revenue sharing contract. Then, under the conjecture that vertical contracts may affect competition in the downstream market, institutions can choose an aeronautical charge that induces a shift in the equilibrium airport decision from granting exclusive to non-exclusive sharing contracts, or vice versa. In this way, all airlines are allowed to appropriate the positive externality they help generate, in addition to taking advantage of the benefits for society that this type of contract has. In line with the received literature, concession revenue sharing con- tracts increase traffic and social welfare. However, under certain conditions, there exists a misalignment between passengers prefer and airport interests.

Finally, some of the results can be extended to the case of airport competition. In particular, we find that an airport prefers to use concession revenue sharing contracts given the rival does not, and that non-exclusive concession revenue sharing contracts provide more sharing than exclusive one. Besides, when airline services are rather differentiated, the existence of a competing airport induces an increase in the equilibrium sharing proportions. To end, in case airlines form an alliance, airports typically share more of its commercial revenues to alliance partners as compared to the case with no alliance when the relative (airport vs airline) profit margin is large enough.

The next Section sets out the model and presents the main result. The welfare analysis is the content of Section 3. Section 4 discusses the results and offers two extensions. Finally, the conclusions of the analysis appear in Section 5.

2 The Model

Consider a single airport with two airlines, i and j, operating a given route. Both airlines compete by providing differentiated air services. Passenger preferences are described by the following representative consumer utility function:

$$U(q_i, q_j) = a(q_i + q_j) - \frac{b}{2}\left(q_i^2 + q_j^2\right) - d q_i q_j + y, \quad (1)$$

with $a, b, d > 0$; where q_i and q_j denote the number of passengers served by each airline. Parameter a denotes the maximum willingness to pay for traveling. Parameter d, which is assumed to be smaller than b, measures the degree of substitutability between airline services, so that for a given b a higher d implies less differentiated services, while $d = 0$ corresponds to the case of independent services. After utility maximization subject to the budget constraint (defined as $M = y + p_i q_i + p_j q_j$ with M denoting the representative consumer's income), the following inverse demand system for services is obtained:[1]

$$p_i = a - b q_i - d q_j \quad (2)$$

$$p_j = a - b q_j - d q_i \quad (3)$$

in the region of quantity space where airfares become positive, where p_i is the airfare paid for traveling with airline i, similarly for p_j.

[1] The inverse demand system satisfies the usual properties: (i) downward-sloping demand $\frac{\partial p_i}{\partial q_i} = -b < 0$ (ii) own effects dominate cross effects $\frac{\partial p_i}{\partial q_i}\frac{\partial p_j}{\partial q_j} - \frac{\partial p_i}{\partial q_j}\frac{\partial p_j}{\partial q_i} = b^2 - d^2 > 0$.

There is a vertical relationship between airports and airlines that can be consolidated through an agreement called concession revenue sharing contract (RSC). This kind of contract has been employed before by Fu and Zhang (2010), and contains two variables, (r, f). The sharing proportion, r, displays the effort of airports to capture 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 (a two-part tariff contract) because it is more akin to attain medium/long-term cooperation between airports and airlines, and, as it is well-known, it gets more more traffic and social welfare (Zhang et al., 2010).

Airline i's profit function, π_i, is composed of two terms, the standard operating profits term and profits derived from concessions, in the case that airline i signs an RSC. Operating profits are $(p_i - c - w)q_i$, where w denotes aeronautical charges per passenger paid by airlines to airports and c is the marginal cost per passenger. On the other hand, passengers spend money on non-aeronautical services at the airport, which generates additional revenue, denoted by hQ, where h is the per passenger net revenues generated and $Q = q_i + q_j$. Concession profits are, precisely given by $hQr_i - f_i$, where r_i is the proportion (sharing proportion) of concession revenues that goes to airline i, with $r_i \geq 0$, and f_i is the fixed payment made by the airline to the airport in exchange.

Myopic passengers have been considered. The literature distinguishes two alternative ways to integrate terminal shopping into the air ticket purchasing decision. Passengers are myopic when both decisions are independent. There is a justification of myopic behavior when there is a separation between the time of purchase and the time of side services consumption (Zhang and Zhang, 2003). Our analysis would apply to airports and routes with a majority of occasional travelers that consider both consumption types as independent. Knowledgeably, for frequent-travelers, buying a ticket is not independent of the number of commercial services at the airport (like car rentals), and this would justify the consideration of foresighted passengers. See

Czerny (2006), Czerny (2013), and Flores-Fillol et al. (2018) for treatments on this assumption. The model could be adapted to partially incorporate an interaction between the two types of consumption by assuming that the maximum willingness to pay for traveling increases with the variety of commercial services available at the airport. Since we understand that our paper is among the first to explore the endogenous choice of exclusive sharing and their implications, we offer some prelim- inary intuitions of what we might expect with myopic passengers.

Finally, the airport also has two sources of revenue. It obtains wQ from aero- nautical activities; whereas, non-aeronautical activities yield the airport concession revenues from commercial activities equal to hQ in case no concession is given to airlines.[2] The airport may decide to share concession revenues either with one air- line (the exclusive sharing case) or with both (the non-exclusive sharing) or none of them (the no-sharing case). If the airport opts for exclusive sharing to airline i the airport keeps $(1 - r_i)hQ$ of concession revenues, and receives f_i. However, if the revenue sharing is non-exclusive, the airport keeps $(1 - r_i - r_j)hQ$, receiving the fixed payment from each airline, $f_i + f_j$. Finally, τ is the marginal aeronautical cost, while fixed costs are normalized to zero. Therefore, the airport profits denoted by Y, are equal to $(w - \tau)Q + (1 - r_i)hQ + f_i$, when airline i obtains exclusive concession revenue sharing; and $(w - \tau)Q + (1 - r_i - r_j)hQ + f_i + f_j$ in the case of non-exclusive concession revenue sharing. The next expressions show airport's profits of every case:

$$Y^0 = (w - \tau + h)Q^0, \quad (4)$$

$$Y^{ne} = (w - \tau)Q^{ne} + (1 - r^{ne}_i - r^{ne}_j)hQ^{ne} + f^{ne}_i + f^{ne}_j, \quad (5)$$

$$Y^{ex} = (w - \tau)Q^{ex} + (1 - r^{ex})hQ^{ex} + f^{ex}_i. \quad (6)$$

Where superscript 0 denotes the no-sharing case, ne the non-exclusive case, and ex

[2] This simple representation where net concession revenue is strictly complementary to passen- ger volume has been used by Zhang et al. (2010), Fu and Zhang (2010), and Yang et al. (2015) among others. Besides, IATA makes a strong point on such complementarity when asking for a share of the airport commercial profits derived from their passengers.

the exclusive case.

The per passenger aeronautical charge, w, is assumed to be set by a regulatory body, that is, it is exogenous and the same for both airlines. Another approach would have been to consider that the aeronautical charge is endogenously set by the airport. However, we consider the exogenous w approach since it is interesting to understand the managerial opportunities airports have by using concession revenue sharing contracts when they lack control over airport charges, precisely because the choice of the type of RSC is the main focus of the paper. In any case, our analysis will present in detail how different levels of charges determine this choice. In particular, we will provide the relationship between aeronautical charges, w, and commercial net revenue, h, that is shaping our main result.

