Economics of Transportation 29 (2022) 100248

Contents lists available at ScienceDirect

Economics of Transportation

journal homepage: www.elsevier.com/locate/ecotra

Platform competition and consumer foresight: The case of airports ☆

Giuseppe D'Amico *

Universitat Rovira i Virgili, Spain
ECO-SOS, Spain

ARTICLE INFO

Keywords:
Airports
Two-sided markets
Pricing strategy

ABSTRACT

This paper studies the effect of competition and consumer foresight on platform profits. The focus is on airports, which provide passengers with aeronautical and commercial services through airlines and retailers. Our results can be summarized as follows. First, we unravel the relationship between consumer foresight and the optimal pricing of the two services. When passengers are myopic, they undervalue the surplus they derive from the retail services, so that the airport charges low landing fees and makes profits from the retail business. When passengers are foresighted, they better anticipate the surplus from the retail services, so that the airport changes its strategy by charging higher landing fees and boosting competition in the retail sector. Second, we find that the relationship between profits and consumer foresight strictly depends on the considered market structure. When the airport has no competitors, airport profits are non-decreasing in the degree of consumer foresight. By contrast, under duopoly competition, a weakly-negative correlation between airport profits and consumer foresight is observed. These results allow to derive two main managerial implications. First, airport competition can lead to higher landing fees. Second, under competition, an airport is not necessarily interested in informing passengers about its retail facilities. However, an extension where airports decide whether to set an advertising campaign to inform passengers about their retail facilities reveals that they end up locked in a Prisoner's Dilemma.

1. Introduction

Platforms are typically multi-services. Along with their core product, they offer a wide variety of complementary services to enrich customer experience. Nowadays, many industries are characterized by this kind of structure. Among others, examples include: (i) the video-game industry, where game publishers sell video-games (core business) and allow users to make in-game micropurchases of items that strengthen player performance (secondary services); (ii) the hotel industry, where revenues from in-room services (secondary services) complement those from room rental (primary business); (iii) the banking sector, where customers having savings account (primary business) are offered a wide variety of commercial and financial products (secondary services); (iv) the grocery industry where, despite the lack of a specific core service, products are characterized by multiple network externalities.

Airports constitute a paradigmatic example where only air-travelers (primary business) get access to the restricted shopping area once at the terminal (secondary services).

Although it is common knowledge that such side-services are usually over-charged to exploit the consumers' myopic behavior, they do not always represent a direct source of profit. Bertini et al. (2008) point out that add-on features can change the perceived value of the base good. Thus, side-services may turn out to be a relevant instrument to attract those consumers who attach a low value to the core-product. Over the last years, non-aeronautical operations played a strategic role for airports. Indeed, according to many surveys carried out by the Airports Council International (ACI), non-aeronautical operations constitute the main source of revenue for many airports. Total airport industry revenues in 2016 amounted to \$161.3 billion, of which \$89.3 billion (55.4%) was aeronautical revenue and \$72 billion (44.6%) non-aeronautical.

☆ Acknowledgements
I am grateful to Ricardo Flores-Fillol, Bernd Theilen, Alberto Iozzi, Mark Armstrong, Leo Basso, Achim Czerny, Tiziana D'Alfonso, Robin Lindsey, Anming Zhang, the audiences in Hong Kong (ITEA Conference), Barcelona (Jornadas de Economía Industrial), Paris (ITEA Conference) Reus (Workshop WIPE) and an anonymous referee for the precious comments on earlier drafts of the manuscript. Any remaining errors are, of course, mine. This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 713679 and from the Universitat Rovira i Virgili (URV), Spain.

* Correspondence to: Universitat Rovira i Virgili, Spain.
E-mail address: giuseppe.damico@urv.cat.

https://doi.org/10.1016/j.ecotra.2021.100248
Received 25 March 2021; Received in revised form 17 September 2021; Accepted 3 December 2021
Available online 5 January 2022

However, the importance of non-aeronautical operations does not merely rely on the revenues they directly generate. They can also be a useful tool to attract passengers to the aiports' terminals.[1] Currently, the airport retail sector is undergoing a period of deep renovation. With the digital revolution, both stores and passengers have access to a huge amount of information. Nowadays, passengers can easily compare prices and product features as well as learn about all the available services at the terminal. From the retailers' perspective, facing more informed customers has ambiguous implications. Airport retailers have the advantage of dealing with a larger potential demand as competition has extended to city-center retailers (Czerny and Zhang, 2020; D'Alfonso et al., 2017). Nevertheless, the new marketing methods associated with the digital innovation have given rise to an internal, harsher competition among airport retailers by offering high-quality services and by developing *personalized customer experiences*.[2] Airports, on their side, are making huge investments to extend the commercial area, thus enhancing passenger satisfaction at the terminal and the overall travel experience.[3]

In our framework, airports choose landing fees and organize the non-aeronautical sector by deciding the number of concessions to award. We analyze two market structures: monopoly and duopoly competition. Under monopoly, passengers are just offered the options of traveling from a single airport. Whereas, under duopoly competition, they have the alternative of traveling from another airport.[4] In making their travel decision, passengers attach a personal value to flying and anticipate a surplus they expect to derive from the consumption of retail services (henceforth *retail surplus*). It follows from the above discussion that those passengers who assign a low value to the flight (core business) need to anticipate retail surplus to travel. However, consumers may underestimate the true value of the retail surplus as they are, generally, myopic when accounting for side-services or products' secondary attributes (Ellison, 2005). It turns out that the extent to which travelers anticipate the retail surplus, i.e., their degree of consumer foresight, is crucial in determining their travel decision.

The main purpose of this paper is analyzing the pricing mechanism of a multi-product airport when changes in the competitive environment occur. It constitutes a first attempt to study the effect of competition and consumer foresight on platform profitability. Our results can be summarized as follows. First, we unravel the relationship between consumer foresight and optimal pricing for the two services. On the one hand, when consumers are myopic, they undervalue the true retail surplus, thus airports optimally set low landing fees and allow for a concentrated retail market. On the other hand, when consumers are foresighted, they have a more correct perception and are more sensitive to changes in the retail surplus, thus airports set high landing fees and boost competition in the retail market. These results are insensitive to changes in the market structure as they hold under monopoly and duopoly. The rationale behind these strategies relies on the extent of consumer foresight. When consumers are myopic, they underestimate the true retail price and the average mismatching cost, which depend on the number of retailers in the market. As a consequence, airports use the aeronautical sector to attract passengers to the terminals and make profits through the retail business by inducing the highest possible retail price. For a sufficiently high level of consumer foresight, passengers are more sensitive to changes in the retail surplus than to changes in the airfare. As a consequence, airports award the maximum possible number of concessions to boost the retail surplus and attract passengers, while making profits through the aeronautical business by setting high landing fees.

Second, our results emphasize the importance of market structure when considering the impact of consumer foresight on platform profitability. Under monopoly, airport profits are increasing in consumer foresight (a result obtained in Flores-Fillol et al., 2018), whereas they decrease under duopoly competition when the product differentiation in the retail sector is high. Such a difference comes from the loss in the airport's geographical market power. These results yield two main implications. First, airport competition can lead to higher landing fees. Second, under competition, an airport is not necessarily interested in informing passengers about its retail facilities. However, an extension of the study where airports decide whether to set an advertising campaign to inform passengers about their retail facilities reveals that they end up locked in a Prisoner's Dilemma.

Our paper is related to three streams of economic literature: *(i) non-aeronautical revenues, (ii) add-ons and consumer foresight* and *(iii) airport competition and two-sided markets*.

Non-aeronautical revenues. The liberalization of air transportation has emphasized the role of non-aeronautical revenues for airport profitability. The existing complementarity between aeronautical and non-aeronautical business turns non-aeronautical operations into a strategic tool to raise airport profits. On the one hand, they have a direct impact on airport profits through commercial sales. On the other hand, they can foster the demand for aeronautical services (Bracaglia et al., 2014; Starkie, 2002, 2008; Zhang and Zhang, 2003; 2010; Adler et al., 2014; Oum et al., 2004; Yang and Zhang, 2011). Flores-Fillol et al. (2018) suggest that: (i) when consumers are myopic, airports decrease aeronautical charges to attract more passengers and increase commercial sales, and (ii) when consumers are foresighted, non-aeronautical operations are used as a tool to attract passengers at the terminal so that the airport can increase its aeronautical revenues. Consistently, our results align with these findings and show that this airport strategy is independent of the air-travel market structure.

Add-ons and consumer foresight. Typically, add-ons are used to exploit consumers' myopic behavior and represent a significant source of profit (Verboven, 1999; Gabaix and Laibson, 2006; Ellison, 2005). Retail services can be considered as an add-on that complements the consumption of aeronautical services. As a consequence, passengers do not consider add-ons as a mere cost. When the airport faces myopic travelers, our findings align with the current literature. By contrast, when passengers are foresighted and account for retail prices, airports implement a *loss-leader pricing strategy* and retail services are priced at the marginal cost to induce a higher demand for aeronautical services.

Airport competition and two-sided markets. The literature on air transport has not really focused on the role of airports and airlines as platforms. Nevertheless, it seems that airports are a unique type of platform that connects several groups of agents. Bettini and Oliveira (2016) study the recent privatization of Brazilian airports and observe that profit-oriented airports develop strong network effects between aeronautical and non-aeronautical business similar to a multi-sided platform. Ivaldi et al. (2012) claim the multi-sided nature of airports because of their connecting role between airlines and passengers and in their article provide an empirical methodology to test it. Differently, Malavolti and Marty (2017), Flores-Fillol et al. (2018) assert that

[1] The rationale behind the rise of the airport cities, so called "Aerotropolis" (Kasarda, 2019), builds on a similar concept.

[2] More detailed information about how to develop a customer experience at https://www.adlittle.com/sites/default/files/viewpoints/ADL_Customer_Experience.pdf and https://home.kpmg/xx/en/home/media/press-releases/2019/10/customer-obsessed-brands-drive-greater-share-of-wallet.html.

[3] There are uncountable examples. In 2015, Aeroporti Di Roma approved a multi-year plan to pursuing a progressive passenger experience strategy. The value of the investment is (approximately) $12 billion http://www.airport-business.com/2015/04/rome-fiumicinos-e12bn-transformation-enhancing-end-end-travel-experience/. Recently, the Changi Airport Group (CAG) has inaugurated the new Terminal 4. The group has awarded all concession contracts for retail, food & beverage and service outlets at its new terminal. Overall, Terminal 4 will have more than 80 outlets over 16,000 squared meters of space. The total value of the investment is of $985 million.

[4] Different from the standard definition of *monopoly airport* adopted in the transport literature (where the term "monopoly" indicates that the airport is dominated by a single carrier), here we refer to a geographical monopoly, where the airport has a sort of exclusivity over a certain catchment area.

the airport two-sided structure is based on the duality of its source of revenue (aeronautical and commercial). In our paper, airports compete and need to take into account the cross-demand elasticity between aeronautical and non-aeronautical business to design a profitable strategy. To our knowledge, this is the first article making a two-sided market analysis on airport competition. More general insights about platform competition can be found in Rochet and Tirole (2003), Armstrong (2006).

