# Making Sense of (Ultra) Low Cost Flights

## Vertical Differentiation in Two-Sided Markets

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**Abstract**

The business model of low cost carriers is now well established and accounts for a large share of western civil aviation, particularly in Europe. To understand why it has proven so successful, we develop a theoretical model which exploits the two-sided nature of flights as connectors of supply and demand for goods and services other than traveling itself across physical space. Carriers offer flights of different quality and may sign agreements with suppliers of goods and services at destination so as to subsidize and foster demand from the carriers' travelers as in standard two-sided markets. Customer-travelers care about home and destination consumption and about the flight's quality. Hence, beyond the thickness of the connected sides of the market, the quality of the airline-platform has an intrinsic value to travelers. We show that only cash constrained travelers fly with low cost airlines, while no-frills carriers are more likely to act as a platform than legacy airlines. We study the impact on the equilibrium market structure of the airline industry of several features, such as how competitive is the destination market, or the extent to which home and destination consumption are substitutes.

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# 1 Introduction

Almost all Europeans and most Americans are familiar with low cost flying. While low cost airlines exist since the '70s,[1] the phenomenon has constantly grown. At least since the late '90s it has reached a mass market status into what is now considered an established but still growing industry. This is particularly true of the European commercial aviation: with the emergence of budget airlines in the late '90s the growth trend of established network carriers has stopped. Today, full service carriers still handle approximately the same demand for air travel as in 2000, while their relative market share has decreased. In contrast, low cost carriers have grown at high double digit rates and captured large parts of the market. They have expanded their market share from 5% in 2001 to 32% in 2008. In some European countries, low cost carriers even dominate the market. In Spain, they account for 50% of the total international capacity offered, in Poland even for 52%. Also in other economies, budget carriers have been able to expand their market share in an impressive way over the last decade, which puts severe pressure on established network carriers. In Germany, Europe's largest economy, low cost airlines operate 29% of the international and 44% of the domestic flights.[2]

While low cost companies were growing steadily, the 2000s witnessed a sharp increase in the demand for air travel in Europe, which jumped by around 47% between 2000 and 2008.[3] To some extent this may be due to a higher flying frequency for some travelers but that does not explain the entire picture. The evidence suggests that the entrance of low cost carriers into the industry has made access to air traveling possible to lower income people for whom traveling with established carriers was not affordable.[4] A considerable share of the new traffic is made up of tourists traveling inside Europe.[5] At least until recently, attracting this 'new demand' has been the core business of budget airlines.

The recognized champion of the low cost flying saga is Ryanair, which alone has a market share of short haul passengers in Europe around 14%.[6] Such an impressive score is accompanied by announcements like that released by Ryanair chief executive Michael O'Leary in November 5, 2007: "It's our ultimate ambition to get to a stage where the fare is free."[7] That interview focused on cost containment

[1]During the '60s and the '70s Loftleidir pioneered as a low fare service airline across the North-Atlantic flying into Luxembourg "the heart of Europe." The airline became very popular among college students traveling abroad and soon became know as "The Hippie Airline" flying among others former US president Bill Clinton. The first fully low cost airline is generally considered to be the American company Southwest which launched in 1971, with the then revolutionary concept that you could lower the cost of ticket prices by eliminating some of the extras and therefore save passengers money.

[2]Future Scenarios for the European Airline Industry, a 2010 Report of the Center for Scenario Planning, Roland Berger Research Unit and HHL - Leipzig Graduate School of Management.

[3]See Footnote 2.

[4]"In the 1950s flying was a privilege enjoyed by only the wealthiest. The costs of flying were simply too high for most ordinary folk. In 1952 a London-to-Scotland return flight would set the average Englishman back a week's wages; a trip to New York might require saving up for five months. But in 2013 flying is a mass market, due in no small part to the growth of "no-frills" airlines offering flights at very low prices." from The Economist website at www.economist.com/blogs/economist-explains/2013/10/economist-explains-13.

[5]See, e.g, the UK Civil Aviation Authority report "Demand for Outbound Leisure Air Travel and its Key Drivers" (December 2005) available at www.caa.co.uk/docs/5/erg_elasticity_study.pdf.

[6]Ryanair share of seats among all carriers in period April 29 – May 5, 2013. See www.centreforaviation.com/analysis/ryanair-europes-lowest-cost-producer-wins-again-reporting-record-profit-of-eur569-million-110543.

[7]See www.dailymail.co.uk/news/article-491907/No-cost-flights-Ryanair–passengers-incur-costs.html.

as Ryanair was about to introduce a tightening of the pay-for-frills policy with the doubling of check-in as well as baggage fees. Indeed, cost minimization is the backbone strategy of every low cost airline: saving on 'frills' to lower prices and attract low budget travelers. However, Ryanair's average fare in 2013 (€48) was by far the lowest, with the second cheapest (Easyjet, €82) charging 71% higher.[8] Which allows Ryanair to define itself as a (ultra) low cost carrier. Can this performance be explained just as a result of cost reduction? Clearly not.

A distinguished feature of its business strategy is the way Ryanair deals with its more than seventy 'bases' around Europe.[9] Among the airports in which Ryanair operates, the bases are those hosting the carrier's fleet. More importantly, most bases are almost exclusively operated by Ryanair, which is by far the first carrier of the airport. This is not by chance: Ryanair carefully chooses its bases targeting minor airports situated not far from attractive locations. The small size of such airports — at least before the arrival of Ryanair — grants the carrier a bold stance when bargaining the terms of its operations. The convenient location grants Ryanair a sustained demand, perhaps because next to an important touristic attraction. The one described so far is just an aggressive cost minimizing/demand enhancing strategy.