On the other hand, the International Air Transport Association (IATA) prohibits to price discriminate on aviation services, so the aeronautical charge must be the same. There are two principles regarding the setting of w. Under the single till approach, all airport activities (including aeronautical and commercial) are taken into consideration when the airport regulators decide on the level of aeronautical charges. This contrasts with the dual till approach, where only aeronautical activities are considered. Single till seems to be more efficient since it allows the joint consideration of both complementary activities. Dual till performs better in the presence of congestion (see Lu and Pagliari (2004); Czerny (2006); Yang and Zhang (2011) and Kidokoro et al. (2016)). On top of that the IATA strongly supports the single till approach. With respect to the model solved, dual till will be more restrictive in the sense that the per passenger aeronautical charges should not be lower than the marginal aeronautical costs, i.e. $w \geq \tau$, while single till would entail $h + w \geq \tau$. Please refer to Zhang and Czerny (2012) for a discussion on relevant literature on airport regulation.

Agents make decisions in two stages. In the first stage, for any given per passenger aeronautical charge, the airport announces whether it offers the contract to one or both airlines or none and decides on the terms of the concession revenue sharing contract(s), accordingly. Airlines have the option to accept or reject the contract. In the second stage, airlines compete for the number of passengers served, given the terms of the contract or contracts accepted in the first stage. To solve the model the subgame perfect Nash equilibrium is obtained.

2.1 Second stage: airline competition

There are three qualitatively different subgames that can be reached at the second stage depending on the concession revenue sharing decision taken by the airport in the first stage. The first one, the no-sharing case, corresponds to the case where the airport does not offer a concession revenue sharing contract. The second one, the non-exclusive sharing case, is the case where both airlines are offered a non-discriminatory concession revenue sharing contract. Finally, the third subgame corresponds to the case where only one airline, say airline i, is offered a concession revenue sharing contract, while the other, say airline j, the non-signatory airline is not. This subgame is the exclusive sharing case.

The no-sharing case

Airline i (respectively, j) chooses q_i (q_j) to maximize its profits[3] defined by $\pi_i = (p_i - c - w) q_i$ ($\pi_j = (p_j - c - w) q_j$). The equilibrium quantities, q_i^0 and q_j^0, are the solution of the following system of two first order conditions, i.e. $\frac{\partial \pi_i}{\partial q_i} = 0$, $\frac{\partial \pi_j}{\partial q_j} = 0$ and are equal to:[4]

$$q_i^0 = q_j^0 = q^0 = \frac{a - c - w}{2b + d}, \quad Q^0 = 2q^0. \tag{7}$$

In order to ensure a positive equilibrium output, it is assumed that $w < a - c$.

[3] Empirical evidence from Brander and Zhang (1990, 1993) states that the model which best fits with airline market competition is Cournot; moreover, it is widely used in the literature.

[4] Both the second-order conditions for a maximum ($\frac{\partial^2 \pi_i}{\partial q_i^2} = \frac{\partial^2 \pi_j}{\partial q_j^2} = -2b < 0$) and the stability conditions ($\frac{\partial^2 \pi_i}{\partial q_i^2}\frac{\partial^2 \pi_j}{\partial q_j^2} - \frac{\partial^2 \pi_i}{\partial q_i \partial q_j}\frac{\partial^2 \pi_j}{\partial q_j \partial q_i} = 4b^2 - d^2 > 0$) are satisfied. Also, there is strategic substitution between services ($\frac{\partial^2 \pi_i}{\partial q_i \partial q_j} = -d < 0$).

Plugging the above expressions into the corresponding inverse demand functions in (2) yields the following equilibrium airfares and profits,

ab+(+)(c+)

2b+12.d

p0=0=0bdw= ;π0=π0=π0=b(q0)21p2p (8)

The non-exclusive sharing case

In this subgame, the airport and each airline have agreed on the RSCs defined by
{rne,fne}and{rne,fneiijj},whichimplythefollowingairlineprofits,

π=(pcw)q+rneneii

−−ihQi−fi, (9)

π=(pcw)q+rnenejj

−−jhQj−fj. (10)

We denote by Πi and Πj the corresponding airline profit gross of fixed payments. Similarly as above, the equilibrium quantities are the solution to the system of the two first order conditions that follows,

∂πi ∂pi
=pcw+q+nei
−−ihr=0(11)∂q∂qi,ii
∂πj ∂pj
=pcw+q+nej
−−jhr=0(12)∂q∂qj.jj

With respect to the no-sharing case, there is a new and positive term in (11) and (12) which is proportional to the sharing proportion. This new term will imply an outward shift in the reaction function of each airline, leading to an equilibrium with more traffic and lower airfares at equilibrium provided that rne nei ,rj ≥ 0. The equilibrium quantities, prices, aggregate quantity, and profits are respectively,

(2br ne −drnehnenene0ij)q 4b2 −d2 i(ri,rj)=q+ , (13)

(2br ne −drnehnenene0ji)q 4b2 −d2 j(ri,rj)=q+ , (14)

((2b2 −d2)rnebdrnehnenene0 −i+j))pi(ri,rj)=p,(15)4b2 −d2

((2b2 −d2)rnebdrnehnenene0 −j+i))pj(ri,rj)=p(16)4b2 −d2

h(rne rne nenene 0 i+j) 2b+d Q(ri,rj)=Q+ , (17)

πnenenenenene2nenenei(ri,rj)=Πifi=b(qi)+hriqjfi,(18)

πnenenenenene2nenenej(ri,rj)=Πjfj=b(qj)+hrjqifj.(19)

The exclusive sharing case

In this subgame, only the signatory airline i receives concession revenues according to the terms of the RSC, {rex,fexii}.Airlineprofitsare,

πi = (pi −c−w)q+hQrex−fexiii,(20)

πj = (pj −c−w)qj. (21)

Note that the asymmetry in profits carries over to the first order conditions implying that the reaction function of the signatory airline shifts outwards provided that rexi ≥ 0, while that of the non-signatory one does not. Since quantities are behaving as strategic substitutes, this shift leads to both an increase in the equilibrium quantity of the signatory airline and a reduction in the equilibrium quantity of the non-signatory one. Solving the two first-order conditions we obtain the equilibrium quantities, prices, aggregate quantities, and profits as follows,

2bhr ex

4b2

−d 2

qex(rexq0iii)=+, (22)

hrex

qex(rex q0

−diji)=,(23)4b2

−d 2

(2b2 d2)hrex

pex(rex) = p0

−−iii,(24)4b2

−d 2

hrex

pex(rex p0

−bdiji)=,(25)4b2

−d 2

rex

2b+d

Qex(rex)=Q0hii+,(26)

πex(rex)=Πexiii

−fex=b(qex)2+exex−exiihriqjfi,(27)

πex(rex)=Πex=(qex)2jijbj.(28)

In order to ensure positive equilibrium outputs for the non-signatory airline and then to keep the same market structure downstream, it is assumed that the sharing proportion,rexi,isboundedfromabove.Inparticular,itisassumedthroughoutthe paperthatrexi=(4b2−d2)q0i.

Proposition 1 Traffic increases with concession revenues, while airfares decrease,

∂Qne ne ex ∂pne ∂pne ∂pne ∂pne ∂pex

bhdjis, ∂Q=∂Q>0,i+j<0,i=j<0andinenee xnenenenee ex<0,

j ∂ri ∂ri ∂ri ∂rj ∂rj ∂ri ∂ri

∂pex

j

∂r ex < 0. Finally, exclusive sharing creates a competitive advantage for the signatory airline that entails a reduction in profits of the non-signatory one as compared totheno-sharingcase,sinceqex 0j<q.

The above proposition shows the way the airport can attract passengers by using the sharing proportion. Furthermore, it highlights the strategic effect on the non-signatory airline in case the airport employs an exclusive concession revenue contract, which can be exploited by the airport when setting the terms of the contract. The intuitions displayed in Proposition 1 have been put forward by earlier research, for instance in Fu and Zhang (2010) and Zhang et al. (2010). We show it for the linear case and summarize the result for the sake of the exposition.

These results suggest that airports have an incentive to share concession revenues with airlines, since they increase traffic as shown in (17) and (26).