Our paper presents some differences with respect to the literature on two-sided markets and platform competition. First, the network externalities between airlines and retailers do not depend on a direct interaction between them. Indeed, what links aeronautical and non-aeronautical sector is their relative importance for the passengers who are the real end-users of the airports. In our paper, although potential passengers differ in their distance from the airport (or, more generally, willingness to pay), airports cannot price-discriminate on the basis of passengers' location as they can only charge uniform prices for aeronautical and non-aeronautical activities. Second, although the airport extracts all the profits from the non-aeronautical sector, it does not have full control over retail prices as it only decides the number of competing retailers. Finally, different from standard platform models, airlines are not atomistic and there is a double-marginalization problem that prevents airports from directly charging passengers.

In a similar framework, Flores-Fillol et al. (2018) analyze the case of a monopoly airport and find that airport profits increase as consumers become more foresighted. However, their analysis considers just one airport and their findings hold for specific values of consumer foresight. Our set-up has the advantage of being more tractable and general, so that we can qualitatively recover the monopoly results in Flores-Fillol et al. (2018) for any degree of consumer foresight. Interestingly, airport competition crucially determines the effect of consumer foresight on airport profits. In the same way, airports' profit composition is also affected by airport market structure.

Hagiu and Hałaburda (2014) study the impact of consumer information on platform profits under monopoly and duopoly market structures. They show that, under monopoly, platforms are more profitable when facing informed users. Instead, this result is reverted under duopoly competition. Despite the substantial differences in terms of modeling, the rationale for this similarity stems from the common effect that *consumer information* and *consumer foresight* have on the aggregate demand. In Hagiu and Hałaburda (2014), buyers can exhibit either responsive or passive rational expectations over developers' participation. The way buyers are informed affects their responsiveness to changes in developers' prices. In the same way, consumer foresight affects the passengers' responsiveness to retail prices, thus affecting airport strategy.

The paper is structured as follows. Section 2 proposes an airport-specific model with the purpose of deriving clear results and derive managerial implications. Section 3 characterizes the airports' optimal choices under monopoly and duopoly. Section 4 analyzes the effect of airport competition on profits. Managerial implications are provided in Section 5. Finally, Section 6 concludes. Proofs are provided in Appendix.

2. An airport model

Airports, in the upstream market, provide essential inputs to the downstream markets that serve the demand with a base good (aeronautical services) and a complementary add-on (retail services). In detail, we assume that: (i) airports are dominated by a single carrier that pays a per-passenger landing fee for the use of its infrastructure (ℓ), (ii) airports decide the number of concessions to award in the retail market (n).[5]

[5] Although the monopoly airline assumption might appear strong, actually, several airports are dominated by a single carrier. However, assuming airline competition does not provide any additional information and, qualitatively, does not alter the sense of the paper.

Passengers. Passengers derive utility from flying and making purchases at the terminal. We consider a continuum of passengers with a linear utility function of the form $Z_i(p_A, \boldsymbol{p_R}; \theta) = z - s\theta_i + \delta\mathbb{E}[CS\left(\boldsymbol{p_R}\right)] - p_A$, where p_A is the airfare and $\boldsymbol{p_R}$ is the final retail price set by the n retailers; z is the gross benefit that passengers derive from traveling; $s > 0$ is the per unit cost born by travelers to reach the airport and $\theta \in [0,1]$ identifies traveler location; $\delta \in [0,1]$ is the *degree of consumer foresight*, with $\delta = 1$ identifying perfect foresight and $\delta = 0$ full myopia; and $\mathbb{E}CS\left(\boldsymbol{p_R}\right)$ is the *expected surplus* each passenger derives from the consumption of the retail product.[6] Consequently, if consumers are not fully myopic ($\delta > 0$), flight decisions are not independent from retail purchases. Passengers can purchase at most one flight ticket and have a zero outside option. Let $\widetilde{\theta}$ be the location parameter characterizing the indifferent consumer between flying or not. Thus, the demand for flights is defined as

$$Q(p_A, \boldsymbol{p_R}) = \int_0^{\widetilde{\theta}(p_A, \boldsymbol{p_R})} dF(\theta) = \frac{z - p_A + \delta\mathbb{E}[CS\left(\boldsymbol{p_R}\right)]}{s}, \tag{1}$$

whenever this is positive.[7]

Retail market structure. Our retail structure recovers the one in Flores-Fillol et al. (2018). The n retailers sell a differentiated good and pays to the airport a fee f to stay in the terminal. Retailers are symmetrically distributed around a Salop circle of unit length, with $n \geq 2$. As already discussed, the retail product is available only to that segment of demand making use of aeronautical services. The mass of potential consumers is $Q(p_A, \boldsymbol{p_R})$. Each consumer has a unit demand and a taste parameter x for the retail good, which is uniformly distributed over the support $[0,1]$ and identifies her position around the circle. When buying from the nearby retail firm located in x_j, a consumer located at x_i derives a utility of the form: $V_i(p_{R_j}; x_i) = v - p_{R_j} - t|x_i - x_j|$, where p_{R_j} is the price set by retailer j, $\forall j \in 1, \dots, n$, $t > 0$ is the standard Salop *transportation cost* capturing product differentiation and v denotes the gross utility from retail. To ensure passengers will always anticipate a positive $\mathbb{E}[CS(\boldsymbol{p_R})]$, v is assumed to be sufficiently high.[8] As it will become clear at a later stage, this implies

$$v > \frac{5}{8}t. \tag{2}$$

Demand and profits are derived in the standard way. By assuming symmetrically located retailers around the circle, the marginal consumer between firm j and one of its nearest rivals, say firm k, is $\widetilde{x}_{j,k} = (2n)^{-1} + (p_{R_k} - p_{R_j})/2t$. In a symmetric equilibrium, the demand for j becomes $Q_R(p_{R_j}, \boldsymbol{p_{-j}})Q(p_A, \boldsymbol{p_R}) = 2\widetilde{x}_{k,j}\left(p_{R_j}, p_{R_k}\right)Q(p_A, \boldsymbol{p_R})$. After normalizing costs to 0, retailer i's profits are

$$\begin{aligned}\pi_j\left(p_A, p_{R_j}, \boldsymbol{p}_{R_k}, \boldsymbol{p_R}\right) &= p_{R_j} Q_R(p_{R_j}, p_{R_k}) Q(p_A, \boldsymbol{p_R}) - f \\ &= p_{R_j}\left(\frac{1}{n} + \frac{p_{R_k} - p_{R_j}}{t}\right)\frac{z - p_A + \delta\mathbb{E}[CS\left(\boldsymbol{p_R}\right)]}{s} - f.\end{aligned} \tag{3}$$

When making their flight decision, travelers do not exhibit clear preferences over the retail product (they do not know their location x on the Salop circle), yet. Therefore, they are just able to form an expectation over the surplus they will enjoy from consuming retail services. Such expectation takes the form: $\mathbb{E}[CS(p_R)] = v - t/4n - p_R$, where v is the gross utility passengers derive from the consumption of retail services; p_R is the retail price; and $t/4n$ is the average mismatch disutility suffered by passengers when there is an imperfect alignment between their preferences and the services offered by the retailer.[9]

[6] The sum $z - s\theta$ is the *passenger willingness to fly* that uniquely identifies travelers.

[7] By assuming that $\theta \sim U[0,1]$, we are implicitly allowing for a linear demand function.

[8] To avoid irregularities, another important assumption is $v < \frac{24}{5}z$.

[9] Without any loss of generalities, by recovering Salop (1979), we assume that passengers anticipate the Salop average consumer welfare minus an

Lastly, it is important to underline that: (i) retailers do no coordinate on a unique retail price, p_R; and (ii) we assume that, unilaterally, a single retailer does not contribute to the airport demand formation, thus the yielded market price p_R only depends on the competition among retailers. In other terms, we might say that they hold passive expectation over the airport demand. Therefore, when setting their retail price p_i, they do not try to affect the general demand $Q(p_A, p_R)$.

The timing of the game is the following:

- First stage: Upstream choice. The airport sets the landing fee (ℓ) and the number of concessions to be awarded in the retail market (n);
- Second stage: Downstream choice. Retailers compete á la Salop and a unique price (p_R) is formed in the retail market; at the same time, the monopoly airline sets the airfare (p_A);
- Third stage: Consumer choice. Passengers observe (p_A, p_R) and make their travel decision.

3. Equilibrium analysis

In this section, we present two scenarios. In the first one, we analyze the case of a single airport providing services within a certain catchment area. In the second one, we turn to the case of two competing airports.

3.1. Monopoly

Consider a monopoly airport serving a certain catchment area. The airport is uncongested and dominated by a single carrier.[10]

The advantage of using such an approach is to have analytical solutions for the whole range of δ and a setting that can be easily compared with the duopoly case. We first analyze the second-stage equilibrium in which retailers and the single airline choose their prices and, then, we consider the first-stage equilibrium in which the airport sets the landing fee and the number of retail concessions to be awarded.

Second stage. Retailers and the monopoly airline simultaneously choose prices. Retailers hold fixed expectations on $Q(p_A, p_R)$. As a consequence, their price decisions do not affect these expectations, i.e., $\partial \mathbb{E}CS(p_R)/\partial p_{R_j} = 0$.

Each retailer is involved in a symmetric price game with the other retailers and maximizes its profits, i.e., $\max_{p_{R_j}} \pi_j \left(p_A, p_{R_j}, \boldsymbol{p}_j, p_R\right) = p_{R_j} Q_R(p_{R_j}, \boldsymbol{p}_j) Q(p_A, \boldsymbol{p}_R) - f$. Similarly, the monopoly airline chooses optimally its airfare by solving $\max_{p_A} \pi_A \left(p_A, \boldsymbol{p}_R\right) = \left(p_A - \ell\right) Q(p_A, \boldsymbol{p}_R)$. In line with the literature, aeronautical services are sold to airlines at a uniform per-passenger landing fee $\ell \geq 0$.[11]

Lemma 1. *The second stage equilibrium yields the following retail and airline prices:*

$$p_R(\ell, n) = \frac{t}{n}, \qquad p_A(\ell, n) = \frac{z+\ell}{2} + \frac{\delta}{2}\left(v - p_R(\ell, n) - \frac{t}{4n}\right). \tag{4}$$

In equilibrium, the retailers set the standard symmetric Salop price. The result obtained for the airfare is composed of a standard double-marginalization term plus a mark-up that depends on the degree of consumer foresight and the equilibrium consumer surplus from retail activities.[12] Therefore, as the retail surplus increases, the airline optimally responds by raising its fares. Given these results, we can rewrite the retail surplus anticipated by travelers as $\mathbb{E}[CS(n)] = v - 5t/4n$ and (1) as $Q(\ell, n) = (z - \ell)/2s + \delta(v - 5t/4n)/2s$. In equilibrium, the assumption in (2) guarantees that $\mathbb{E}[CS(n)]$ is strictly positive.