Ryanair, however, is the only carrier which goes (way) beyond that: realizing that many of its passengers are leisure travelers and likely customers of destination goods and services (hotels and touristic services, local food products, fashion garment, etc.) the carrier actively exploits its role of connector between demand and supply to extract part of (and sometimes most of) the potential gains from trade. In fact, to some extent all air carriers build networks which create exchange opportunities — i.e. network externalities. But only Ryanair actively exploits this platform côté of air traveling. To see how, one has to look at the contracts agreed to by Rayanair when the airline opens a base. Such contracts are typically signed with the companies managing the airport but most often involve local authorities, business representatives such as chambers of commerce and, more generally, 'destination stakeholders'. Some examples of destination stakeholders are: the Oriocenter Shopping Center[10] in Milan Orio al Serio, Airgest and Regione Sicilia in Trapani Birgi, Regione Puglia in Brindisi, Cataluña and Costa Brava hotels in Reus and Gerona,[11] etc.

The agreements between the (ultra) low cost carrier and destination stakeholders usually stipulate that the latter pay Ryanair an amount varying with the number of passengers that the carrier commits to fly at destination. For instance, Trapani paid €20 millions in five years and passengers soared from 533 thousands in 2008 to 1.2 millions in 2012.[12] In some cases the contractual relationship is mutually advantageous and sustainable, but it frequently happens that the terms disproportionately favor Ryanair: while, for instance, Orio al Serio and Brindisi are success stories, the airport of Verona — which paid

[8]Source: latest published company year end information, as reported in the Full Year Results 2013, Ryanair.

[9]The opening of the 71st base (Bratislava) was announced on Nov 13, 2014 on the Ryanair Website. In December 2013 Ryanair had 57 bases according to the Full Year Results 2013.

[10]More information at www.oriocenter.it.

[11]See (in Spanish) www.elperiodicomediterraneo.com/noticias/castellon/cataluna-paga-46-millones-ryanair-traer-turistas-reus-girona_728694.html.

[12]For concise information on Italian airports dealing with Ryanair see (in Italian) https://it.finance.yahoo.com/foto/gli-aiutini-di-stato-a-ryanair-slideshow.

the carrier €24/passenger until recently — got close to bankruptcy.[13]

This paper is about the economics underlying the business model of Ryanair. It aims at explaining the success of the (ultra) low cost carrier, its impact on the industry and the consequences for the consumption habits of millions of low–to–mid income people. It does so by recognizing and modeling the unique feature of Ryanair's strategy: not just competing on quality as a normal low cost carrier, but actively exploiting the network externalities inherent in moving people across markets. Ryanair acts as a platform connecting demand and supply located in different countries and extracts part of the generated surplus to keep its fares at otherwise unprofitably low levels. It therefore competes on quality with other carriers but, at the same time, generates profits by selling its platform services in many two-sided markets around Europe, each associated to a specific network externality characteristic of each route.

We deem natural to model the airline industry as a vertically differentiated duopoly in which two airlines, a low quality (low cost) carrier and a high quality (full service) one, compete to attract potential travelers on a given route as in standard models. Customer-travelers have different income levels and care primarily about the flight's quality and, secondly, about goods' consumption. They can purchase goods both at home and, if they travel, at destination, where they can source from a number of shops. These destination businesses are collectively represented by a local stakeholder (chamber of commerce, regional council, shopping mall, etc.). We depart from the standard vertical differentiation setup assuming that carriers have the opportunity to propose a contract for operating the route to the local stakeholder. The latter can strike a deal with just one carrier — that is, contracts are exclusive. The destination stakeholder, however, sells goods and services to the travelers brought at destination by both carriers. Hence, while traveling with either carrier generates positive network externalities on travelers — i.e., being able to purchase at destination — only one carrier can price on both sides of the market as a proper platform, whereas the other prices just on the traveler's side. Put differently, exclusivity implies that only one carrier can internalize the network externalities it generates. We study and compare three scenarios: a standard competition benchmark in which no carrier deals with the local stakeholder, one in which the stakeholder deals with the full service carrier and one in which he deals with the low cost carrier.

We find that the optimal contract between the local stakeholder and a carrier is a two-part tariff prescribing a per-passenger payment to the carrier in exchange of a fixed amount to the stakeholder. Not surprisingly, the stakeholder finds always optimal to deal with a carrier rather than not signing any contract — i.e., the competition benchmark is never an equilibrium when contracting is possible. More importantly, we show that the overall demand for air traveling depends on the level of low cost carrier tariff and increases when the latter decreases. Indeed, we find that demand is larger when a carrier deals with the stakeholder and, in particular, it is largest when the carrier is a low cost one, confirming the evidence from low cost airlines' emergence and passengers' data. Moreover, travelers flying low cost are cash-constrained — i.e., they would prefer to travel on a full service flight — while very low-income consumers prefer not to fly at all — i.e., the marginal passenger is not cash-constrained.

[13]See Footnote 12.

Next, we find conditions under which contracting with the low cost carrier is more efficient than contracting with the full service carrier. It turns out that dealing with the low cost airline is more efficient whenever the cost of consumption is high relative to the cost of flying: when this is so, because the tariff reduction is stronger under low cost–stakeholder contracting, dealing with the low cost generates a larger increase in demand, as seen above, and allows consumers/travelers to spare more money to spend at destination. We then verify how the parameters of the model such as the love for variety, the number of goods' varieties and their production costs affect the chances that the equilibrium contract is offered to either carrier.