2.2 First Stage: the revenue sharing contract

In the first stage, the airport decides on the terms of the concession revenue sharing contract, that is $\{f, r\}$, and announces whether it offers two contracts, one or none. In general, by announcing k contracts, the airport commits to sign the contract to at most k airlines; any signatory airline pays the fixed payment f and gets the corresponding share r of concession revenues. The equilibrium terms of the contract $\{f, r\}$ are therefore a function of k. In case that more than k airlines are willing to pay f, k of them are chosen at random. Having observed the number of contracts offered and the terms of the contract, airlines unilaterally and independently accept or reject the deal. This implies that all the bargaining power is assigned to the airport, as it makes a take-it-or-leave-it offer to the candidate airline(s). This assumption allows us to better focus on the airport's point of view as it plays a central role in granting concession RSCs. It is true that airlines may have some bargaining power to negotiate the terms of the contract with the airport. However, it is limited when there are several candidates to be signatory airline(s) and, in any case, it is much lower than that of the airport.

2.2.1 The fixed payment in the concession revenue sharing contract

To compute the terms of the contract(s), the airport chooses the corresponding sharing proportion(s) that maximizes its profits subject to the corresponding participation constraint(s) for the signatory airline(s). 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(s) indifferent between accepting or rejecting the contract; next, each fixed payment is plugged into the airport profits and finally, airport's profits are maximized with respect to the sharing proportion(s).

The computation of the outside option, that is what a signatory airline gets in case of rejection, is different for the cases k < n and k = n, for n the number of airlines. The difference is that, for k < n, by unilaterally refusing the airport's offer the airline ends up being a non-signatory airline competing with k signatory ones, since the airport committed to sign the contract with k airlines. However, when k = n, by unilaterally refusing the airport's offer the number of signatory airlines decreases by one, since each airline is guaranteed to have a contract, so an airline can reduce the number of signatories from n to (n − 1) by choosing not to accept the contract.

When the airport offers (k,r,f) for k < n, in equilibrium at least k + 1 firms decide to have a contract and k of them are chosen at random. This is our exclusive case. The equilibrium fixed payment f(k) is equal to the difference in gross profits between being one of the k signatory airlines and being a non-signatory airline, given k signatory airlines.[5] Suppose k = 1 and that airline i is the signatory airline. Then, the fixed payment is given by,

fex(rex) = Πex(rex) −exrexbqex2−qex2rexhqexiiiiΠj(i)=((i)(j))+ij.(29)

For the non-exclusive case we have that k = 2, that is k = n. Then, the f(k = n) is now equal to the difference in gross profits between being one of the n signatory airlines and being a non-signatory airline given (n − 1) signatory airlines. If airline irejects,giventheotherairlineaccepts,itwouldobtainπnebqne,rne2i0=i0(0j),where ne qne(0,rne)=q0i0j −rjdh,andthesub-index"i0"denotesairlineirefusingthenon-(4b2−d2) exclusive contract while airline j accepting it. (πnej0 is defined similarly). The fixed

[5] Just note that this is a convenient simplification to focus on the airport incentives to choose the type of contract. In general, the fixed payment would be obtained as the solution of a Nash-Bargaining problem as follows: f(α) = α(π⋆ −π−−α⋆0)(1)(Y−Y0),whereα∈[0,1]isthe airport'sbargainingpower.Notethatπ⋆ ⋆ i and Y denote the airline's and airport profits in case of agreement and π0 and Y0 denote the airline's and airport's disagreement profits (outside options), respectively. The fixed fee is increasing in α and, in the limit case we are studying, corresponds to the airline's opportunity costs of signing the contract (i.e. the participation constraint). In case all the bargaining power were allocated to the airline, f turns out to be negative, meaning that the airport is paying the fee to the airline, which is so far not observed in the data.

payments for airline i and j are therefore given by,

$$f_i^{ne}(r_i^{ne}, r_j^{ne}) = \Pi_i(r_i, r_j) - \pi_i^0 = b((q_i^{ne})^2 - (q_0^{ne})^2) + r_i^{ne} h q_j^{ne}, \quad (30)$$

$$f_j^{ne}(r_i^{ne}, r_j^{ne}) = \Pi_j(r_i, r_j) - \pi_j^0 = b((q_j^{ne})^2 - (q_0^{ne})^2) + r_j^{ne} h q_i^{ne}. \quad (31)$$

2.2.2 Sharing proportion

The sharing proportions for the non-exclusive and exclusive cases are presented in this subsection.

The non-exclusive sharing case

Consider first the case when the airport announces non-exclusive contracts. After plugging the fixed payments $f_i^{ne}(r_i^{ne}, r_j^{ne})$ and $f_j^{ne}(r_i^{ne}, r_j^{ne})$ defined above into the airport profit expression in (5), the equilibrium sharing proportions are, therefore, obtained by solving the following system of first-order conditions: $\frac{\partial Y^{ne}}{\partial r_i^{ne}} = 0$, $\frac{\partial Y^{ne}}{\partial r_j^{ne}} = 0$. Since both airlines are symmetric and making use of (7) above, the symmetric equilibrium sharing proportion reads as follows,[6]

$$r^{ne} = r_i^{ne} = r_j^{ne} = \frac{b^2(4-d^2)((2b-d)(h+w-\tau)+d^2 q_0)}{2(4b^3 - 2bd^2 + d^3)h}, \quad (32)$$

which is positive since both numerator and denominator are positive and it implies that both fixed payments are equal, $f^{ne} = f_i^{ne} = f_j^{ne}$.

The exclusive sharing case

In this case, the airport chooses the sharing proportion that will maximize airport profits shown in (6) once the fixed payment in (29) has been plugged. Then, by solving the derivative of (6) with respect to r^{ex} equal to zero we obtain,

$$r^{ex} = \frac{(2b-d)(h+w-\tau)+d(2b+d)q_0}{2bh}. \quad (33)$$

The equilibrium sharing proportion in expression (33) is positive. Furthermore, notice that both equilibrium sharing proportions must be smaller than $\bar{r}$ in order to

6 Note that second order conditions are satisfied.

ensure the duopoly structure downstream. This is equivalent to $h < \bar{h}$, that is, the net revenue generated by travelers cannot exceed a given threshold.[7]

Ranking of sharing proportions

The airport shares a large proportion of concession revenues to a single firm in the exclusive case. However, the total sharing in the non-exclusive sharing is larger than the exclusive one if the net concession revenue per passenger is large enough, $h > h_r$.[8]

Furthermore, there is an inverse relation between the equilibrium sharing proportions and the net concession revenue per passenger. The effect can also be easily seen in (32) and (33). For instance, if an increase in h is considered, the same total concession revenues, rhQ, can be reached by reducing the sharing proportion, and vice versa. That is why there is an inverse relation between r and h and in this sense both are substitutes.

2.2.3 Airport'scontractchoice

Once the terms of the concession revenue sharing contracts are defined, the airport decides the profit maximizing type of contract that it is going to offer. The analysis focuses on the case of the interior solutions where $h < \bar{h}$. First note that the no-sharing case is giving the airport the following profits $Y_0 = (w - \tau + h)Q_0$, which correspond to the opportunity cost of entering into agreements with airlines to share concession revenues. For the sake of the presentation, we first consider the decision about the type of contract and then whether the airport always signs concession revenue sharing contracts. This first result is based ~~on the comparison~~ of Y_{ne} with Y_{ex} and makes use of h^*, which is the largest h that satisfies $Y_{ne}(h) = Y_{ex}(h)$, once the equilibrium terms of the contract have $h < \bar{h}$ veensubstitutedinexpressions(5)(3−23)2−23−23 ≡ d(2b+d)4b4bd+d+2bd2b(4bd)(4b2bd+d)and(6).Inparticular,hq0−3−3−(w−τ).(2bd)(4bd) h^*

[7] Note that, to satisfy max $\{r_{ex}, r_{ne}\} < 1$ we have $h < \bar{h} \equiv (2b+d)(4b^2-2bd-d^2)$ ~~0d(2b−d)q−(w−τ)~~.