First stage. In the first stage, the airport maximizes profits by setting the landing fee and choosing the number of concessions to award in the retail market. By following Flores-Fillol et al. (2018), concessions are awarded such that the retailers have no rights on a potential extra-profit, e.g., by means of a first-price auction.[13] Therefore, the airport is able to fully extract profits from retail activities and charge the airline a per-passenger landing fee for the use of the infrastructure, thus we can write its profit maximization problem as $\max_{\ell \geq 0, n \geq 2} \Pi(\ell, n) = \left(\ell + p_R\right) Q\left(\ell, n\right)$. It is important to notice that an increased number of retailers leads to two significant consequences. First, the retail price, p_R, decreases due to the fiercer competition in the retail sector. Second, the probability of a perfect match between a passenger's preferences and the services offered by a retailer increases, thus decreasing the average disutility from a mismatch, $t/4n$.

Our analysis allows to differentiate between two different scenarios with respect to consumer foresight:

(i) Myopic passengers, with $0 \leq \delta \leq 4/5$,
(ii) Foresighted passengers, with $4/5 < \delta \leq 1$.[14]

Propositions 1 and 2 summarize the optimal airport choices in these two scenarios. Let us denote ℓ^* and n^* the equilibrium landing fee and the optimal number of retailers allowed to operate at the terminal.

Proposition 1. *When passengers are myopic (i.e., $0 \leq \delta \leq 4/5$) the optimal landing fee and number of concessions chosen by the monopoly airport are given by*

$$\ell^* = \begin{cases} \frac{z - \frac{t}{n}}{2} + \frac{\delta}{2}\left(v - \frac{5t}{4n}\right) & if\ t < t_1, \\ 0 & if\ t \geq t_1, \end{cases} \qquad n^* = 2\ , \tag{5}$$

with $t_1 \equiv \dfrac{8(z + \delta v)}{4 + 5\delta}$.

When passengers are myopic, the airport sets relatively low landing fees and induce a high retail price by keeping a concentrated market structure on the retail side. On the one hand, when making their flight decision, myopic consumers' choice is mostly driven by the airfare, whereas the expectations over the retail surplus do not play a significant role. On the other hand, the airport is indifferent about making money through the aeronautical or the commercial sector. As a consequence, the airport minimizes $\mathbb{E}[CS(n)]$ by setting an extremely concentrated retail market ($n = 2$), thus yielding the highest possible retail price p_R, and attracts more demand through the aeronautical sector by charging relatively low landing fees.[15]

average price, p_R, $W(n, p_R) = 2n \int_0^{1/2n} v - tx - p_R \, dx = v - t/4n - p_R$. It is worthy to notice that such expectations are formed before passengers observe prices. Therefore, when setting their profit-maximizing prices, retailers will take the $\mathbb{E}[CS(p_R)]$ as part of an expectation they cannot change. In other words, at the time of setting their prices, they assume they cannot affect the overall demand.

[10] As already stated in the introduction, such assumptions do not alter qualitatively the results of the paper as the way the downstream market is designed does not affect airport choices at the first stage, more precisely, a more fragmented airline market decreases the demand for the single airline, thus, scaling down profits.

[11] Allowing for $\ell < 0$ would not change qualitatively our results. It can be interpreted as the aeronautical mark-up obtained by the airports. Therefore the case $\ell < 0$ corresponds to a situation in which the airport sets the fee below its marginal cost to attract more passengers with the ultimate purpose of boosting revenues from the retail activity.

[12] Notice that retailers' fixed expectations over the general demand make that the airline has internalized the retail price in its optimal strategy, while retailers have set their price independently of the airline's choice.

[13] Imposing a sharing-rule ensuring positive profits for the concessionaires does not alter qualitatively our findings.

[14] The threshold 4/5 comes from the maximization problem. Details can be found in the proofs of Propositions 1 and 2.

[15] By modeling à la Salop the competition in the retail sector, we have implicitly ruled out the possibility for the platform to totally control the retail market structure. We have, indeed, two dimensions of competition, t and n, and we delegated only one to the platform choice.

Furthermore, by looking at the equilibrium landing fee in (5), we can observe that it is composed of two components: a fixed component, independent of consumer foresight, and a variable one whose extent depends on several factors, included δ. That variable component comes from the *one-way complementarity effect* of the non-aeronautical sector over the aeronautical one. The extent of this effect strictly depends on the profitability of the retail sector for the airport. As product differentiation (t) increases, the retail sector becomes more profitable and the airport optimally responds by lowering its landing fee, which can even reach 0 for $t > t_1$.

Higher levels of consumer foresight turn the non-aeronautical sector into a valuable tool to attract passengers rather than a source of profits for the airport, as it is stated in the following proposition.

Proposition 2. *When passengers are foresighted (i.e.,* $4/5 < \delta \leq 1$*), the optimal landing fee and number of concessions chosen by the monopoly airport are given by*

$$\ell^* = \frac{1}{2}(z + \delta v), \qquad n^* \to \infty \; . \tag{6}$$

When passengers are foresighted, at the time of making their flight decisions, they are able to almost perfectly anticipate the retail surplus ($\mathbb{E}[CS]$). As a consequence, passengers have a more realistic perception of the true retail price (p_R) and of the average disutility from a mismatch ($t/4n$). From the airport's perspective, this raises the opportunity cost of inducing a higher retail prices by limiting the number of concession to award on the retail market.

Therefore, the airport sets the most fragmented market structure, $n^* \to \infty$, thus yielding the lowest possible retail price that equals its marginal cost 0 and eliminating the mismatch disutility incurred by passengers. By doing so, $\mathbb{E}[CS(n)]$ increases and boosts the demand for flights. When δ is very high, the retail market loses its function as a source of profit and it is merely used by the airport as a tool to attract demand.

3.2. Duopoly

In this subsection, we builds our model on Armstrong (2006) where we consider the presence of two competing airports. Differently from the previous scenario where passengers faced a zero outside option, here they have the alternative of going to a rival airport.[16]

We consider two airports competing à la Hotelling. Either airport is composed of a retail sector and an aeronautical sector. The timing of the game is the same used in the case of a monopoly airport: in the first stage, airports simultaneously and non-cooperatively set the landing fee and the number of concessions to be awarded in the retail market; in the second stage, in each airport, the retailers and the monopoly airline choose their prices; finally, travelers make their travel decisions and payoffs are collected.

Airline and airport demand. The two airports, denoted 0 and 1, compete à la Hotelling and are located at the endpoints of a linear city of unit length.[17] Airports are differentiated and there is a unitary population of consumers with $\theta \sim U[0,1]$ identifying passenger location.

Airport demand is worked out in the standard way. Passengers decide which airport to fly from depending on the following indirect utility function: $Z_i(p_A, \boldsymbol{p_R}; \theta) = z + \delta\mathbb{E}[CS_h] - p_{A_h} - s|\theta_i - A_h|$, where $A_h = \{0,1\}$ is the airport location; and general considerations on θ_i, δ, $\mathbb{E}[CS_h]$ and p_A still hold from the monopoly case. To conclude, s is the Hotelling transportation cost and captures the intensity of the competition between airports. Therefore, the marginal consumer is given by

$$\hat{\theta} = \frac{p_{A_1} - p_{A_0}}{2s} + \frac{\delta}{2s}\left(\mathbb{E}[CS_0] - \mathbb{E}[CS_1]\right) + \frac{1}{2}. \tag{7}$$

Since traveler are uniquely identified by their taste parameter, $\hat{\theta}$ identifies the demand for airport 0 and it allows to rewrite the demand for airport h as

$$Q_h(\boldsymbol{p_A}, \boldsymbol{p_R}; \delta) = \frac{p_{A_{-h}} - p_{A_h} + s}{2s} + \frac{\delta}{2s}\left(\mathbb{E}[CS_h] - \mathbb{E}[CS_{-h}]\right) \quad {\scriptstyle h=\{1,0\},}\, . \tag{8}$$

Second stage. In both airports, retailers and airlines choose prices simultaneously. For a generic airport h, retailers and airlines maximize: $\pi_i\left(\boldsymbol{p_A}, p_{R_j}, p_k; \delta\right) = p_{R_j} Q_R(\boldsymbol{p_A}, p_{R_j}, p_{R_k}; \delta) Q_h(\boldsymbol{p_A}, \boldsymbol{p_R}; \delta) - f$ and $\pi_A\left(p_A\right) = \left(p_A - \ell\right) Q(\boldsymbol{p_A}, \boldsymbol{p_R}; \delta)$, respectively, obtaining the following results.

Lemma 2. *The optimal retail price is given by the standard Salop symmetric equilibrium outcome and the optimal airfare is composed of a standard Hotelling term plus a component depending on* δ*:*

$$p_{R_h}(\boldsymbol{\ell}, n_h) = \frac{t}{n_h}, \qquad p_{A_h}(\boldsymbol{\ell}, \boldsymbol{n}) = \frac{3s + 2\ell_h + \ell_{-h}}{3} + \frac{\delta}{3}\frac{5}{4}\left(\frac{t}{n_h} - \frac{t}{n_{-h}}\right). \tag{9}$$

The joint analysis of Lemmas 1 and 2 suggests that retailers, independently of the airport market structure, set-up a standard Salop price. Under fixed expectations, retailers do not react to airport competition and set a price independently of the actual degree of consumer foresight. Although there is a single airline in each of the airports, airlines inherit the competition from airports and charge an airfare that embodies part of the potential passenger retail surplus.

By using (9), the demand for an airport h can be rewritten as

$$Q_h(\boldsymbol{\ell}, \boldsymbol{n_R}; \delta) = \frac{\ell_{-h} - \ell_h + 3s}{6s} + \frac{\delta}{6s}\left(\frac{5}{4}\frac{t}{n_h} - \frac{5}{4}\frac{t}{n_{-h}}\right) \quad {\scriptstyle h=\{1,0\}.} \tag{10}$$

As we can observe in (10), the market share for each airline depends on the gap between the airports' choice variables ($\ell_{-h} - \ell_h$ and $n_{-h} - n_h$).

First stage. Airports fully extract profits from the retail market and compete by choosing landing fees and the number of concessions to allocate. Each airport is profit maximizer and, given the results in (9) and (10), chooses its optimal strategy by solving: $\max_{\ell_h \geq 0, n_h \geq 2} \Pi_h(\boldsymbol{\ell}, \boldsymbol{n}) = \left(\ell_h + p_{R_h}\right) Q_h(\boldsymbol{\ell}, \boldsymbol{n})$, with $h = \{0,1\}$.

Proposition 3. *When passengers are myopic (i.e.,* $0 \leq \delta \leq 4/5$*), the optimal landing fee and number of concessions chosen by each duopoly airport are given by*

$$\ell_h^* = \begin{cases} 3s - \frac{t}{2} & \text{if} \quad 0 < \frac{t}{s} < 6 \\ 0 & \text{if} \quad \frac{t}{s} \geq 6 \end{cases}, \qquad n_h^* = 2 \qquad {\scriptstyle h=0,1.} \tag{11}$$

When travelers are myopic, each airport awards the minimum number of retail concessions and charges a landing fee below the standard Hotelling outcome. The airports set a relatively low landing fee to attract passengers to the terminals and induce high retail prices, so that the retail business is the more profitable one. The rationale behind these results stems from the myopic nature of passengers. Myopic passengers value more a cut in the airfare rather than a lower retail price. Thus, as in the monopoly case, airports optimally react by discounting the retail price from the landing fees, i.e., ($\ell^* = 3s - p_R$) and inducing a positive retail price.