Our results closely track the strategy and market outcomes observed in practice. From a theoretical point of view they are made possible by the combination of vertical differentiation and two-sidedness into a single framework. The literature is vast on both aspects and reviewing it goes beyond the scope of this work. See, however, Rochet and Tirole (2006) on two-sided markets and Tirole (1988) on vertical differentiation. Our work lays at the intersection of these strands of the literature. To the best of our knowledge, no other work shares a structure similar to ours. However, following Armstrong (2006), many authors have studied competition between networks and the idea that competing platforms may differentiate is not novel. Although we do not model network competition, it is worth mentioning those works which have studied differentiation in such models. Argenziano (2008) presents a model in which two ex-ante identical networks compete to attract agents who have imperfect information about the network quality (a common value) as well as heterogeneous (private) valuations about the goods on sale. She finds conditions for unique equilibria to emerge and shows that networks are suboptimally differentiated because consumers fail to internalize externalities due to the asymmetric information structure of the model. Our model differs in several ways: carriers' qualities — i.e., the common value — are common knowledge; consumers are heterogeneous with respect to their income levels, not preferences; both carriers compete on the air traveling market but only one uses platform pricing. Gabszewicz and Wauthy (2014) model competition between two vertically differentiated platforms — while Ribeiro, Correia-da-Silva, and Resende (2014) build on their framework. In these works a platform's quality is endogenous and is higher the larger the market share and the associated network externalities. Their platforms compete to attract users as in classical models and have no value *per se*. To the contrary, because in our framework consumers care *directly* about it, airlines compete on the intrinsic quality of their flights, independently of network externalities. These are internalized on top of and interact with the standard competitive environment of a vertically differentiated duopoly.

The paper is organized as follows: Section 2 presents the model. Section 3 analyses optimal consumer's behavior, studies monopolistic competition between destination shops and derives flights' demand as a function of the carrier's pricing decisions. Section 4 studies the standard competition scenario, the scenario in which the low cost carrier deals with the local stakeholder and than in which the full service does, and compare the equilibrium outcomes. Section 5 characterizes the market structure which emerges endogenously in equilibrium and its determinants. Section 6 concludes.

## 2 Model

*Players.* Two airlines must decide how to operate a route to a given location providing services of different qualities: airline $F$ is a Full Service carrier committed to high-quality standards, airline $L$ is a Low Cost carrier with a no-frills policy. Carrier $F$ offers a quality $Q_F$ and charges a tariff $T_F$ per passenger while carrier $L$ offers quality $Q_L < Q_F$ and charges $T_L$. For tractability reasons we take qualities as exogenous, $Q_L$ is normalized to 0 without loss of generality, and we assume that carrier $F$ sustains no cost for meeting quality standard $Q_F$.[14]

Located near the destination airport are $M \geq 3$ businesses — they could be hotels, museums, etc. but for the remaining of the paper we will call them *shops* and, to name them collectively, we will adopt the Mall example, using alternatively the terms shops and Mall. Each traveler $k$ may buy a quantity $q_{ik} \geq 0$ of the good provided by shop $i$ at price $p_i$. Shops are naturally interested in airlines' decisions insofar as passengers are potential buyers. In order to attract buyers, the shops — which, for the sake of simplicity, create the 'Mall' to deal with airline companies[15] — may be willing to subsidize airline $I$ with a transfer $S_I$ per traveler carried to destination. To partially compensate for this, optimal contracts between airlines and the Mall may have a two-part tariff structure, prescribing a fixed transfer $Z_I$ to the Mall, which is evenly split between shops. In this case each shop subsidizes airline $I$ with a payment $s_I = S_I/M$ per traveler carried by airline $I$ and receives a fixed payment $z_I = Z_I/M$.[16] Goods have constant unit cost $c > 0$ to each shop. Beyond goods at destination, whether he flies or not, a potential traveler $k$ may consume a quantity $q_{0k} \geq 0$ of a numéraire good at home at the normalized price $p_0 = 1$.

Finally, there is a unit-mass of travelers indexed by $k$ and characterized by a uniformly distributed income $I_k \sim \mathrm{U}[0,1]$. Travelers use all their income for flying and buying goods, i.e. they derive no utility from money *per se* and care only about the flight's quality and shopping at home and at destination. Building on Dixit and Stiglitz (1977), the utility function of traveler $k$ when flying with carrier $I$ is a nested CES on consumption goods with the addition of a quasi-linear component on flight's quality

$$U_I^k\left(Q_{Ik}, q_{0k}, q_{1k}, ..., q_{Mk}\right) = Q_{Ik} + \left(q_{0k}^{\varphi} + \left(\sum_{i=1}^{M} q_{ik}^{\rho}\right)^{\frac{\varphi}{\rho}}\right)^{\frac{1}{\varphi}} \qquad I = F, L \tag{1}$$

where the CES parameters $\varphi \in (0,1)$ and $\rho \in (0,1)$ reflect consumers' *taste for variety*: between home

[14]While the model is robust to the introduction of a cost of quality — as long as it keeps the Full Service carrier in business —, the zero costs assumption simplifies the analysis without sacrificing any intuition. The only drawback is that the profits of the Full Service carrier are trivially higher than those of the Low Cost carrier in equilibrium. A complete analysis is available upon request.