[8] The expression of this threshold on h_r is derived in the Proof of Proposition 2 included in the Appendix.

The next Proposition is our main result and presents under which conditions a non-exclusive contract is chosen.

Proposition 2 The airport's choice of either an exclusive or a non-exclusive concession revenue sharing contract depends on the size of per passenger net revenue, h, and the degree of substitutability, d/b, as follows:

a) When $0 < \frac{d}{b} < 0.9575$, it happens that $h^* < \bar{h}$. Therefore, the airport chooses a non-exclusive contract when $h^* < h < \bar{h}$, and an exclusive one otherwise.

b) When airline services are rather similar, $0.9575 < \frac{d}{b} < 1$, then $\bar{h} < h^*$ and the airport only offers an exclusive contract for all h.

A sufficient condition for the airport to only offer an exclusive contract for all $\frac{d}{b}$ is that $\bar{h} < h_r < h^*$.

The degree of substitutability measures the intensity of airline competition. When airline services are sufficiently differentiated as in case a) of the proposition, the per passenger net revenue determines the type of contract chosen by the airport. A large enough h is associated to non-exclusive contracts choices. To see the intuition note that airport profits is the sum of profits generated by passengers, $(h + w - \tau)Q$, and those coming from airlines due to the use of RSCs, which are equal to $f - h_r Q$ per airline. As shown in the Appendix, the exclusive contracts have an advantage upon the non-exclusive in this second source of profits. The reason is that the airport is taking advantage of the threat of awarding the contract to the rival airline to obtain a large fixed payment from the signatory airline. Therefore, the only option for non-exclusive contracts to arise at equilibrium is that they attract more passengers. This occurs for a sufficiently large h. In particular for $h > h_r$, it happens that $Q^{ne} > Q^{ex}$. However, to offset the advantage of exclusive contracts in extracting profits from airlines, a larger per passenger net revenue is required, that is, $h > h^*$. Since h^* is increasing in d/b the exclusive contract is chosen for a larger interval of h as competition downstream increases when airline services become more similar. Finally, when competition is strong enough, i.e. case b), the contract offered at equilibrium is always an exclusive contract. In this case the per passenger net surplus required to compensate for profits coming from airlines is too large since strong competition increases the premium of becoming the signatory airline.

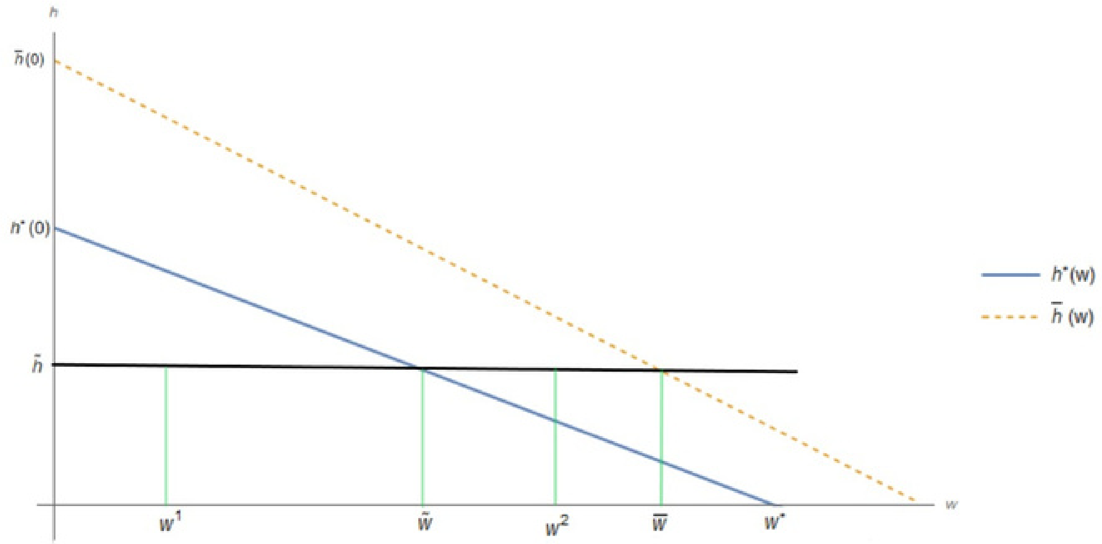
There remains to check whether the no-sharing case is an option that arises in equilibrium. To do so, we only need that one of the two concession RSCs dominates no sharing. Consider the non-exclusive case, the sign of the difference in airport profits between the non-exclusive and the no sharing cases is the result of three terms, a positive one that incorporates the difference in aeronautical profits, which is positive for a positive r^{ne}, i.e. $(w - \tau)(Q^{ne} - Q^0) > 0$. A second negative term that measures the difference in non-aeronautical revenues, in particular $(1 - 2r^{ne})hQ^{ne} - hQ^0 < 0$. The third term is the payments the airport receives for the concession revenue contract which is obviously positive. In the Appendix it is shown that the positive terms dominates the other, then no sharing is never an airport's equilibrium choice as indicated in the next Proposition.

Proposition 3 The airport always shares its non-aeronautical revenues with airlines.

It is therefore proved that the airport is better off by giving up a portion of its non-aeronautical revenues to attract more passengers and rents from airlines through CRS contracts. This is not a surprising result. Spengler (1950) first noted the inefficiency created by the double marginalization effect of a linear contract between an upstream and a downstream firm. The vertical externality and the effect of hQ can be internalized with the right choice of the two-part tariff contract offered. Besides, this is advantageous to the airport. Later, Vickers (1985) considered the strategic effects of delegation showing that delegation, viewed as incentive to increase output, aligns the upstream and downstream firms' profits. This natural logic was suggested by Fu and Zhang (2010) in the air transport industry, which is here confirmed when an airport faces the choice between an exclusive and a non-exclusive concession RSC.

Proposition 2 reveals the airport equilibrium strategy in terms of concession revenue and it is obtained for any given per passenger aeronautical revenue, w. In

Figure 1: Implications of changes in w



some sense it is assumed that this parameter is set by a regulatory authority with a given objective. It is out of the scope of this paper to set w but it is important to highlight that under particular values of the parameters in the model, a change in w will imply a change in the airport strategy about concession sharing.

Result 1 For any $h \in (0, h^\star(0)]$ a sufficiently large increase in w will imply a change in the type of concession revenue contract offered by the airport from exclusive to non-exclusive.

This is only possible for case a) in Proposition 2 when $\bar{h} > h^\star$ and there is the option to choose between exclusive and non-exclusive. Thus, for example, in Figure 1 and for a given value of h represented by the horizontal line, $\tilde{h}$, with $\tilde{h} < h^\star(0)$, different values of w will lead to different choices by the airport in terms of concession revenues proportions and type of contract. That is, any $w \in (0, \tilde{w}]$ implies an exclusive contract choice, while for $w \in (\tilde{w}, \bar{w}]$ the choice is the non exclusive contract. Therefore, if institutions change w from w1 to w2, they are affecting the airport equilibrium choice from the exclusive to the non-exclusive contract. This example illustrates the implication of Result 1. Institutions by modifying w are not only affecting airport aeronautical revenues, but also affecting the way airports and airlines share non-aeronautical revenues, which in turn modifies traffic levels and airfares.