Moreover, the results in the above proposition depend on the ratio t/s. A low (high) t/s can be explained by either an intense (soft) competition within the retail sector or by a high (low) airport geographical market power. When t/s is relatively high (case $t/s > 6$), the

[16] We focus on the case where the joint presence of the two airports fully serves the market. Considering the case with partially-served market would imply that either airport has a geographical monopoly over its catchment area, thus leading back to the monopoly case discussed in the previous subsection.

[17] The choice of the location does not affect qualitatively our results and does not impose any bounds to the analysis as the presence of an indicator of competition intensity ($s \in \Re^{++}$) allows us to analyze the equilibrium outcomes for different degrees of airport competition.

retail product is very differentiated and retail competition is soft (or the airport geographical market power is very low), thus reinforcing the upward pressure on retail prices and making the non-aeronautical business more lucrative than the aeronautical one. As a consequence, the airport optimally responds by setting the lowest possible landing fee ($\ell^* = 0$). When t/s is relatively low (case $t/s < 6$), the competition in the retail market is more intense (or the airport geographical market power is higher), which mitigates the effect of having a maximal retail concentration and allows the airport to raise its landing fee above 0.

The difference between the monopoly and the duopoly market structures is found by looking at the effect of δ on ℓ^*. In the monopoly case, $\delta > 0$ ensures the landing fee to embody a positive mark-up through the one-way complementarity effect from the retail activity. More precisely, the assumption in (2) along with the zero outside option guarantee the one-way complementarity effect from the retail activity to be effective in equilibrium so that the demand is increasing in δ. A higher consumer foresight attracts farther passengers, thus boosting air-travel demand, and strengthens the market power over the closest passengers. As a consequence, the airport optimally reacts by charging higher landing fees.[18] In the duopoly case, the equilibrium landing fee does not depend on δ. The rationale can be found going back to the consumer decision process. More precisely, an increase in δ exerts an upward pressure on landing fees to drain the exceeding new surplus from passengers, but competition exerts a downward pressure of the same magnitude. As a consequence, landing fees are kept at an inefficiently low level and consumer welfare increases.[19] Second, the size of the landing fee depends on the current frictions in the retail and aeronautical market, which can be summarized by the ratio t/s. The optimal landing fee in (11) is composed of two components: (i) $3s$, which is a standard Hotelling outcome, and (ii) $-t/n^*$, which is the standard Salop price multiplied times -1.

Now, let us consider the case with foresighted consumers ($\delta > 4/5$). In this case, travelers have a higher valuation of their retail surplus and the following proposition arises.

Proposition 4. *When passengers are foresighted (i.e., $4/5 < \delta \leq 1$), the optimal landing fee and number of concessions chosen by each duopoly airport are given by*

$$\ell_h = 3s, \qquad n_h \to \infty \qquad {}_{h=0,1}. \tag{12}$$

When passengers are foresighted, each airport awards the maximum possible number of retail concessions (inducing low retail prices) and charges a higher landing fee. More precisely, passengers value more a boost in the retail surplus rather than a cut in the airfare. Therefore, airports compete on their common catchment area by offering the travelers the maximal possible retail surplus and inducing a low retail price ($p_R^* = 0$). Thus, it turns out that only the aeronautical business is profitable.[20]

4. Profit analysis

Our previous results show how consumer foresight affects airport optimal choices under monopoly and duopoly. As it has been already discussed, we can highlight some similarities between the two market structures. When consumers are myopic, airports try to attract new passengers through the aeronautical sector (the one travelers value more) and make most profits through the retail sector (the one they value less). Alternatively, when consumers are sufficiently foresighted, they are attracted through the non-aeronautical sector and airport profits are totally driven by the aeronautical business.

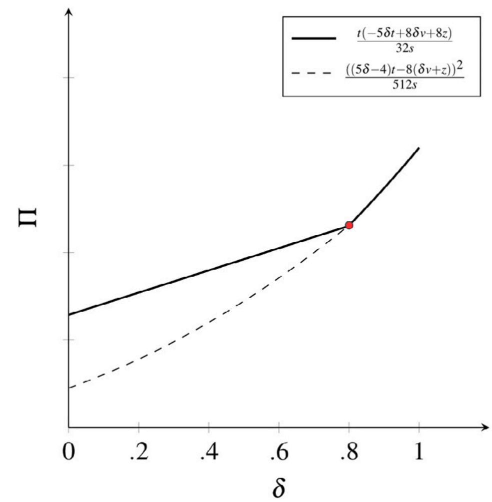

Fig. 1. Monopoly airport profit function. Thick line ($t = 3.5$, $s = 0.5$, $v = 3$ and $z = 1$); Dashed line ($t = 1$, $s = 0.5$, $v = 3$ and $z = 1$).

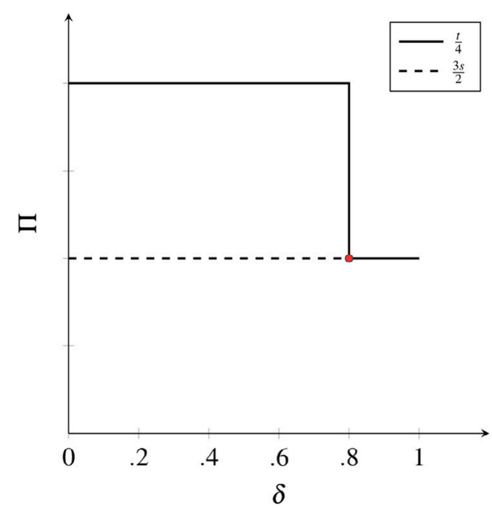

Fig. 2. Duopoly airport profit function. Thick line ($t/s > 6$); Dashed line ($t/s \leq 6$).

Although these considerations are relevant for both market structures, airport profits and their composition are sensitive to changes in consumer foresight and market structure, as shown in the following proposition.

Proposition 5. *The impact of consumer foresight on airport profits differs between monopoly and duopoly.*

(i) Under monopoly, airport profits are (strictly) increasing in consumer foresight.

(ii) Under duopoly, airport profits are (weakly) decreasing in consumer foresight.

Figs. 1 and 2 show how profits evolve with consumer foresight under both market structures. The economic intuition of the above proposition is as follows.

Under monopoly, the most profitable payment scheme from the airport's perspective is $(\ell^*, p_R^*) = ((z + v)/2, 0)$, which is observed in equilibrium when consumers are perfectly foresighted ($\delta = 1$). In such

[18] Interestingly, when δ increases, the yielded raise in landing fees just partially erase the increment in air travel demand. Again, it reflects the trade-off faced by the airport in finding an optimal payment scheme for the two groups of passengers.

[19] The expression in (8) suggests that the role of δ comes to be relevant in determining the demand only when the difference $\mathbb{E}[CS_h] - \mathbb{E}[CS_{-h}] \neq 0$.

[20] Far from the monopoly case where the one-way complementarity effect of the retail sector boosts the aeronautical profits, the symmetry of the duopoly model makes ineffective the effect of any exogenous increase of consumer foresight on the air-travel demand.

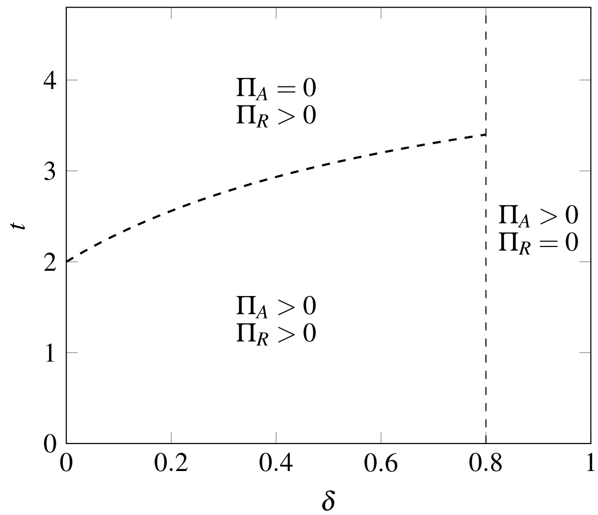

Fig. 3. Profit composition of a monopoly airport ($z = 1$, $s = 0.5$ and $v = 3$).

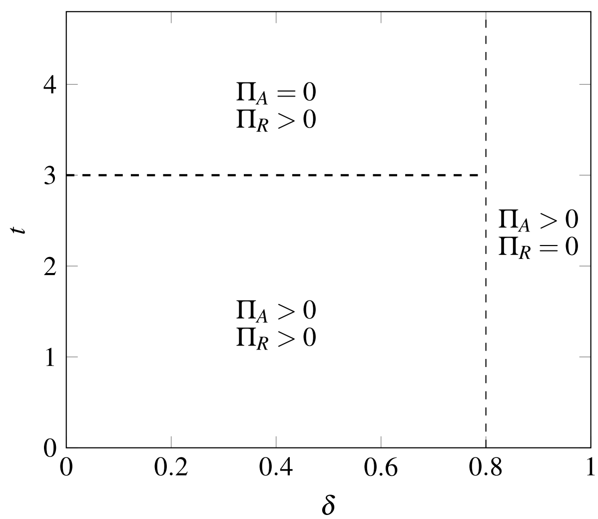

Fig. 4. Profit composition of a duopoly airport ($z = 1$, $s = 0.5$ and $v = 3$).

a situation, the airport (i) optimally exerts its market power over the passengers with a higher willingness to pay by charging the airline a high landing fees; and (ii) boosts the demand for flights of those farther passengers by inducing a low retail price that increases $\mathbb{E}[CS]$. By contrast, when consumers exhibit a certain degree of myopia ($\delta < 1$), they undervalue the expected retail surplus and, as a consequence, the airport is unable to implement the aforementioned optimal strategy because of the lack of consumer responsiveness to retail prices. Therefore, when passengers are not perfectly foresighted, the monopoly airport induces a sub-profitable payment scheme.

Under competition, a duopoly airport induces a sub-profitable payment scheme whatever the exhibited degree of consumer foresight. Differently from the monopoly case, increasing values of consumer foresight do not boost the airport market share because of the symmetric competition between airports in presence of a fixed size demand.[21] Competition exerts a downward pressure on the airfare as it shrinks the airports' market power. Therefore, the airport is unable to implement the optimal strategy and induces a sub-profitable payment scheme. We obtain that, under duopoly competition, profits are insensitive to changes in consumer foresight. Notably, when the retail business is relatively more lucrative ($t/s > 6$), airports find it more profitable to face a myopic demand (see Fig. 2).[22]

As already stated, changes in consumer foresight affect airport strategy and, consequently, profit formation.