[15] We assume such an association exists and we justify this assumption on two grounds: from an empirical point of view associations like these are common in practice (e.g. the Oriocenter Shopping Center, in Milan Orio al Serio or Chambers of Commerce, Hotels' in Gerona and Reus, etc. See Footnotes 11 and 12); from a theoretical perspective, instead, coordination incentives are typically strong in contexts as the one described here, as it will be clear in the remainder of the paper.

[16]In most of the analysis we will refer to contracts specifying the Mall-level transfers $S_I$ and $Z_I$, but, particularly when dealing with shops' optimal behavior and occasionally elsewhere, we will use the shop-level notation $s_I$ and $z_I$.

and destination goods, $\varphi$, and between goods at destination, $\rho$.[17] The $k$ subscript denotes the choice of consumer $k$ endowed with income $I_k$. The utility of a consumer who does not travel depends on the numéraire good alone and is

$$U_N^k(q_{0k}) = q_{0k}.$$

*Timing.* The structure of the airline industry game is as follows:

$t = 1$ Carriers set the quality levels $Q_I \in \{0, Q_F\}$.

$t = 2$ Carriers set fares $T_I$ and propose contracts $(s_I, z_I)$ to the Mall.

$t = 3$ The Mall decides whether and which contract to accept and shops set prices $p_i$, $i = 1, .., M$.

$t = 4$ Consumers decide whether to fly and the amount of goods to purchase.

*Equilibrium concept and strategies.* The game is a sequential game with complete information and the natural solution concept is Subgame Perfect Nash Equilibrium. We focus on pure strategies. The actions available to carrier $I$ are $\{Q_I, T_I, S_I, S_I\}$ with $Q_I \in \{0, Q_F\}$, $T_I$, $S_I$ and $Z_I$ non-negative. The action space of each shop is $\{$'Accept $(s_I, z_I)$', 'Not Accept $(s_I, z_I)$', $p_i\}$ for $I = F, L$ and $i = 1, ..., M$ with $p_i \geq 0$. Finally, traveler $k$'s actions are $\{$'Not fly', 'Fly with $F$', 'Fly with $L$', $q_{0k}, ..., q_{Mk}\}$.

## 3 Consumers' and shops' behavior

*Consumer's behavior.* Our equilibrium analysis proceeds by backward induction, starting from the consumer's decisions. There are three types of consumers: those who don't fly, those who fly with $F$ and those who fly with $L$. Consumers who don't fly spend all their income for the home good and get utility $U_N^k = I_k$. The consumption decisions of those who fly are more nuanced. Let's thus study the purchasing choices at destination of a traveler who has decided to fly with airline $I \in \{F, L\}$. Given shops' prices, the consumer maximizes (1) subject to the budget constraint

$$I_k - q_{0k} - T_I - \sum\nolimits_{i=1}^{M} p_i q_{ik} \geq 0. \tag{2}$$

The optimal demand of consumer $k$ for the numéraire and destination good $i$ is

$$q_{0k} = \frac{I_k - T_I}{1 + P^{1-\tau}} \tag{3}$$

$$q_{ik} = \frac{P^{\sigma-\tau}}{p_i^{\sigma}} \frac{I_k - T_I}{1 + P^{1-\tau}} \qquad i = 1, ..., M \tag{4}$$

[17] The parameter $\rho$ determines the elasticity of substitution between shops' items, $\sigma = \frac{1}{1-\rho}$. A higher $\rho$ implies a higher substitutability in consumers' preferences for destination goods, a lower $\rho$ a higher taste for variety. Similarly, $\tau = \frac{1}{1-\varphi}$ is the elasticity of substitution between the home numéraire $q_0$ and the bundle of destination goods $(q_1, ..., q_M)$.

where $P \equiv \left(\sum_{i=1}^{M} p_i^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ is the "destination price index" and $\sigma = \frac{1}{1-\rho} > 1$ and $\tau = \frac{1}{1-\varphi} > 1$ are the elasticity of substitution between goods at destination and between home and destination goods respectively.[18] Clearly, the quantity of both home and destination goods purchased by traveler $k$ increases with his income net of traveling costs ('net income' hereafter).

Combining (1), (3) and (4), the utility of traveler $k$ flying with $I$ is

$$U_I^k = Q_I + \frac{I_k - T_I}{\Pi}, \tag{5}$$

where $\Pi \equiv \left(1 + P^{1-\tau}\right)^{\frac{1}{1-\tau}}$ is a "global price index" comprehending both home prices ($1^{1-\tau}$) and the price index of destination goods ($P^{1-\tau}$) and does not exceed 1.[19] Naturally, $U_I^k$ increases in the flight's quality, $Q_I$, and in net *real* income, $\frac{I_k - T_I}{\Pi}$.

Having characterized goods' consumption choices of consumer $k$, let's now consider his flying decisions. Let's begin with the choice to travel altogether. He will travel if, for at least one airline $I$, it holds

$$U_I^k \geq U_N^k \quad \Longleftrightarrow \quad I_k \geq \frac{T_I - \Pi Q_I}{1 - \Pi}, \tag{6}$$

while he will not travel if (6) is never satisfied. The flying condition above is stricter the higher the cost of flying, $T_I$, while it is met more easily when flying provides a higher utility, $Q_I$. More interestingly, the effect of the price index $\Pi$ on the flying decision depends on whether $Q_I/T_I$ — the flight's marginal utility per euro spent on flying — is greater or lower than 1: as $\Pi$ increases, less (resp. more) consumers will travel when $Q_I < T_I$ (resp. $>$). To understand why, notice that: *i*) the utility is linear in income for those who don't fly ($U_N^k = I_k$); and, *ii*) given the constant price of the numéreaire, $p_0 = 1$, an increase of $\Pi$ is, in fact, an increase in $P$, the price of destination goods. Thus, when $Q_I < T_I$, returns to flying per euro spent are low and consumers would not fly if there were no purchasing opportunities at destination: an increase in $\Pi$ makes destination goods relatively more expensive and traveling becomes less appealing. *Vice-versa*, when $Q_I > T_I$, flying provides higher returns than home consumption itself: while, again, destination goods become more expensive and are substituted with domestic consumption, flying becomes relatively cheaper in real terms and its return per euro spent looms larger when other prices increase.