3 Welfare analysis

In this section we analyze the welfare effects of exclusive and non-exclusive sharing agreements to identify a potential misalignment between the private interests and the social ones, either in terms of consumer surplus or social welfare standards. Consumer surplus (CS) is defined as the representative consumer utility function minus the expenditure in the purchase of airline services:[9]

$$CS(q_i,q_j) = U(q_i,q_j) - p_i q_i - p_j q_j = a(q_i+q_j) - \frac{b}{2}q_i^2 - \frac{b}{2}q_j^2 - d q_i q_j - p_i q_i - p_j q_j. \quad (34)$$

Social welfare (SW) is defined as the sum of CS plus profits of all firms in the market.

$$SW(q_i,q_j) = CS(q_i,q_j)+\pi_i(q_i,q_j)+\pi_j(q_i,q_j)+Y(q_i,q_j) = (a+h-c-\tau)(q_i+q_j) - \frac{b}{2}q_i^2 - \frac{b}{2}q_j^2 - d q_i q_j. \quad (35)$$

Note that (35) is increasing in q_i as long as $a+h-c-\tau-bq_i-dq_j>0$ and $i \neq j$, or equivalently, for $p_i + h - c - \tau > 0$, which is always true. Similarly (35) is increasing in q_j. Given that, and for symmetric equilibrium outputs, the case that yields the largest output is the one that implies a larger welfare level. Substituting in (35) above for $q_i=q_j=q^0$ and for $q_i=q_j=q^{ne}$, and after some algebra we obtain SW^0 and SW^{ne}, respectively. Similarly, by substituting for $q_i=q_i^{ex}$ and $q_j=q_j^{ex}$ and

[9] Consumer Surplus only considers aeronautical activities, so any effects derived from shopping at the airport are not taken into account. This approach of normalizing consumer surplus of concession revenues to zero is applied by Zhang et al. (2010). See also Czerny (2013) and Flores-Fillol et al. (2018) for a complete analysis.

notingthatQex=qexqex exi+j,weobtainSW.

SW0 = (2(a+h −c−τ)−(b+d)q0)q0, (36)

SWne = (2(a+h − −c−τ)−(b+d)qne)qne, (37)

b

SWex = (a+h −c−τ)Qex−(Qex)2+(b−d)qexexiqj.(38)2

Focusing now on CS, using expression (3 −)

(4)andnotingthatpi=a−bqi−dqj,andp−−122j=abqjdqi,thenCS(qi,qj)=bq++2iqjdqiqj.Aftersubstitutiono)

CS0=(b+d)(q0)2, (39)

CSne = (b+ −

(d)(qne)2, (40)CSex1=b(qex2ex2exexi)+(qj)+dq (41)2 iqj.

Our first result confirms that RSCs are beneficial to the agents in the market.

Proposition 4 The signing of concession revenue sharing contracts, either exclusive or non exclusive implies greater CS than no sharing. Besides, either exclusive or non-exclusive sharing contracts imply greater SW than no sharing.

The proof of the superiority of concession RSCs upon no-sharing both in terrns of SW and CS lies on the increase in traffic induced by such type of contracts. As it happens with the choice made by the airport, the type of concession RSC that generates the largest SW and CS depends on the size of per passenger net revenue. Propositions 5 and 6 specify the corresponding upper thresholds on h that determine the superiority of exclusive upon non-exclusive contracts regarding SW and CS, respectively.[10]

Proposition 5 The greatest social welfare is achieved when the airport signs exclusive concession revenue sharing contracts with airlines as long as $0 < h < h_w < \bar{h}^-$. Social welfare with non-exclusive contracts is greater when $h_w < h < \bar{h}^-$.

[10] The expressions for h_w and h are in the Appendix.

This identifies a possible conflict between the airport interests and competition authorities following a SW standard. Since hw < h ⋆, there are situations where the airport will choose exclusive sharing, h < h ⋆ (see Proposition 2), while it is non-exclusive sharing the scenario that attains a greater SW level, hw < h.

Finally, the effects of concession revenue sharing contracts on CS are the content of the following result,

Proposition 6 If the per passenger net revenue from commercial services is small enough, that is for h < h+, the greatest consumer surplus is achieved when the airport signs exclusive sharing contracts with airlines; being achieved with non-exclusive contracts otherwise,

The above result is driven by the traffic increases derived by each type of contract noticing that low h supposes higher traffic levels with exclusive contracts. To conclude, note that this result reveals a potential misalignment between what consumers prefer and what is chosen by the airport when h is between h+ and h ⋆ sufficiently. In particular, the airport will select an exclusive sharing contract while consumers are better off with non-exclusive sharing.

4 Discussionandextensions

At an airport, we find two products each related to a different business, the aeronautical and the non-aeronautical activities. The former, associated to the provision of an essential input to airlines, yields revenues where charges are regulated. The latter gathers the demand complementarities between traveling and side services consumption. A concession revenue sharing contract gives the airport the opportunity to control for such complementarities as a substitute managerial tool for the lack of control on airport charges. The vertical relationship between an airport and an airline generates an inefficient outcome and the contract pair (r, f) corrects for such an inefficiency. The variable part of the contract, r, increases the airline's marginal revenue and so output goes up. The fixed payment f transfers profit from the airline to the airport. This argument is well established in the literature (Spengler (1950), Tirole (1988)) and was suggested by Fu and Zhang (2010) in the air transport industry. With several airlines offering services in the same origin-destination trip, additional effects arise. The airport continues to have the contract terms in hand but can control for the intensity of competition and, consequently, profit depending on his choice of either exclusive or non-exclusive sharing. Consider that the airport offers the contract to just one of the airlines. This creates an asymmetry between the airlines that makes the signatory airline to enjoy a competitive advantage similar to what we observe in the delegation literature where the owner of a firm uses a manager to behave as an aggressive seller (Vickers (1985), Fershtman and Judd (1987)). The non-signatory airline is disadvantaged and then the airport can charge a higher fixed payment for the concession by exploiting the threat of awarding the contract to the rival of the potential signatory airline. Symmetry downstream is restored if instead the airport offers equal revenue sharing to both airlines. These are the effects collected in Proposition 1. Whether exclusive or non-exclusive revenue sharing is in place, total traffic goes up. The airport must weigh which scenario leads to higher output and higher payments. Proposition 2 above, our main result, discloses that, typically, for a high enough per passenger net revenue coming from commercial services, the airport prefers to make non-exclusive contracts. The airport chooses exclusive contracts regardless of the size of those per passenger net revenues when airline services are very similar. Consider an airport like the Hong Kong International Airport, where more than 70 % of its revenue comes from concessions. The choice of non-exclusive sharing allows the airport to create a positive impact on all airlines,11 and this is precisely the correct managerial decision since the non-aeronautical business are very profitable in relative terms as compared to aeronautical business. On the other hand, with low per passenger net surplus from commercial services, the effect on traffic is important but secondary and tilts the decision on exclusive sharing; think of regional airports with less potential traffic,

[11] Note that non-exclusive sharing is more effective increasing the number of passengers than exclusive sharing when the per passenger net revenue coming from commercial services is large enough.

and little commercial activity. It is more profitable to the airport to discriminate among airlines, that is, to offer exclusive contracts since the competitive advantage given to the signatory airline is allowing the airport to extract more profits from the signatory airline, in other words, the airport exploits the competition between the two airlines to become the signatory one.