Myopic passengers value more a cut in the airfare rather than a lower retail price. As a consequence, the airport discounts the extent of the retail price from the landing fees, thus inducing a lower airfare and a positive retail price.[23] Therefore, with myopic consumers, airport profits are driven by non-aeronautical revenues. By contrast, foresighted passengers have a better valuation of the expected retail surplus and, consequently, airports induce the lowest possible retail price $p_R = 0$ and raise landing fees. In this case, airport profits are fully driven by the aeronautical business, whereas the non-aeronautical one is used as a mere instrument to attract passengers.[24]

Although there is a common rationale explaining the airport's strategy under monopoly and duopoly, the observation of Figs. 3 and 4 reveals the presence of significant differences between the two market structures. These figures depict profit composition for different values of δ, t and s under monopoly and duopoly, respectively.[25] In both figures, three areas can be identified: one describing a scenario where the airport makes profits exclusively from the aeronautical business (i.e., $\Pi_A > 0$ and $\Pi_R = 0$); another one capturing the other extreme situation where profits come exclusively from the non-aeronautical business (i.e., $\Pi_A = 0$ and $\Pi_R > 0$) and finally, another describing the intermediate situation where both sectors are remunerative (i.e., $\Pi_A > 0$ and $\Pi_R > 0$).

When consumers are foresighted ($\delta > 4/5$), then $n^* \to \infty$ under both market structures, as we can see in Propositions 2 and 4. As a consequence, $\Pi_R = 0$ and profits come exclusively from the aeronautical business. This result holds irrespective of the degree of product differentiation in the retail business.

When consumers are myopic ($\delta \leq 4/5$), profits can come either uniquely from the non-aeronautical business or from both businesses. In this case, we observe different results under monopoly and duopoly. As we can see from Propositions 1 and 3, ℓ^* can be 0 depending on the particular values of t and t/s, respectively. Obviously, $\Pi_A = 0$ when $\ell^* = 0$. The observation of Figs. 3 and 4 shows the followings: under monopoly, the function that delimits the area where $\Pi_A > 0$ and the area where $\Pi_A = 0$ is increasing in δ, whereas under duopoly this function is independent of δ.

By juxtaposing Figs. 3 and 4, we obtain the five regions displayed in Fig. 5, where we consider $s = 1/2$ without loss of generality (s is just a shift factor). It can be observed that market structure has a relevant impact on profit composition in Regions II and IV.

[21] The presence of symmetric competition rules out the advantages of having foresighted consumers. In the symmetric equilibrium, the demand function in (10) does not longer depend on δ as it is equally split between the two airports. In other words, changes in consumer foresight do not affect airports' catchment areas.

[22] When $t/s > 6$, airports have no incentives to foster competition in the retail market by raising the number of the concessions to be awarded. Intuitively, a lower retail price produces two opposite effects on airport profits: (i) it exerts a downward pressure because it lowers the profitability of the non-aeronautical business; and (ii) it exerts an upward pressure since it attracts farther passengers, thus increasing the air-travel demand. It turns out that the airport would never be compensated for lowering the retail price. For this reason, under such payment scheme (p_A, p_R), airports earn higher profits.

[23] Depending on the actual market structure, the airport can either decide to totally or partially discount the extent of the retail price from the landing fee.

[24] By looking at Fig. 2, we can observe that the threshold value $\delta = 4/5$ delimits two segments in the airport's profit function. Within each of these segments, profits remain unaltered as δ changes. The reason is that there is a perfect compensation between an increase (decrease) in ℓ^* and a decrease (increase) in p_R^* due to the symmetric nature of airport competition.

[25] Airport profit function can be rewritten as $\Pi = \ell Q + p_R Q$ to highlight the source of profits: aeronautical (Π_A) and retail (Π_R).

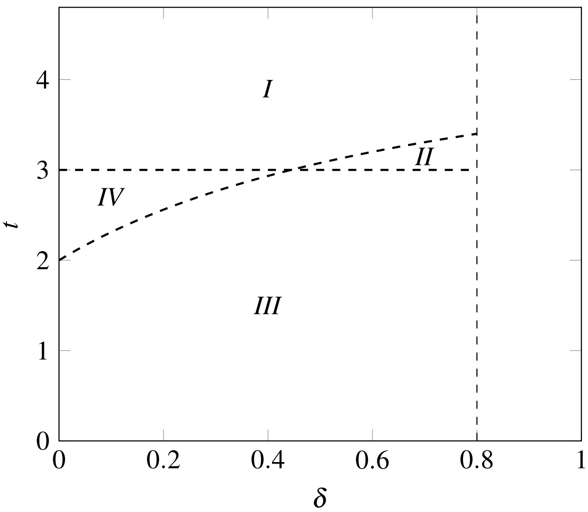

Fig. 5. Comparison of profit composition between a monopoly and a duopoly airport ($z = 1$, $s = 0.5$ and $v = 3$).

In Region II, a monopoly airport makes profits from both businesses ($\Pi_A > 0$ and $\Pi_R > 0$) whereas a duopoly airport focuses exclusively on the retail business ($\Pi_A = 0$ and $\Pi_R > 0$).

This region is characterized by relatively high levels of consumer foresight and a soft competition in the retail market (high t). In the absence of airport competition, higher levels of consumer foresight increase the extent of the anticipated $\mathbb{E}[CS]$, thus boosting travelers' demand and enhancing the airport market power. As a consequence of the enhanced market power, a monopoly airport can set positive landing fees and induce a positive retail price. In the presence of duopoly competition, higher levels of consumer foresight make passengers better off, but it does not turn into a higher travelers' demand as it is of fixed size. Competition prevents airports from gaining market power when consumers are more forward looking. Consequently, a duopoly airport induces the lowest possible airfare p_A (by setting $\ell = 0$) and a positive retail price thus making the retail business the only profitable one.

In Region IV, a monopoly airport makes profits only from the retail business ($\Pi_A = 0$ and $\Pi_R > 0$) whereas a duopoly airport does it from both businesses ($\Pi_A > 0$ and $\Pi_R > 0$).

This region is characterized by relatively low levels of consumer foresight and a fierce competition in the retail market (low t). In the absence of competition, the airport can increase its demand by inducing a low airfare and exploit the lack of consumer responsiveness to retail prices to earn higher profits through the retail business. As a consequence, a monopoly airport fosters the demand by setting a 0 landing fee and induces the highest possible retail price. Under duopoly competition, it is not profitable for an airport to cut prices and to try to attract passengers from its rival's catchment area. As a consequence, airports find it optimal to set positive landing fees and to induce a positive retail price, thus making profits from both businesses.

5. Managerial implications

This section offers managerial implications related to the effect of airport competition on optimal landing fees and to the strategic effect of airport advertising about retail facilities.

5.1. Airport competition and optimal landing fee

By looking at the airport profitability in the duopoly case (see Fig. 4), it is possible to observe that the aeronautical business is not profitable ($\Pi_A = 0$) when consumers are myopic ($\delta \leq 4/5$) and airports compete intensively ($t/s > 6$). Differently, when consumers are foresighted ($\delta > 4/5$), the source of profit changes and the only profitable business is the retail one. The analysis is similar in the monopoly case (see Fig. 3), except for the presence of an intermediate region where both businesses are profitable, so that the transition between the two extreme situations is more gradual.

When competition between airports is less intense ($t/s < 6$), a duopoly airport is able to make money from both businesses, whereas under monopoly $\Pi_A = 0$. In this case, it is easy to verify that landing fees are higher under duopoly competition than under monopoly, as stated in the following proposition.

Proposition 6. *When $s > \hat{s}$, airport competition leads to higher landing fees, with* $\hat{s} \equiv \dfrac{(4-5\delta)t + 4n(\delta v + z)}{24n}$.

The rationale behind this result lies on two main reasons: (i) airport competition is inherited by airlines that set a lower airfare p_A, thus allowing airports to set higher landing fees and (ii) under monopoly, the airport faces a larger catchment area than under duopoly competition. Therefore, the airport optimally gives up aeronautical revenues to boost the demand and to make higher revenues through the retail sector.[26]

When there are no rivals, the lack of competition favors the airline that can exert its market power and can exploit the one-way complementarity with the retail sector, thus leaving less space to the airport to set high landing fees. In addition, the airport can benefit of a bigger catchment area; therefore, it optimally moderates the extent of the airfare by setting low landing fees and makes profits through the retail sector. The rationale of this profit-maximizing behavior can be so explained. When $0 < \delta \leq 4/5$, passengers are myopic and the surplus they derive on the retail side plays a marginal role in their travel decision because they are more sensitive to changes in the airfare. As a consequence, the airport sets lower landing fees under duopoly to attract more passengers and make money through the retail sector. When $4/5 < \delta < 1$, landing fees are lower than the duopoly level which is justified by the higher number of passengers the airport can attract.[27]

With airport competition, airlines cannot longer exploit the one-way complementarity with the retail sector to set high fares as passengers have a valid alternative. This is the first condition pushing airports to set higher landing fees. At this point, we can distinguish two cases depending on the extent of the airport differentiation. First, when airport differentiation is high $s > \hat{s}$, airports can enjoy of a relatively high geographical monopoly over their catchment areas, so they do not find it profitable to cut their prices to attract passengers from its rival and make profits through the retail sector. Both effects push landing fees above the monopoly level. Second, when airport differentiation s is below this critical value, the two airports are more substitutable for passengers and price competition keeps the value of the landing fees below the monopoly level.

[26] Logically, profits are higher under monopoly than under duopoly competition.

[27] However the extent of such fees is not fixed and increases with the degree of consumer foresight, δ. Indeed, from the airport's perspective, the relative profitability of the aeronautical sector over the retail sector increases with δ. When $0 < \delta \leq 4/5$, the airport induces high retail prices. As δ goes to $4/5$, passengers become more aware of the high retail prices and the airport finds more profitable to subordinate the retail business in favor of a more profitable aeronautical business by increasing its fees. When $4/5 < \delta \leq 1$, retail prices are fixed at 0 so that the retail sector is no longer a source of profits for the airport. However, as we move toward $\delta = 1$, passengers gets increasingly aware of the benefits they derive on the retail side and the airport finds profitable to raise its fees.

		Airport 1	
		Ad ($\xi_1 = 1$)	No Ad ($\xi_1 = 0$)
Airport 0	Ad ($\xi_0 = 1$)	$\Pi_0(1,1), \Pi_1(1,1)$	$\Pi_0(1,0), \Pi_1(1,0)$
	No Ad ($\xi_0 = 0$)	$\Pi_0(0,1), \Pi_1(0,1)$	$\Pi_0(0,0), \Pi_1(0,0)$

Fig. 6. Payoff matrix of the stage 0 of the game.

5.2. Airport advertising strategy

A second managerial implication can be derived from Proposition 5. A monopoly airport would be interested in facing foresighted consumers as its profit increases with δ. Instead, a duopoly airport would take advantage from serving a myopic demand, as its profits are non-increasing in δ. Although consumer foresight is assumed to be exogenous, it could be affected by the airport through advertising campaigns. In the light of our results, a monopoly airport would be clearly prone to truthfully inform passengers about its retail facilities. Instead, this strategy cannot be necessarily sustained in the presence of airport competition.