Let's now assume for a moment that (6) holds for both carriers and consider the choice of which airline to patronize. Traveler $k$ will fly with a Full Service carrier if

$$U_F^k \geq U_L^k \quad \Longleftrightarrow \quad Q_F \geq \frac{T_F - T_L}{\Pi}. \tag{7}$$

Condition (7) is indeed a condition for the existence of the demand of Full Service flights and we assume it holds throughout.[20] Its interpretation is straightforward: as long as the price premium associated

[18] See footnote 17.

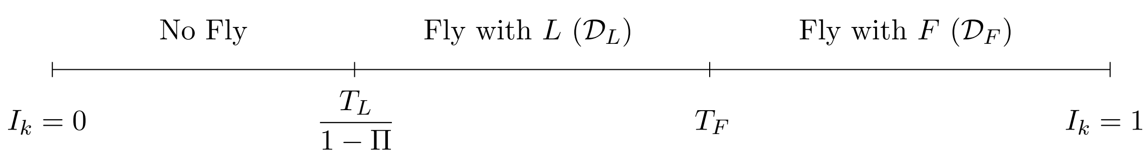
[19] It is easy to show that, for $\tau > 1$ and $P > 0$, it holds $\Pi \in (0, 1)$. See Lemma 2 for further details.

[20] We will check later that, given the exogenous value of $Q_F$, equilibrium tariffs are consistent with condition (7).

to higher quality, $T_F - T_L$, is not too large, travelers prefer a more comfortable flight. However, the condition is harder to be satisfied when the price index is small: in fact, when the price index is low, the marginal utility of money spent at destination is high. Hence, the Full Service carrier has to increase its quality or reduce its fare to attract travelers. Indeed, if prices are low enough, travelers may prefer to save money on flight's extra quality for goods' consumption at destination. Thus, a quality premium which is acceptable for high shop prices may become unacceptable when prices are low enough: flight quality and goods' purchases are substitutes.

Notice that assumption (7) does not depend on income: if it holds, whenever they can afford it, travelers prefer to fly with a Full Service airline. Moreover, it implies that the income level satisfying the flying condition (6) is lower for the Low Cost carrier than for the Full Service carrier. This gives rise to a simple assignment of optimal flight choices based on income: low income consumers (with $I_k < \frac{T_L}{1-\Pi}$) prefer to stay home; those with higher income want to travel and wish to fly with the Full Service airline, but a part of them — say the middle class (with $\frac{T_L}{1-\Pi} < I_k < T_F$) — cannot afford it, while the remaining consumers — the upper class (with $I_k > T_F$) — fly with the high quality company. The market demand for flights just described is illustrated in Figure 1.

Figure 1: Optimal flight choices and Income




While the Full Service carrier's demand is fully determined by a mere cash constraint, the lower bound of the Low Cost carrier's demand is pinned down by a preference constraint and depends in a more nuanced fashion on the goods' consumption preferences through the price index $\Pi$. As it will be clear later, this has deep implications as to the pricing policies and to the capability of the Low Cost carrier of exploiting its platform nature. Finally, throughout the analysis we denote the demand for Full Service and Low Cost flights respectively as $\mathcal{D}_F \equiv 1 - T_F$ and $\mathcal{D}_L \equiv T_F - \frac{T_L}{1-\Pi}$.

*Shops' pricing.* We now proceed to analyze the optimization problem of destination shops, which engage in a standard monopolistic competition framework. First notice that demand for shop $i$, given optimal consumer choices (4) and the income distribution, is

$$q_i = \frac{P^{\sigma-\tau}}{p_i^{\sigma}} \frac{\tilde{I}}{1 + P^{1-\tau}} \tag{8}$$

where

$$\tilde{I} \equiv \int_{T_F}^{1} (I_k - T_F)\, dI_k + \int_{\frac{T_L}{1-\Pi}}^{T_F} (I_k - T_L)\, dI_k \tag{9}$$

is travelers' aggregate net income, i.e. the income not spent by travelers in flight tickets which is available for purchasing goods. The overall demand for shop $i$, $q_i$, decreases as $p_i$ increases while it increases when the overall passengers' net income, $\tilde{I}$, increases. The latter, in turn, clearly increases when the ticket of the Low Cost airline, $T_L$, decreases, as more passengers can afford to travel (extensive margin) and those who already fly save some money (intensive margin); as to the effect of a change in the fare of the Full Service airline, it depends on the uniform density of income in the following way: differentiating (9), a decrease in $T_F$ increases shops' demand if and only if $1 - T_F > T_F - T_L$; put differently, the Full Service tariff which maximizes net income is exactly midway between the maximum available income and the Low Cost fare.