Proposition 3 is not surprising and already found in the literature. Our analysis confirms we that no sharing is always dominated by a certain type of sharing when there is airline competition and, as will become clear in the extensions below, it is also true for the case of airport competition. Despite all the complex strategic issues and externalities arising when there is competition upstream (airport level) and downstream (airline level), the positive effect of concession sharing on reducing the vertical externality in each airport dominates. Abounding on the effects of concession revenue sharing, Proposition 4 provides a welfare analysis that confirms the positive effect of concession RSCs, both at CS and SW metrics. Passengers are better off since sharing implies more traffic and lower prices and the industry is also better off as the sharing reduces negative externalities. Propositions 5 and 6 present the relative social benefits of each type of sharing contract considering the two standards usually followed by antitrust authorities. We find that depending on the standard used one type of sharing dominates the other. In the case of a CS standard, exclusive sharing is more beneficial to passengers than non-exclusive sharing since it implies price dispersion, which is highly valued by passengers, while for the SW standard, it is non-exclusive sharing the one that reaches a higher level of welfare. Regardless of the standard used, a conflict of interest arises since the choice made by the airport is not always the one accepted by an antitrust authority.

Airport competition

Our results have been obtained in a fairly simple setting to clearly emphasize the effects at play when an airport decides on the nature of concession revenue sharing contracts with airlines. One wonders whether our findings are robust to the consider- ation of airport competition. Assume then that there are two airports that compete for passengers in a given catchment area. There are also two airlines, and both offer services at the two airports. When alone, an airport weighs which scenario, whether an exclusive or a non-exclusive contract, yields higher traffic and higher payments, as explained above, despite it being a costly decision as it shares non-aeronautical revenues by using these contracts. However, in the presence of airport competition, an airport must take into account that the choice of a particular contract (and the terms of payment) has implications on the intensity of competition. This becomes relevant since, in addition to how passengers differently value the services provided by each airline, we now have that each airline's services at different airports is also perceived as a differentiated product in the eyes of passengers.

Accordingly, we have considered a model with two airports and two airlines in which there is product differentiation among four different flights departing from the same catchment area (and with the same destination). The game would unfold as follows. In the first stage, the airports decide simultaneously and independently whether not to share non-aeronautical revenues or announce an exclusive contract or a non-exclusive contract along with the terms of payment associated to each choice and each airline has the option to unilaterally accept the offer(s). In the second stage, and knowing the outcome of the first stage, airlines simultaneously and independently compete in quantities.12

The intuitions presented above regarding the effect of the sharing proportions in increasing traffic and reducing airfares remain valid (Proposition 1). Thus, provided that one of the airports does not share its revenues, the other airport makes more profit by sharing. This means that there is a unilateral incentive to employ concession revenue sharing contracts; they allow an airport to achieve a strategic advantage over the competing airport as the sharing proportion allows it to gain passenger market share at the expense of the rival. Then, Proposition 3 is robust to the introduction of airport competition. The result that airport shares a large proportion of concession revenues to a single airline in the exclusive case and that

[12] Computations available from the author upon request.

non-exclusive sharing gives more commercial revenues to airlines than exclusive shar- ing also hold. There is yet a further result: the existence of a competing airport leads to an increase in the sharing proportions when airline services are sufficiently differentiated. This latter result is instructive to illustrate the two conflicting effects that arise when airports decide on the type of contract. On the one hand, there is the traffic expansion effect that occurs with the sharing proportions, as already noted. On the other, another airport offering services introduces a competition effect which works in the opposite direction lowering the profits of airlines and, consequently, the size of the fixed payments. In fact, once the rival airport engages in revenue shar- ing too, an airport responds by lowering its sharing proportion. Thus, one would expect the former effect to dominate the latter and find non-exclusive contracts in equilibrium when product differentiation is weak and per passenger net revenue is large enough, as suggested in Proposition 2.

Airline alliance

Another interesting extension is to study what happens when airlines form an al- liance. Consider then a single airport, as in the main model, and assume that airlines maximize own profit plus a fraction of the other airline profit. Thus, in the second stage of the game, airlines maximize a combination of both airline profits where that fraction measures the degree of cooperation of the alliance or the level of involvement of each firm with the interests of the other, as done by Zhang and Zhang (2006). Individual profit maximization, that is, no alliance, corresponds with a fraction equal to zero whereas full joint profit maximization occurs for a fraction equal to unity. In the first stage, the airport chooses whether to share commercial revenues or not and, in the latter case, the sharing proportion and the fixed payment as in the model developed in the main text. The research question here is to what extent the fact that airlines cooperate can counter the leading position of the airport and possibly get better terms of payment by joining interests.13

Two important remarks are worth making. Firstly, under no sharing, the equilib-

[13] Computations available from the author upon request.

rium number of passengers is decreasing in the degree of cooperation, which follows from the internalization of competition by alliance partners. Secondly, under revenue sharing, the equilibrium number of passengers increases in the sharing proportions when the degree of cooperation is large enough, which reflects that the interests of the airport and the alliance partners are aligned under this condition. Compared with the case of no airline alliance, the airport typically shares less of its commercial revenues when there is an alliance. This is the response by the airport to the in- creased power downstream. Finally, the airport finds it optimal to sign a concession revenue sharing contract when the airport profit margin is relatively larger than the airlines profit margin, thus qualifying the statement in Proposition 2 as not only the size of per passenger net revenue matters for the decision to revenue sharing.

5 Conclusions

Airlines bring in passengers who use airport commercial facilities. The airport commercial market has been boosted due to the traffic increase and passengers' behavior to a US$60bn market annually. This fact has intensified the mutually beneficial airport-airline relationship as it is reasonable that airlines should also profit from the economic benefits of airport commercial activities through concession revenue sharing contracts. Examples can be found where airports share concession revenues with just one airline or all airlines; that is, airports may grant an exclusive agreement or establish non-exclusive agreements. Our paper studies the effects of concession revenue sharing contracts by endogenizing the choice of the signatory airline. With regard to managerial implications, it is shown that an airport finds it profitable to share concession revenues with airlines and that it prefers an exclusive agreement when the net revenue per passenger from airport non-aeronautical services is rather low; it extracts higher payments by exploiting the competition between airlines to become the sole signatory. Alternatively, the choice of non-exclusive concession rev- enue sharing contracts allows the airport to create a positive impact on all airlines, which is the correct managerial decision when the non-aeronautical business are very profitable in relative terms as compared to aeronautical business.

The choice of either exclusive or non exclusive agreements has a welfare impact and hence some policy implications can be obtained. First note that concession revenue sharing contracts increase welfare and passenger surplus as compared to no sharing, therefore, airports, airlines and passengers are better off. However, a conflict of interest may arise since the choice made by the airport is not always the one preferred by passengers. For instance, for a certain size of per passenger net revenue from non-aeronautical services, passengers will be better off with non-exclusive agreements while the airport will choose the exclusive one. This opens the door for public intervention by promoting non-exclusive agreements when the standard used by the antitrust authority is consumer surplus. Note that our paper unveils a connection between regulated per passenger aeronautical charges and the airport endogenous choice of the signatory airline. In particular, all other things equal, a sufficiently large decrease of the per passenger aeronautical charges will imply the airport changing its decision from non-exclusive to exclusive concession revenue sharing contracts. Our main results are robust to the consideration of airport competition and the airline alliance extensions.

Implications for future research can be drawn from this paper. It would be interesting to analyze in detail the effect of different regulations to assess their influence and the real power that institutions have depending on the type of regulation chosen. The analysis in this paper has been of a theoretical nature, the next step would be to contrast these results with real data that endorse and shed more light on these conclusions.

6 Funding

The funding body will be acknowledged following peer review.

References

ACI (2018). Airport economics report.

ATRS, A. T. R. S. (2017). Global airport performance benchmarking.

Barbot, C. (2011). Vertical contracts between airports and airlines is there a trade-off between welfare and competitiveness? Journal of Transport Economics and Policy (JTEP), 45(2):277–302.

Barbot, C. and D'Alfonso, T. (2014). Why do contracts between airlines and airports fail? Research in Transportation Economics, 45:34–41.