Proposition 7. *Under competition, an airport is not necessarily interested in informing passengers about its retail facilities.*

A monopoly airport is interested in informing passengers about the retail services offered at the terminal as it can exploit the complementarity between the services to increase the demand, thus strengthening its market power and making higher profits. By contrast, under duopoly, symmetric competition prevents airports from exploiting such complementarity. As a consequence, if the retail business is highly profitable, airports are more interested in facing myopic passengers and making profits through overcharged side-services.

Interestingly, while for a monopoly airport it is unambiguously profitable to truthfully inform passengers about its retail facilities, it is not that clear when considering a duopoly airport. On the one hand, a duopoly airport might find it more profitable to keep passengers uninformed and make profits by selling overcharged retail services. On the other hand, not informing passengers when the rival airport does might translate into a loss of demand and profits. The following analysis studies the information strategy of a duopoly airport.

Extension including airport advertising. Let us consider a game where the competing airports decide whether to inform potential travelers about the retail facilities in their terminals through advertising campaigns or not to inform them. By looking at the profit evolution in Fig. 2, it is possible to observe that when the retail sector is profitable enough ($t/s > 6$), airports would be better off when facing myopic consumers ($0 < \delta \leq 4/5$). In the analysis that follows, we restrict our attention to a relevant case in which airport competition (t/s) is intermediate and the gross retail surplus (v) is high enough.[28] Moreover, without any loss of generality, we assume that advertising campaigns are costless for the airports.

Therefore, it is interesting to insert a stage 0 into our previous game where the airports decide whether to set an advertising campaign or not. This choice is represented by an airport-specific information-disclosure variable denoted by $\xi_h \in \{0,1\}$ with $h \in \{0,1\}$. Consequently, the profits of airport h can be expressed by $\Pi_h(\xi_h, \xi_{-h})$, giving rise to the game displayed in Fig. 6.

From the point of view of airport h, consumers turn to have the following indirect utility function: $Z_i(p_A, p_R, \xi; \theta) = z + \xi_h \delta \mathbb{E}[CS_h] - p_{A_h} - s|\theta_i - A_h|$. More specifically, we can identify two cases: (i) $\xi_h = 0$, the airport does not set advertising campaigns and consumers are not informed at all about the retail facilities in the terminal; and (ii) $\xi_h = 1$, consumers are informed and they are characterized by their innate degree of consumer foresight.[29]

The payoffs for the symmetric case presented in Fig. 6 refer to the results we derive from the duopoly case in Section 3.2, where we implicitly assume that both airports exogenously do inform/not inform travelers about the retail services ($\Pi_h(0,0), \Pi_h(1,1)$). While, the results for the asymmetric case in which one airport informs the consumers and the other does not ($\Pi_h(1,0), \Pi_h(0,1)$) are derived in the Appendix.

As in the previous sections, we consider the case of myopic and foresighted consumers. When $0 < \delta \leq 4/5$, travelers are myopic and they can anticipate a small percentage of the $\mathbb{E}[CS]$ and airports can induce a high price for the retail services and make profits rather than use them as an instrument to boost the demand. Instead when $4/5 < \delta < 1$, travelers are foresighted and they can anticipate a high percentage of $\mathbb{E}[CS]$, thus *forcing* the airports to induce a price for the retail services equal to the marginal cost (0 in this case) and use them to boost the demand. By looking at the profit evolution in Fig. 2, in case of a high degree of product differentiation (t), it is possible to observe that both the airports would have an unambiguous incentive to not set any advertising campaign and keep passengers uninformed. However, each airport has an unilateral incentive to deviate and make passengers informed. As a consequence, the following proposition can be derived.

Proposition 8. *Airport h profits are ordered as follows: $\Pi_h(1,0) > \Pi_h(0,0) > \Pi_h(1,1) > \Pi_h(0,1)$. Consequently, airports face a Prisoner's Dilemma as they are better off facing uninformed passengers, but they end up informing them by choosing $\xi_0 = \xi_1 = 1$.*

The intuition of the above result deals with the $\mathbb{E}[CS]$. When v is high enough, the extent of the expected retail surplus $\mathbb{E}[CS]$ is significant and boosts the demand that is attracted by the airport that decides to inform the passengers. Therefore, although a non informing airport could exploit the hidden nature of the retail products and keep their price at the maximum without affecting the passengers' decision, the demand would be too low and $\Pi_h(1,1) > \Pi_h(0,1)$. Therefore, informing passengers creates such an important advantage for the informing airport that the rival is forced to align and inform passengers as well.

6. Conclusion

In a framework where a multi-product airport faces passengers exhibiting a certain degree of consumer foresight, competition leads to significant implications. Our paper tries to capture some of them and yields the following results. First, the airports' strategy is insensitive to changes in market structure: in the presence of myopic passengers, it is optimal to charge low landing fees and induce high retail prices, so that the main source of profits is the retail business. Instead, when passengers are foresighted, airports optimally charge higher landing fees and induce lower retail prices. Second, the relationship between profits and consumer foresight strictly depends on the considered market structure. A monopoly airport can exploit the complementarity of the retail business to attract more passengers and, consequently, the effect of consumer foresight on airport profits is positive. Instead, under duopoly, the threat of competition prevents airports from using the aforementioned strategy and a weakly-negative correlation between airport profits and consumer foresight is observed.

[28] More precisely, we consider $6 < t/s < 18$ and $v > \frac{45st - 180s^2}{4t}$.

[29] Despite related, consumer foresight and consumer information are not the same concept as the myopia defines the characteristic that is inherent to a consumer who might fail to perfectly anticipate a utility she will derive in the future. Therefore, it cannot be chosen by the airport. Differently, consumer information can more easily be affected by the airport. In this particular case, a lack of information ($\xi_h = 0$) corresponds to a fully myopic case, while informed consumers ($\xi_h = 1$) still exhibit their natural degree of consumer foresight.

These results yield two main managerial implications. First, airport competition can lead to higher landing fees. Second, under competition, an airport is not necessarily interested in informing passengers about its retail facilities. However, the huge investments in advertising campaigns operated by airports suggest two possible scenarios: (i) a first one where passengers are foresighted and airport competition in most catchment areas is not very intense; and (ii) a second one characterized by myopic passengers and harsh airport competition.

Moreover, the main findings of the model suggest two testable hypotheses about the implications that the digital revolution have on the air-travel industry. With more informed passengers, airports have an incentive to expand the commercial area and to enhance the passenger overall travel experience. From the retailers' perspective, facing more informed customers translates into a harsher retail competition to offer the best personalized experience and to drive down prices.

Nonetheless, this model just partially captures the complexity of multi-sided platforms and consumer foresight. Primary activities are usually supported by a notable amount of complementary services and add-ons, each one with a different degree of complementarity. Heterogeneity in the degree of complementarity between services and primary activities can lead to the formation of more complex strategies.[30] Furthermore, this paper assumes consumer foresight to be homogeneous across passengers. The reality suggests that airports face a wide diversity of travelers, who are, among all, characterized by different degrees of consumer foresight. Moreover, we assume that airports do not have to compete for retailers. Actually, airports can make use of exclusive contracts to exclusively attract retailers at the airport. These limitations suggest extensions of our model which are left for future research.

CRediT authorship contribution statement

Giuseppe D'Amico: Conceptualization, Formal analysis, Writing.

Appendix A. Proofs

Proof of Propositions 1 and 2

The airport profit function $\Pi(\ell,n) = \left(\ell + \frac{t}{n}\right) Q(\ell,n)$ yields the following first-order derivatives:

$$\frac{\partial \Pi(\ell,n)}{\partial \ell} = Q(\ell,n) + \frac{\partial Q(\ell,n)}{\partial \ell}(\ell + \frac{t}{n}), \tag{A.1}$$

$$\frac{\partial \Pi(\ell,n)}{\partial n} = -\frac{t}{n^2}Q(\ell,n) + \frac{\partial Q(\ell,n)}{\partial n}(\ell + \frac{t}{n}). \tag{A.2}$$

Furthermore, notice that $\Pi(\ell,n)$ is concave in ℓ and that, as long as $t < \frac{8(z+\delta v)}{4+5\delta}$, $\lim_{\ell\to 0}\frac{\partial \Pi(\ell,n)}{\partial \ell} > 0$ and $\lim_{\ell\to\infty}\frac{\partial \Pi(\ell,n)}{\partial \ell} < 0$. These conditions along with continuity of $\Pi(\ell,n)$ imply that for an interior solution to exist, the following condition has to be satisfied: $\frac{\partial \Pi(\ell,n)}{\partial \ell}|_{\ell=\ell^*(n)} = 0$. Then, from (A.1) we can work out $\ell^*(n)$. By substituting it in (A.2), we obtain

$$\left.\frac{\partial \Pi(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)} = -\frac{t}{n^2}Q(\ell^*(n),n) + \left.\frac{\partial Q(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)}(\ell^*(n) + \frac{t}{n}), \tag{A.3}$$

where $\ell^*(n) = \frac{(4-5\delta)t+(4n(\delta v+z))}{8n}$, $\left.\frac{\partial Q(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)} = \frac{5\delta t}{8n^2 s}$, $Q(\ell^*(n),n) = \frac{(4-5\delta)t+(4n(\delta v+z))}{16ns}$.

By rearranging (A.3) and defining $\phi(\delta) \equiv \frac{(5\delta-4)t}{4(z+\delta v)}$ and $\psi(\delta) \equiv \frac{(z+\delta v)(5\delta-4)t}{16n^3 s}$, we obtain

$$\frac{\partial \Pi(\ell,n)}{\partial n} = \psi(\delta)\left[n - \phi(\delta)\right], \tag{A.4}$$

where

$$\phi(\delta)\begin{cases} <0 & if\ 0 \le \delta < \frac{4}{5} \\ =0 & if\ \delta = \frac{4}{5} \\ >0 & if\ \frac{4}{5} < \delta \le 1 \end{cases}, \qquad \psi(\delta)\begin{cases} <0 & if\ 0 \le \delta < \frac{4}{5} \\ =0 & if\ \delta = \frac{4}{5} \\ >0 & if\ \frac{4}{5} < \delta \le 1 \end{cases}. \tag{A.5}$$

The case of $\delta = \frac{4}{5}$ yields $\frac{\partial \Pi(\ell,n)}{\partial n} = 0\ \forall n$ and, therefore, has not been considered.

Now, consider first the case in Proposition 2, i.e., $0 \le \delta < \frac{4}{5}$. An interior would exist if satisfying the condition

$$n = \phi(\delta). \tag{A.6}$$

When $0 \le \delta < \frac{4}{5}$, $\phi(\delta) < 0$ so that an interior solution for n cannot exist because it can obtain only positive values. Indeed, by looking at the sign of (A.4):

$$\frac{\partial \Pi(\ell,n)}{\partial n} = \underbrace{\psi(\delta)}_{<0}\left(\underbrace{n - \phi(\delta)}_{>0}\right) < 0. \tag{A.7}$$

As we can observe, the expression in (A.7) is negative $\forall n \in [2,+\infty)$ as $\phi(\delta) < 0$ is always negative for that range of δ. Therefore, we obtain a corner solution, namely $n = 2$.