Shop $i$ sets price $p_i$ under monopolistic competition to maximize profits

$$\max_{p_i \geq 0} \left\{ (p_i - c)\, q_i - s_F\,(1 - T_F) - s_L\,(T_F - T_L) + z_F + z_L \right\}, \tag{10}$$

where $q_i$ is given by 8 and $s_F$ and $s_L$ are the per–passenger transfers (possibly) agreed to with the Full Service and the Low Cost airline respectively. The optimal price is the same for all shops and equals

$$p = \frac{\sigma}{\sigma - 1} c. \tag{11}$$

Equation (11) has a simple interpretation: because shops have identical costs and traveler's utility is symmetric with respect to good varieties, the price is the same for all shops and is increasing in the marginal cost. Moreover, $p$ decreases and approaches the marginal cost as $\sigma$ increases, i.e. Monopolistic competition hits harder on shop's margins as the elasticity of substitution between their products grows larger, driving prices down to the competitive level.

Clearly, a shop's profit is the same across shops and, given the optimal price and transfers $s_F \geq 0$ and $s_L \geq 0$, is

$$\pi = \frac{K}{\Pi} \frac{\tilde{I}}{M} - s_F\,(1 - T_F) - s_L \left( T_F - \frac{T_L}{1 - \Pi} \right) + z_F + z_L, \tag{12}$$

where

$$K \equiv \sigma^{-1} P \left( 1 + P^{\tau - 1} \right)^{\frac{\tau}{1 - \tau}}.$$

We summarize the subgame equilibrium play in the consumer goods' market in the following lemma.

**Lemma 1.** *Assume that: (i) condition (7) is satisfied; (ii) $0 < T_L < T_F < 1$; and (iii) the contracts $(s_L, z_L)$ and $(s_F, z_F)$ are accepted by the shops. Then:*

- *Consumers with income below $\frac{T_L}{1-\Pi}$ don't fly; those with income between $\frac{T_L}{1-\Pi}$ and $T_F$ fly with the Low Cost airline; and those with income above $T_F$ fly with the Full Service carrier.*
- *Destination shops charge the same price, $p = \frac{\sigma}{\sigma-1}c$ and each shop's profit is (12).*
- *Non-traveling consumers spend all their income on the numéraire and their utility is $U_k^N = I_k$;*

*passenger $k$ flying with airline $I$ purchases the quantity $q_{0k} = \frac{I_k - T_I}{1+P^{1-\tau}}$ of the numéraire good and the quantity $q_{ik} = \frac{q_{0k}}{P^{\tau} M^{\frac{\sigma}{\sigma-1}}}$ of all other goods $i = 1, ..., M$. The utility of travelers is (5).*

*Two sidedness.* We have characterized the optimal decisions of travelers and shops, given carrier's strategies. The analysis has been standard up to this point. However, before studying airlines' decisions, we shall notice that our model has a distinct two-sided framework. Indeed, airlines in our model are platforms connecting consumers on one side to shops on the other. A common definition of two-sided markets — see Rochet and Tirole (2006) — is that, *cæteris paribus*, the net utility of players on one side increases with the number of players on the other.[21] In our setting, this amounts to say that, given $T_I$ and $Q_I$ such that some consumers travel, assuming that contracts $s_I$ and $z_I$ are accepted by the Mall, and taking optimal purchasing and pricing decisions of travelers and shops, a traveler's utility increases with the number of shops at destination, $M$, and a shop's profit increases with the number of travelers arriving at destination.

To show that our model is indeed a two-sided market, notice that the number of consumers arriving at destination is $1 - \lambda$ with $\lambda \equiv \frac{T_L}{1-\Pi}$. Thus, the market we are modeling can be defined a two-sided market if a traveler's utility (5) increases with $M$ and a shop's profit (12) gross of the payments to and from the carrier(s) decreases with $\lambda$.

Substituting optimal price (11) into (5) yields the following utility for a traveler $k$ who flies — i.e. with income $I_k \geq \frac{T_L}{1-\Pi}$ — and profit for any shop

$$\begin{aligned} U_I^k &= Q_I + (I_k - T_I)\left(1 + M^{\frac{\tau-1}{\sigma-1}}\left(\frac{\sigma-1}{c\sigma}\right)^{\tau-1}\right)^{\frac{1}{\tau-1}} \qquad \forall\, I = L, F \\ \pi &= \frac{K}{\Pi}\frac{\tilde{I}_\lambda}{M}. \end{aligned}$$

where $\tilde{I}_\lambda$ is the aggregate net income (9) rewritten as a function of $\lambda$, that is

$$\tilde{I}_\lambda \equiv \int_{T_F}^{1} (I_k - T_F)\, dI_k + \int_{\lambda}^{T_F} (I_k - T_L)\, dI_k.$$

It is easy to see that a traveler's utility increases with $M$, while a shop's profit increases as the number of travelers increases — i.e., $\lambda$ decreases. We summarize the previous discussion in the next proposition.

**Proposition 1.** *The flights market is characterized by network externalities typical of a two-sided market. In particular, for any profile of tariffs $T_I$, qualities $Q_I$ and transfers $s_I$ and $z_I$, $I = L, F$, such*

[21] Another definition — see, again, Rochet and Tirole (2006) — is that the volume of transactions depends on how the total price paid to the platform is shared between sides. Here it is clearly so: suppose that carrier $I$ deals with the Mall and charges tariff $T_I$ to travelers and $S_I$ per traveler to the Mall — i.e., a total platform price of $T_I + S_I$. It is clear from (9) and Figure 1 that the volume of transactions $\tilde{I}$ as well as the overall flights' demand $1 - T_L/(1-\Pi)$ are affected by a change in the composition of the total platform price, either directly (under Low Cost – Mall contracting) or through strategic interaction (under Full Service – Mall contracting).