Brander, J. A. and Zhang, A. (1990). Market conduct in the airline industry: an empirical investigation. The RAND Journal of Economics, pages 567–583.

Brander, J. A. and Zhang, A. (1993). Dynamic oligopoly behaviour in the airline industry. International journal of Industrial organization, 11(3):407–435.

Czerny, A. I. (2006). Price-cap regulation of airports: single-till versus dual-till. Journal of Regulatory Economics, 30(1):85–97.

Czerny, A. I. (2013). Public versus private airport behavior when concession revenues exist. Economics of Transportation, 2(1):38–46.

D'Alfonso, T. and Nastasi, A. (2012). Vertical relations in the air transport industry: a facility-rivalry game. Transportation Research Part E: Logistics and Transportation Review, 48(5):993–1008.

Fershtman, C. and Judd, K. L. (1987). Equilibrium incentives in oligopoly. The American Economic Review, pages 927–940.

Flores-Fillol, R., Iozzi, A., and Valletti, T. (2018). Platform pricing and consumer foresight: The case of airports. Journal of Economics & Management Strategy, 27(4):705–725.

Fu, X., Homsombat, W., and Oum, T. H. (2011). Airport–airline vertical relationships, their effects and regulatory policy implications. Journal of Air Transport Management, 17(6):347–353.

Fu, X. and Zhang, A. (2010). Effects of airport concession revenue sharing on airline competition and social welfare. Journal of Transport Economics and Policy (JTEP), 44(2):119–138.

Kidokoro, Y., Lin, M. H., and Zhang, A. (2016). A general-equilibrium analysis of airport pricing, capacity, and regulation. Journal of Urban Economics, 96:142–155.

Lu, C.-C. and Pagliari, R. I. (2004). Evaluating the potential impact of alternative airport pricing approaches on social welfare. Transportation Research Part E: Logistics and Transportation Review, 40(1):1–17.

Oum, T. and Fu, X. (2008). Impacts of airports on airlines competition: Focus on airport performance and airports-airlines vertical relations. joint transport research centre, international transport forum. In International Transport Forum, OECD.

Saraswati, B. and Hanaoka, S. (2014). Airport–airline cooperation under commercial revenue sharing agreements: A network approach. Transportation Research Part E: Logistics and Transportation Review, 70:17–33.

Spengler, J. J. (1950). Vertical integration and antitrust policy. Journal of political economy, 58(4):347–352.

Starkie, D. (2001). Reforming uk airport regulation. Journal of Transport Economics and Policy (JTEP), 35(1):119–135.

Tirole, J. (1988). The theory of industrial organization. MIT press.

Vickers, J. (1985). Delegation and the theory of the firm. The Economic Journal, 95:138–147.

Yang, H. and Zhang, A. (2011). Price-cap regulation of congested airports. Journal of regulatory economics, 39(3):293–312.

Yang, H., Zhang, A., and Fu, X. (2015). Determinants of airport–airline vertical arrangements: analytical results and empirical evidence. Journal of Transport Economics and Policy (JTEP), 49(3):438–453.

Zhang, A. and Czerny, A. I. (2012). Airports and airlines economics and policy: An interpretive review of recent research. Economics of Transportation, 1(1-2):15–34.

Zhang, A., Fu, X., and Yang, H. G. (2010). Revenue sharing with multiple airlines and airports. Transportation Research Part B: Methodological, 44(8-9):944–959.

Zhang, A. and Zhang, Y. (1997). Concession revenue and optimal airport pricing. Transportation Research Part E: Logistics and Transportation Review, 33(4):287–296.

Zhang, A. and Zhang, Y. (2003). Airport charges and capacity expansion: effects of concessions and privatization. Journal of Urban Economics, 53(1):54–75.

App endix

Proof of Proposition 1

By inspection, it is easy to check that :

1. Traffic increases with concession revenues sharing contracts.

∂Qne = ∂Qne = ∂Qex = h > 0.
∂ri ∂rj ∂ri 2b+d

2. Airfares are reduced with concession revenues sharing contracts.

∂pne ∂pne ex
= = (22-2
h bd) ∂ rj i 42 − 2 < 0, i ∂ r ∂ r b d
∂pne ∂pne ∂pex
= b d h 0 . ∂ r i i 42 − 2 < j ∂ r ∂ r b d

3. Exclusive sharing introduces a competitive advantage on the signatory airline. The signatory airline i receives more passengers than the non-signatory one j since q ex < q 0 ex j < q i.

Proof of Proposition 2

Proposition 2 analyzes under which conditions the airport prefers exclusive or non-exclusive RSCs. The airport profits for each type of contract are,

2ne ne
Yne = (
−)(0rhwτQ+−ne02rh)+h(12r)(Q+)+2fne,2b+d2b+d
= (
−)(0rexhexYexwτQ+−ex0rh)+h(1r)(Q+)+fex.2b+d2b+d

If the difference in profits showed below is positive, the airport prefers to offer exclusive contracts upon non-exclusive ones,

Yex
−Yne = (h+w−τ)(Qex−Qne)+
−h(rexQex−2rneQne)+fex−2fne. (42)

Note that the sign of the first term above, which measures the relative ability of each contract to generate traffic, is positive if the exclusive contract yields larger trafficthannon-exclusiveex Qex
−Qneh(rex−2rneclusivecontracts,thatis,if=).2b+d
The condition for rex > 2rne is equivalent to the value for h that satisfies the next

inequality (2b − d)(4b3 − d3)(h − w − τ) − d (2b + d)(4b3 − 4b2d + d3)q0 < 0, that is,
h < h ≡ r d (2b+d)(4b3 4b2d+d3) q0 / (2b d)(4b3 d3) (− w − τ) < h̄.

The terms in the lower line of (42) simplify to:

hrex(dq0(2b + d)
−bhrex) ne 20 2 2 3 2 3 ne
−2hr(dq(4b−d)−(4b−2bd+d)hr)4b2
−d2 (4b2−d2)2 >0.
d2(2b + d)(8b4 + 4b3d
−8b2d2+2bd3+d4)(q0)2+(2b−d)2(4b3−d3)(h+w−τ)2=
4b(4b2
− d2)(4b3 − 2bd2 + d3)

Therefore, the exclusive contract has an advantage upon the non-exclusive in terms of the net income obtained by the airport from the terms of the contract. Then, a sufficient condition for the exclusive contract to be chosen is that h < hr.

To obtain the necessary and sufficient condition in the statement of the proposition, we substitute for rex and rne in (42), which simplifies to the following concave quadratic function in h,

1
(d2(2b + d)(8b4 + 4b3d −8b2d2+2bd3+d4)(q0)2(4b(2b−d)(2b+d)(4b3−2bd2+d3))
+ 2(2b
− d)d(2b + d)(4b3 − 4b2d + d3)q0(h − w − τ)
− (2b−d)2(4b3−d3)(h+w−τ)2)

The above expression is negative for
√
⋆d(2b+d)(4b3−4b2d+d3)+2bd2b(4b2−d2)(4b3−2bd2+d3h>h
≡)q0(2b− ()(43)d)(4b3−d3 −w−τ.)

It can be easily proven that h⋆ is increasing in d/b and that h⋆ < h̄ if and only if d/b ≶ 0.9575 which leads to the two different cases in Proposition 2.

√
⋆⋆2bd2b(4b2−d2)(4b3−2bd2+d3r)Finallynotethathcanbewrittenash=h+q0,which
(2b)(4b3−d3)
implies that hr < h⋆.