Now consider the case in Proposition 2, i.e., $\frac{4}{5} < \delta < 1$. Here, $\phi(\delta) > 0$ so that a critical point could exist if $\phi(\delta) \ge 2$. The function $\phi(\delta)$ is strictly increasing in δ and t; thus, by evaluating it at $\delta = 1$ and $t \to t^{max}$, it is possible to find un upper bound for $\phi(\delta)$. It is necessary to recall that $v < 24z/5$ and $v > 5t/8$ and, therefore, $t < 192z/25$.

By replacing them in $\phi(1)$, we obtain $\phi^{max} = \frac{192z/25}{z+24z/5} < 1$, where $\phi^{max} < n^{min} = 2$, so that an interior solution is not possible.

Again, by analyzing the sign of (A.4):

$$\frac{\partial \Pi(\ell,n)}{\partial n} = \underbrace{\psi(\delta)}_{>0}\left(\underbrace{n + \phi(\delta)}_{>0}\right) > 0. \tag{A.8}$$

From (A.8) we notice that the first-order derivative is positive, meaning that $n \to \infty$. □

Proof of Propositions 3 and 4.

The proof of these propositions follows the same intuition as in the proof of Propositions 3 and 4.

The profit function of a generic airport h is defined as $\Pi_h(\boldsymbol{\ell},\boldsymbol{n}) = \left(\ell_h + p_{R_h}\right) Q_h(\boldsymbol{\ell},\boldsymbol{n})$ and yields the following first-order derivatives:

$$\frac{\partial \Pi(\boldsymbol{\ell},\boldsymbol{n})}{\partial \ell_h} = Q_h(\boldsymbol{\ell},\boldsymbol{n}) + \frac{\partial Q_h(\boldsymbol{\ell},\boldsymbol{n})}{\partial \ell_h}(\ell_h + \frac{t}{n_h}), \tag{A.9}$$

$$\frac{\partial \Pi(\boldsymbol{\ell},\boldsymbol{n})}{\partial n_h} = -\frac{t}{(n_h)^2}Q_h(\boldsymbol{\ell},\boldsymbol{n}) + \frac{\partial Q_h(\boldsymbol{\ell},\boldsymbol{n})}{\partial n_h}(\ell_h + \frac{t}{n_h}). \tag{A.10}$$

By following the same framework of the previous proof, notice that $\Pi_h(\boldsymbol{\ell},\boldsymbol{n})$ is strictly concave in ℓ_h; furthermore, as long as $\frac{t}{s} < 6$, $\lim_{\ell_h\to 0}\frac{\partial \Pi(\boldsymbol{\ell},\boldsymbol{n})}{\partial \ell_h} > 0$ and $\lim_{\ell_h\to\infty}\frac{\partial \Pi(\boldsymbol{\ell},\boldsymbol{n})}{\partial \ell_h} < 0$. These conditions along with continuity of $\Pi_h(\boldsymbol{\ell},\boldsymbol{n})$ implying that, for an interior solution to exist, the following condition has to be satisfied: $\frac{\partial \Pi(\boldsymbol{\ell},\boldsymbol{n})}{\partial \ell_h}|_{\ell_h} = \ell_h^*(\boldsymbol{n},\ell_{-h}) = 0$. Because of the symmetry of the problem, the first-order derivatives can be, generically, rewritten as a function of ℓ and n, i.e.,

$$\frac{\partial \Pi(\ell,n)}{\partial \ell} = Q(\ell,n) + \frac{\partial Q(\ell,n)}{\partial \ell}(\ell + \frac{t}{n}), \tag{A.11}$$

$$\frac{\partial \Pi(\ell,n)}{\partial n} = -\frac{t}{n^2}Q(\ell,n) + \frac{\partial Q(\ell,n)}{\partial n}(\ell + \frac{t}{n}). \tag{A.12}$$

Thus, from (A.11), we can easily work out $\ell = \ell^*(n)$. By substituting it in (A.12) we obtain:

$$\left.\frac{\partial \Pi(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)} = -\frac{t}{n^2}Q(\ell^*(n),n) + \left.\frac{\partial Q(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)}(\ell^*(n) + \frac{t}{n}), \tag{A.13}$$

[30] For example, the *non-aeronautical sector* is composed of numerous services, e.g., car parking, shops and restaurants, real estate services, ground connections and so forth. Each one has a different degree of complementarity with the aeronautical sector.

where: $\ell^*(n) = 3s - \frac{t}{n}$, $\left.\frac{\partial Q(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)} = \frac{5\delta t}{24n^2 s}$, $Q(\ell^*(n),n) = \frac{1}{2}$.

By rearranging (A.13), we get

$$\left.\frac{\partial \Pi(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)} = \frac{(5\delta-4)t}{8n^2}. \tag{A.14}$$

When $0 \le \delta < \frac{4}{5}$ (the case relative to Proposition 3), we notice that, once applied symmetry, the $\left.\frac{\partial \Pi(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)} < 0$, so that we end up having the corner solution $n = 2$. Instead, when $\frac{4}{5} < \delta \le 1$ (the case analyzed in Proposition 4), $\left.\frac{\partial \Pi(\ell,n)}{\partial n}\right|_{\ell=\ell^*(n)} > 0$ and the function tends to its maximum as $n \to \infty$. □

Appendix B. Extension including airport advertising

From the above analysis, we already know that $\Pi_h(0,0) > \Pi_h(1,1)$ when $t/s > 6$ and $4/5 < \delta \le 1$. Therefore, in order to establish the ordering of profits in Proposition 8, we need to derive the payoffs for the asymmetric case in which just one of the two competing airports informs passengers about the retail facilities, i.e., $\xi_h \ne \xi_{-h}$ with $h \in \{0,1\}$.

Airline and airport demand. As in the previous section, the two airports compete à la Hotelling and are located at the endpoints of a linear city of unit length and $\theta \sim U[0,1]$ identifies passenger location. Differently from the previous section, travelers have the following indirect utility function:

$$Z_i(p_A,\boldsymbol{p_R};\theta) = \begin{cases} z + \delta\mathbb{E}[CS_h] - p_{A_h} - s|\theta_i - A_h| \\ \qquad \text{if the airport-h provides information,} \\ z - p_{A_h} - s|\theta_i - A_h| \qquad\qquad \text{otherwise.}\end{cases} \tag{B.1}$$

where, general considerations on θ_i, δ, $\mathbb{E}[CS_h]$ and p_A still hold from the previous sections. If passengers are not informed about the presence of retail facilities at the terminal, they behave in a fully myopic way. However, it is important to make two observations: (i) since $\mathbb{E}[CS_h] > 0$ by construction, when $p_{A_h} = p_{A_{-h}}$ passengers derive a higher utility by joining the airport providing information and (ii) when considering the *non-informing* airport, passengers do not take into account the price charged in the retail sector, which acts as a hidden cost.

By assuming that the airport located at h is the informing one, airports' demand turn to be

$$Q_h(\boldsymbol{p_A},\boldsymbol{p_R};\delta) = \frac{p_{A_{-h}} - p_{A_h} + s}{2s} + \frac{\delta}{2s}\mathbb{E}[CS_h], \tag{B.2}$$

$$Q_{-h}(\boldsymbol{p_A},\boldsymbol{p_R};\delta) = \frac{p_{A_h} - p_{A_{-h}} + s}{2s} - \frac{\delta}{2s}\mathbb{E}[CS_h]. \tag{B.3}$$

Second stage. In both airports, retailers and airlines choose prices simultaneously. For a generic airport h, retailers and airlines maximize: $\pi_j\left(\boldsymbol{p_A}, p_{R_j}, p_{R_k};\delta\right) = p_{R_j} Q_R(\boldsymbol{p_A}, p_{R_j}, p_{R_j};\delta)\, Q_h(\boldsymbol{p_A},\boldsymbol{p_R};\delta)$ and $\pi_A\left(p_A\right) = \left(p_A - \ell\right) Q_h(\boldsymbol{p_A},\boldsymbol{p_R};\delta)$, respectively, obtaining the following results.

Claim 1. *The optimal retail price is given by the standard Salop symmetric equilibrium outcome and the optimal airfare is composed of a standard Hotelling term plus a component depending on δ:*

$$p_{R_h}(\boldsymbol{\ell},\boldsymbol{n}) = \frac{t}{n_h}, \qquad p_{A_h}(\boldsymbol{\ell},\boldsymbol{n}) = \frac{3s + 2\ell_h + \ell_{-h}}{3} + \frac{\delta}{3}\frac{5}{4}\frac{t}{n_h}, \tag{B.4}$$

$$p_{R_{-h}}(\boldsymbol{\ell},\boldsymbol{n}) = \frac{t}{n_{-h}}, \qquad p_{A_{-h}}(\boldsymbol{\ell},\boldsymbol{n}) = \frac{3s + 2\ell_{-h} + \ell_h}{3} - \frac{\delta}{3}\frac{5}{4}\frac{t}{n_h}. \tag{B.5}$$

From the analysis of Claim 1, we observe that retailers, independently of the information provided by the airport, set-up a standard Salop price. Indeed as specified in the previous sections, under fixed expectations, retailers do not react to airport competition and set a price independently of the actual degree of consumer foresight. Differently, by looking at the prices set by the airlines, it is possible to observe that they are affected by the information provided by the airports. Indeed, if the airport provides information, travelers anticipate the surplus from the retail sector and the airline can set a higher airfare; otherwise, it has to set a lower airfare to attract more passengers.

By using (B.5), airports' demand can be rewritten as

$$Q_h(\boldsymbol{\ell},\boldsymbol{n};\delta) = \frac{\ell_{-h} - \ell_h + 3s}{6s} + \frac{\delta}{6s}\frac{5}{4}\frac{t}{n_h}, \tag{B.6}$$

$$Q_{-h}(\boldsymbol{\ell},\boldsymbol{n};\delta) = \frac{\ell_h - \ell_{-h} + 3s}{6s} - \frac{\delta}{6s}\frac{5}{4}\frac{t}{n_h}. \tag{B.7}$$

First stage. Airports compete by choosing landing fees and the number of concessions to allocate. Each airport is profit maximizer and, given the results in (B.4), (B.3) and (B.5), chooses its optimal strategy by solving: $\max_{\ell_h \ge 0, n_h \ge 2} \Pi_h(\boldsymbol{\ell},\boldsymbol{n}) = \left(\ell_h + p_{R_h}\right) Q_h\left(\boldsymbol{\ell},\boldsymbol{n}\right)$, with $h = \{0,1\}$.