*that some consumers travel and shops agree to contracts, travelers gain from a larger number of shops at destination, $M$, and shops profit from a larger number of travelers, $1-\lambda$.*

We have shown that, in fact, airlines in our model are platforms of a two-sided market where the sides to be connected are travelers/consumers and destination shops. Notice, however, that carriers are not pure platforms whose value to a buyer (traveler) is only determined by the number of potential sellers (shops) it provides a connection with: in fact $(i)$ both carriers connect travelers to the same set of shops; and $(ii)$ buyers in our setup care about the platform quality, $Q_I$, which is independent from the utility they derive from destination consumption. As we will show, this allows us to characterize an equilibrium with vertical differentiation where the intrinsic value of the flight plays a distinct role, neatly distinguishing our model from those of Argenziano (2008) and Gabszewicz and Wauthy (2014).

In the next sessions we will develop the analysis of airlines' pricing strategies and characterize optimal contracts between the airlines and the Mall. [22] Let's thus denote the Mall's profit as

$$\pi_S = \frac{K}{\Pi}\tilde{I} - S_F\left(1-T_F\right) - S_L\left(T_F - \frac{T_L}{1-\Pi}\right) + Z_F + Z_L,$$

where the subscript $_S$ denotes the Mall. Note that $\frac{K}{\Pi}$ is the profit per unit of net income if $S_I = Z_I = 0$ — i.e., when the Mall does not cooperate with any airline. Consistently, it takes values between zero and one as proved by the following lemma.

**Lemma 2.** *For all admissible values of the relevant parameters,* i) $0 < K < \Pi < 1$, *and* ii) $\Pi < P$.

Lemma 2 is useful because, introducing the parametric index $K$, it allows us to present most results avoiding exponential functions, difficult to interpret, sign and visualize to the reader. Instead, most of our results from now on will be expressed in terms of $K$ and $\Pi$, which are conveniently ranked.

# 4 Market structures

We are interested in studying the viability of commercial agreements between airlines and destination businesses. We will then characterize the optimal contracts proposed by different carriers to the Mall and show how our model closely reproduces the special real world contracts typical of the flights industry. Notice, however, that any contract can always be rejected by the Mall if it finds it unprofitable. Put differently, the Mall has the possibility to implement standard competition between the carriers by refusing to sign any cooperation agreement, a reference point carriers should consider when proposing cooperation agreements with local businesses. Hence, in what follows we characterize first the standard competition benchmark.

[22] While shops' optimization was clearly done at the shop-level, because shops are identical it is theoretically plain to assume that they coordinate perfectly when dealing with airlines. Hence, we shift the focus of our analysis from the single shop to the collective entity. See also footnote 15.

### 4.1 Standard competition benchmark

Denote by a superscript $^C$ the benchmark scenario, and the profits of the Low Cost, Full Service and Mall as $\pi_i^C$, $i \in \{L, F, S\}$. It holds by assumption $S_I^C = Z_I^C = 0$, while optimal tariffs are chosen simultaneously to maximize

$$\pi_L^C = T_L \left( T_F - \tfrac{T_L}{1-\Pi} \right) \quad \text{and} \quad \pi_F^C = T_F \left(1 - T_F\right),$$

yielding

$$T_L^C = \tfrac{1-\Pi}{4} \quad \text{and} \quad T_F^C = \tfrac{1}{2}.$$

Note that $\left(T_L^C, T_F^C\right)$ is an equilibrium only if (7) is satisfied — i.e.,

$$Q_F \geq Q_F^C, \quad \text{with} \quad Q_F^C \equiv \tfrac{1+\Pi}{4\Pi}. \tag{A1}$$

Finally, equilibrium profits in the competition benchmark are all positive and $\pi_L^C$ is decreasing in $\Pi$ (see Table 1 in the Appendix). This is because flying with the Low Cost airline increases travelers' utility just indirectly, by allowing them to purchase destination goods: as these become more expensive, the carrier reduces its fare to avoid loosing too many travelers, and the final effect is a net loss to the airline.

We summarize the above in the following proposition.

**Proposition 2.** *Assume $S_I^C = Z_I^C = 0$. Then, the flight industry equilibrium exists and is characterized by tariffs $T_L^C = \frac{1-\Pi}{4}$ and $T_F^C = \frac{1}{2}$ and by a quality level $Q_F \geq \frac{1+\Pi}{4\Pi}$. Equilibrium demand for flights and goods are those of Lemma 1.*

We close this subsection by noting that any agreement between an airline and the Mall, which we will analyze next, must be Pareto improving on the standard competition outcome for the cooperating parties.

### 4.2 Low Cost – Mall agreement

Equipped with the benchmark case, we now characterize optimal tariffs $T_F$ and $T_L$ and transfers $S_L$ and $Z_L$ when the Low Cost airline is the only carrier cooperating with the Mall — i.e. when $S_F = Z_F = 0$ by assumption. Denoting by a superscript $^L$ the case at hand, the Low Cost carrier sets $T_L^L$ to jointly maximize its own profits and those of the Mall, i.e. $\pi^L = \pi_S^L + \pi_L^L$. He will then extract all the possible surplus from the Mall through the two-part tariff $\left(S_L^L, Z_L^L\right)$ where $S_L^L$ is the per–passenger transfer while $Z_L^L$ is the fixed part. The airlines choose simultaneously $T_L^L$ and $T_F^L$ to maximize, respectively, the following profits

$$\pi^L = \tfrac{K}{\Pi} \tilde{I} + T_L \left( T_F - \tfrac{T_L}{1-\Pi} \right) \quad \text{and} \quad \pi_F^L = T_F \left(1 - T_F\right),$$