Proof of Proposition 3

This Proposition shows that the airport prefers to share concession revenues with airlines. We will prove that the non-exclusive contract always dominates no sharing. This happens if the following difference in airport profits is positive,

Yne
−Y0=(w−τ)Qne+(1−2rne)hQne+fne+fne−(wτ+)Q0ij−h.

(
QneQ0hrnene02324−1222+d4+hrnefnefnehrq(bbd)(where=+and== 12b3 − 8b2d2bd2 +d3)) .
2b+d f j (4b2 −d2)2

Simplifying the above expression we obtain,

hwτ) − (4b3 − 2bd2 + 3)dhr ne)

−02hrneYneY=((4b2−d2)d2)q0+(8b3−4b2d−2bd2+d3)(+(4b2

− d2−)2

where the expression is parenthesis is positive if and only if

2
ne (4b
−d2)((2b−d)(h−τ+w)+d2q0)r<.
h (4b3
− 2bd2 + d3)
4 2

2 (2)(−+)+d2q0
Butthisisalwayrne(bd)(bdhτw)sthecasesince=
2b(4b32bd2+d3)

Proof of Propositions 4, 5 and 6

In this section of the Appendix we will prove the three Propositions related to SW and CS.

Social welfare comparisons

Expression (35) in the text can be conveniently written as

SW(q,q) = (a h −

−c−τqq−b2ij+)(i+j)(qi+qj)+(b−d)qiqj(44)2

Substitutingaboveforq=qq0 qq ne 0 neij=andfori=j=q,weobtainSWandSW, respectively,

SW0 = (2(a+h

−c−τ)−(b+d)q0)q0 (45)

SWne = (2(a+h

−c−τ)−(b+d)qne)qne (46)

An therefore, the difference is

SWne

−SW0 = (2(a+h−c−τ)−(b+d)(qne+q0))(qne−q0)

= ((pne+h

− c − τ) + (p0 + h − c − τ))(qne − q0) (47)

Wqne

−q0hrnehichispositivesince=>0andthetwomarginsatequilibrium2b+d

arepositive.Nowbysubstitutingin(44)forqqex exi=iandqj=qjandnotingthat

Qex=qexqex SWexi+j,weobtain

ex

−−ex−bSW=(a+hcτ)Q(Qex)2+(b−d)qexqexij(48)2

The difference between SWex and SW0 is

SWex –

−0 −−−bSW=((a+hcτ)(Qex+Q0))(Qex−Q0)2
+(b

−d)((qexqex−q02ij())(49)

Usingtheexpressionsforqexandexiqa

−c−wbdq0jandnotingthat=(2+)the

above expression reads:

hrex
exbb
−d2bdbq0hw−τ−bb2−d2hrexSW +)+ q0(2b+d) 2 <
−SW0(2(2)(2+)(+(+))(43))=.2(4b2
− d2)2

(50)

Which is positive if rex < 2(2b−d)2(2b+d)(bq0+h−τ+w). But note that rex (2 −)(−
(4b2
−32 ≡bdhτwdbhd) bh
2(2b
−d)2(2b+d)(bq0+h−τ+w) SWex>SW0
bh(4b2
Comparison of SWne and SWex
d2) Therefore,

The comparisons presented in this subsection are the proof of the second part in

Proposition 4.

AftersubstitutingforQne,qne,Qex,qex qexi andj inequations(37)and(38),the
expressions for SWne and SWex are equal to:

(02SWne02−0exbq+h+w−τ−b(4−32)=(3b+d)(q)+2(h+wτ)q+hr bdhr)ex
bd

bdhr
(2b+d 2(42−2)20 neSWex 02 −0ne2(bq+h+w−τ)(+)=(3b+d)(q)+2(h+wτ)q+hr −2b+d (2+)2).
b d

Making use of the expressions for rex and rne in the terms in parentheses, it happens

that neifandonlyif
SWex > SW

b rex
−d2 b d(b3−bd2 d3)h−τ w q b bd bd d 2(2)(2+) 125 +3 (+)+ 16 (4 2 2 34)) 0 2 +
> (42 +)((2)(12)(0 3 2 2 +3)+ (2+)(16 20 +4 +3)) .
b3 rne
−bd2 d3 b−d b2−d2 h−τ w q b d b− bd bd d

The above condition is satisfied if and only if h is suffic

(2+)(3 − dbbd √ientlysmall,thatis,for:2+d3)B(b,d))q0−(w−τ),(51)
−2h<h w b dA(b,d)+2(2b)(4− d C b,d
≡ (2b)()

where,

A(b,d) = +80 b6d3 − 80 b5d4 + 48 b4d5 − 20 b3d6 − 2b2 d7 + 4 bd8 − d9),

−(128b9 − 192b8d + 32b7d2

B(b,d) = 64b10+64b9d b7d3 + 144 b6d4 − 104 b5d5 − 38 b4d6 − 30 b3d7 + 5 b2d8 + 6 bd9 + d10,

− 144b8d2 − 160

C(b,d) = 192b8 b3d5 − 18 b2d6 + 2 bd7 + d8.

− 144b6d2 + 40b4d4 + 8

Notice that polynomials B(b,d) and C(b,d) are always positive, while A(b, d) is negative. It can be easily proven that 0 < hw < h̄ and that 0 < hw < h⋆. We conclude that SWex > SWne if 0 < h < hw, while the opposite occurs when hw < h < h̄.

Consumer surplus analysis

We first check that the non-exclusive sharing case implies a larger consumer surplus than the non-sharing case.

()CSne(qne,qne)−CS0(q0,q0)=(b+d)(qne)2−(q0)2>0.(52)

As qne > q0, the above difference is positive. Next, we check that the exclusive sharing case also leads to larger consu

(mersurplusthanthenon-sharingcase.)CSex(qexex−000bex0exi,qj)CS(q,q)=(qqq−q0qexq0qexi+)(i)+(
−(q0)2)). (53)

Which can be written as follows:

ex0

( )exexex−000(qi−q)CS(qi,qj)CS(q,q)=4(2b−d)(b+d)q0+(4b2−3d2)(qexi−q0).8b (54)

Where(54)ispositivesinceqex 0i>q.Thecomparisonspresentedinthissubsection are the proof of the first part in Proposition 4.

Comparison of CS^{ne} and CS^{ex}

Finally, consider the difference between the consumer surplus in the non-exclusive and the exclusive sharing case to prove

b

(Proposition6.)CSex(qex,qex−CSneqne,qneqneij)()=(+qexex−neneexex−n

−ne2ij(q)).(55)

After substitution of the corresponding equilibrium quantities, we obtain:

h(b + d q0 rex

−neCSex

−CSne)(2r)= 2b+d

h2 ((4b3

−3bd2)(rex)2−2(4b3−3bd2+d3)(rne)2)+.(56)

2(2b

− d)2(2b + d)2

To find a necessary and sufficient condition for CSex > CSne, we substitute for expressions rne and rex in (56) to obtain a quadratic convex function on h; such that

CSex > CSne if an

≡

(donlyifh∈[h−,h+],where,√)(2b+d)−E(b,d)±2(2b−d)(4b3−2bd2+d3)(2b−d)(b+d)F(b,d)h+,−q0(2b

(w,

− d)G(b, d)

with, (57)

E(b,d) = 6128b9 +1126b8 d _48b5 4d _16b4 +36b3d6 _ 14b2d7 + d9,

− 64b8d − 96b7d2

F(b,d) = 32b8+16b7d 2044+2bd b3d5 +10b2d6 + d5 _d8,

− 8b5d3 −

G(b,d) = 64b8 +24 b3d5 + 2 b2d6 _ 10bd7 b +3d8 .

− 48b6d2 − 8b4d4

Notice that E(b,d), G(b,d) and (Fb,d) are always positive. It can be checked that

h− < 0 < h+ < h̄. It is also true that h+ < h*