Claim 2. *When passengers are myopic (i.e., $0 \le \delta \le 4/5$), the optimal landing fee and number of concessions chosen by the airports are given by*

$$\ell_h^* = \begin{cases} 3s - \frac{t}{2} + \frac{\delta}{3}(v - \frac{5}{4}\frac{t}{2}) & \text{if} \quad 0 < \frac{t}{s} < \frac{72}{12-5\delta}, \\ \frac{1}{2}(3s - \frac{t}{2} + \delta(v - \frac{5}{4}\frac{t}{2})) & \text{if} \quad \frac{t}{s} > \frac{72}{12-5\delta} \end{cases} \tag{B.8}$$

$$\ell_{-h}^* = \begin{cases} 3s - \frac{t}{2} - \frac{\delta}{3}(v - \frac{5}{4}\frac{t}{2}) & \text{if} \quad 0 < \frac{t}{s} < \frac{72}{12-5\delta}, \\ 0 & \text{if} \quad \frac{t}{s} \ge \frac{72}{12-5\delta} \end{cases}, \qquad n_h^* = n_{-h}^* = 2. \tag{B.9}$$

When travelers are myopic, each airport awards the minimum number of retail concessions and charges a relatively low landing fee, although the one charged by the informing airport might be above the standard Hotelling outcome.[31] Analogously to the airfare in the second stage, the landing fees embody the informative role of the airport. Indeed, as in the monopoly case, the informing airport can benefit of a positive mark-up given by the one-way complementarity with the retail sector, whereas the opposite holds for the non informing airport.

Generally, the rationale is the same of the monopoly and duopoly model observed in the previous sections: when consumers are myopic, they value more a lower airfare rather than a cut in the retail prices. Therefore, both airports induce the highest possible retail price by allowing for a concentrated retail sector and set relatively low landing fees to attract more passengers.

Also in this case, the results in the above claim depend on the ratio t/s. However, differently from the previous sections, we focus the explanation around the changes in s, that can be considered the airport geographical market power. When t/s is relatively high (case $t/s > \frac{72}{12-5\delta}$), because of the high competition, the airport geographical market power is very low, thus strengthening the position of the informing airport that can increase its customer base through the retail sector and set a positive landing fee and deteriorating the position of the non informing airport that responds by setting the lowest possible landing fee ($\ell_{-h}^* = 0$). When t/s is relatively low (case $t/s < \frac{72}{12-5\delta}$), the competition is less intense and the airport geographical market power is higher, high levels of s enhance the role of local monopolist held by either airports which can set positive landing fees.

It is worthy to observe that, when studying the asymmetric duopoly, we recover the role of δ on ℓ^* which we found in the monopoly case. While in the symmetric case the airports make identical choices, thus off-setting the effect on the landing fees of the one-way complementarity, in the asymmetric case airports behavior when setting landing fees critically changes depending on whether passengers were informed or not.

Now, let us consider the case with foresighted consumers ($\delta > 4/5$). In this case, travelers have a higher valuation of their retail surplus and the following claim arises.

[31] When $v > \frac{12t+5\delta t}{8\delta}$, the mark-up given by the one-way complementarity with the retail sector through $\mathbb{E}[CS_h]$ is so high that the airport can set landing fee above the standard Hotelling outcome.

Claim 3. *When passengers are foresighted (i.e., $4/5 \leq \delta \leq 1$), the optimal landing fee and number of concessions chosen by the airports are given by*

$$\ell_h^* = \frac{3s+\delta v}{2}, \qquad n_h^* \to \infty, \tag{B.10}$$

$$\ell_{-h}^* = 0, \qquad n_{-h}^* = 2. \tag{B.11}$$

When passengers are foresighted, they value more a decrease in the retail price rather than a cut in the airfare, but if not informed, they just focus on the airfare.

On the one hand, the strategy of the informing airport is not different from what we observed in the monopoly and symmetric duopoly cases, since passengers value more a decrease in the retail price, the airport allows concessions to make the retail sector as fragmented as possible, thus inducing a low retail price (zero in this case) and set high landing fees. Therefore, it turns out that only the aeronautical business is profitable.

On the other hand, the strategy of the non informing airport changes totally from what we have observed in the previous sections as the airport keeps the retail sector concentrated and set landing fees at the marginal cost (zero in this case). The rationale for this strategy can be explained through the passenger behavior. First, since passengers are not informed about the presence of the retail facilities, they are not aware about the presence of a retail price. Indeed, the retail price for a non informing airport cannot be used as an instrument to boost the demand by attracting travelers, thus it turns out that it would be unprofitable to induce a $p_{R_{-h}}^* \neq p_{R_{-h}}^{max}$. Therefore, the non informing airport award the minimum possible number of concessions. Finally, to boost the demand and try to compete with the informing airport, the airport sets the lowest possible landing fees $\ell_{-h}^* = 0$ and makes profits through the non-aeronautical sector.

It is now possible to make a precise ordering of the profits when $t/s > 6$. Consistently with the rest of the paper, we consider the case for myopic and foresighted consumers. For the sake of notation, let us use the subscript "S" to refer to the case in which just a single airport provides information and, for simplicity, we refer to airport h as the airport that informs travelers about its retail services, when the other does not.

When $0 < \delta \leq 4/5$ and both airports behave in the same way ($\xi_h = \xi_{-h}$), the equilibrium values are the same $n_h^* = n_{-h}^*$ and $\ell_h^* = \ell_{-h}^* = 0$ and the demand is perfectly split, therefore $Q_h^* = Q_{-h}^* = 1/2$, with $h \in \{0,1\}$. When $0 < \delta \leq 4/5$ and airports' choice is different ($\xi_h \neq \xi_{-h}$), we derive from the observation of (B.8), (12) and (B.9) that $n_h^* = n_{-h}^* = n_{S,h}^* = n_{S,-h}^* = 2$, but $\ell_{S,h}^* > \ell_h^* = \ell_{-h}^* > \ell_{S,-h}^* = 0$ and, by replacing the equilibrium values in (B.6) and (B.7), we have that $Q_h > 1/2 > Q_{-h}$.

Therefore, taking into account that the profit function for airport h is $\Pi_h = (\ell_h^* + t/n_h^*)Q_h^*$ and the considerations above, we can straightforwardly derive that $\Pi_h(1,0) > \Pi_h(0,0) > \Pi_h(1,1) > \Pi_h(0,1)$, with $h \in \{0,1\}$.

When $4/5 < \delta < 1$ and both airports behave in the same way ($\xi_h = \xi_{-h}$), also in this case the equilibrium values are the same and $Q_h^* = Q_{-h}^* = 1/2$. When $4/5 < \delta < 1$ and airports' choice is different ($\xi_h \neq \xi_{-h}$), we derive from the observation of the equilibrium values in (B.10), (12) and (B.11) that $\ell_{S,h}^* > \ell_h^* = \ell_{-h} > \ell_{S,-h} = 0$ and that $n_{S,h}^* = n_h^* = n_{-h}^* > n_{S,-h}^* = 2$ (so that, the retail sector is profitable only for the airport that does not inform travelers when the other does). Moreover, by replacing the equilibrium values in the demand function, it is easy to see that $Q_{S,h}^* > 1/2 > Q_{S,-h}^*$.

Differently from the previous case, the ordering is not that straightforward as not all the scenarios are directly comparable. However, by replacing the equilibrium values in the profit function, we obtain:

$$\Pi_h(1,0) = \frac{(3s+\delta v)^2}{24s}, \tag{B.12}$$

$$\Pi_h(1,1) = \frac{3s}{2}, \tag{B.13}$$

$$\Pi_h(0,0) = \frac{t}{4}, \tag{B.14}$$

$$\Pi_h(0,1) = \frac{t(9s-\delta v)}{24s}. \tag{B.15}$$

Then, it is easy to verify that: $\Pi_h(1,0) > \Pi_h(0,0) > \Pi_h(1,1) > \Pi_h(0,1)$, with $h \in \{0,1\}$. □

References

Adler, N., Fu, X., Oum, T.H., Yu, C., 2014. Air transport liberalization and airport slot allocation: The case of the Northeast Asian transport market. Transp. Res. A 62, 3–19.

Armstrong, M., 2006. Competition in two-sided markets. Rand J. Econ. 37 (3), 668–691.

Bertini, M., Ofek, E., Ariely, D., 2008. The impact of add-on features on consumer product evaluations. J. Consum. Res. 36 (1), 17–28.

Bettini, H.F., Oliveira, A.V., 2016. Two-sided platforms in airport privatization. Transp. Res. E 93, 262–278.

Bracaglia, V., Nastasi, A., D'Alfonso, T., 2014. Competition between multiproduct airports. Econ. Transp. 3 (4), 270–281.

Czerny, A.I., Zhang, H., 2020. Rivalry between airport ancillary and city-center supplies. Transp. Res. E (ISSN: 1366-5545) 141, 101987.

D'Alfonso, T., Bracaglia, V., Wan, Y., 2017. Airport cities and multiproduct pricing. J. Transp. Econ. Policy 51 (4), 290–312.

Ellison, G., 2005. A model of add-on pricing. Q. J. Econ. 120 (2), 585–637.

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

Gabaix, X., Laibson, D., 2006. Shrouded attributes, consumer myopia, and information suppression in competitive markets. Q. J. Econ. 121 (2), 505–540.

Hagiu, A., Hałaburda, H., 2014. Information and two-sided platform profits. Int. J. Ind. Organ. 34, 25–35.

Ivaldi, M., Sokullu, S., Toru, T., 2012. Are airports two-sided platforms?: A methodological approach. In: Pricing Behavior and Non-Price Characteristics in the Airline Industry. Emerald Group Publishing Limited.

Kasarda, J.D., 2019. Aerotropolis. In: The Wiley Blackwell Encyclopedia of Urban and Regional Studies. Wiley Online Library, pp. 1–7.

Malavolti, E., Marty, F., 2017. State aids granted by regional airports: a two-sided market analysis. Transp. Res. Procedia 25, 30–40.

Oum, T.H., Zhang, A., Zhang, Y., 2004. Alternative forms of economic regulation and their efficiency implications for airports. J. Transp. Econ. Policy 38 (2), 217–246.

Rochet, J.-C., Tirole, J., 2003. Platform competition in two-sided markets. J. Eur. Econom. Assoc. 1 (4), 990–1029.

Salop, S.C., 1979. Monopolistic competition with outside goods. Bell J. Econ. 10 (1), 141–156.

Starkie, D., 2002. Airport regulation and competition. J. Air Transp. Manag. 8 (1), 63–72.

Starkie, D., 2008. The airport industry in a competitive environment. OECD Publishing.

Verboven, F., 1999. Product line rivalry and market segmentation—with an application to automobile optional engine pricing. J. Ind. Econ. 47 (4), 399–425.

Yang, H., Zhang, A., 2011. Price-cap regulation of congested airports. J. Regul. Econ. 39 (3), 293–312.

Zhang, A., Zhang, Y., 2003. Airport charges and capacity expansion: Effects of concessions and privatization. J. Urban Econ. 53 (1), 54–75.

Zhang, A., Zhang, Y., 2010. Airport capacity and congestion pricing with both aeronautical and commercial operations. Transp. Res. B 44 (3), 404–413.