where $S_L^L$ and $Z_L^L$ wash out of profits $\pi^L$ as they are mere transfers between the carrier and the Mall. Optimal fares are

$$T_L^L = \frac{(1-\Pi)^2(\Pi-K)}{2(\Pi+(1-2\Pi)(\Pi-K))} \quad \text{and} \quad T_F^L = \frac{1}{2},$$

where, by Lemma 2, $T_L^L < T_F^L$. Assuming for a moment that (7) is satisfied, let's turn to the optimal choice of $S_L^L$: the Low Cost carrier wants to implement the first best and will set $S_L^L$ such that, given $T_F^L$, the fist order condition when maximizing $\pi_L^L$ with respect to $T_L$ evaluated at $T_L^L$ is zero. Thus $S_L^L$ solves

$$\left.\frac{\partial\left(\left(T_L+S_L^L\right)\left(T_F^L-\frac{T_L}{1-\Pi}\right)\right)}{\partial T_L}\right|_{T_L=T_L^L} = 0, \qquad \text{which yields:} \qquad S_L^L = \frac{K(1-\Pi)}{2(\Pi+(1-2\Pi)(\Pi-K))}.$$

Finally, $\left(T_L^L, T_F^L, S_L^L\right)$ are equilibrium strategies only if (7) is satisfied, i.e.

$$Q_F \geq Q_F^L, \quad \text{with} \quad Q_F^L \equiv \frac{1-\Pi(\Pi-K)}{2(\Pi+(1-2\Pi)(\Pi-K))}. \tag{A2}$$

Notice that $Q_F^L > Q_F^C$: it is now more difficult to induce travelers to choose a full service flight. In fact, due to the subsidy $S_L^L$ payed by the Mall to the Low Cost carrier, the latter can reduce its tariff ($T_L^L < T_L^C$) thereby inducing a stronger preference for low cost flights, which has to be compensated with higher flight quality from the full service airlines.

Before characterizing the optimal fixed transfer $Z_L^L$, let's focus on profits, which are reported in Table 1. Given Lemma 2, it is not difficult to show that $\pi_L^L > \pi_L^C$ and $\pi_F^C = \pi_F^L$ for all values of the price indexes — i.e., the agreement is beneficial to the Low Cost carrier while it leaves the Full Service carrier indifferent *vis-à-vis* the competition benchmark. While the former result is intuitive insofar as the Low Cost carrier enjoys one more instrument, $S_L^L$, than under standard competition, the latter depends on the fact that, as discussed above, the Full Service carrier's demand is only determined by a cash constraint, which, in turn, is not affected by the agreement between the Low Cost airline and the Mall. Furthermore, the zero cost assumption implies that the higher quality provided by the Full Service ($Q_F^L > Q_F^C$) has no impact on his profits. If we assumed a cost for quality then the natural result ($\pi_F^C > \pi_F^L$) obtains. As to the Mall's profits, it can be shown that $\pi_S^L > \pi_S^C$ if and only if $\Pi > 5/6$: in other words, given the transfer required by the airline, the Mall's profits are larger under cooperation when the prices charged at destination are large enough.[23]

We can now complete the characterization of the optimal agreement between the Low Cost airline and the Mall. The fixed part of the contract is clearly $Z_L^L = \pi_S^C - \pi_S^L$ whenever positive and zero otherwise — i.e., it amounts to a transfer from the airline to the Mall when the global price index falls short of 5/6 and equals zero when prices are higher. The intuition is simple: when prices are high the subsidy $S_L^L$ is more than repaid by travelers' purchases and the Mall can keep the additional surplus because of the opt-out possibility. When, instead, prices are low, after paying the per-passenger subsidy, the Mall is worse-off *vis-à-vis* the standard competition scenario and the airline has to compensate it

[23]More precisely, $\Pi > 5/6$ if and only if $P > 5\left(6^{\tau-1} - 5^{\tau-1}\right)^{\frac{1}{1-\tau}}$, with $P = M^{\frac{1}{1-\sigma}} \frac{\sigma}{\sigma-1} c$ in equilibrium.

with a transfer $Z_L^L > 0$.

We have then established the following proposition.

**Proposition 3.** *Assume $S_F^L = Z_F^L = 0$. Then, the flight industry equilibrium exists and is characterized by tariffs $T_L^L = \frac{(1-\Pi)^2(\Pi-K)}{2(\Pi+(1-2\Pi)(\Pi-K))}$ and $T_F^L = \frac{1}{2}$, and by a quality level $Q_F \geq \frac{1-\Pi(\Pi-K)}{2(\Pi+(1-2\Pi)(\Pi-K))}$. The equilibrium contract between the Low Cost carrier and the Mall prescribes a per-passenger transfer of $S_L^L = \frac{K(1-\Pi)}{2(\Pi+(1-2\Pi)(\Pi-K))}$ and, only if $\Pi < 5/6$, a fixed transfer $Z_L^L = \pi_S^C - \pi_S^L$ Equilibrium profits are given in Table 1. Equilibrium demand for flights and goods are those of Lemma 1.*

### 4.3 Full Service – Mall agreement

We now turn to the case of a Full Service airline cooperating with the Mall. In this case, adopting a similar notation, we assume $S_L^F = Z_L^F = 0$ and characterize the optimal contract $\left(S_F^F, Z_F^F\right)$ proposed by a Full Service carrier who maximizes joint profits $\pi^F = \pi_S^F + \pi_F^F$. Profits at the stage of setting tariff are

$$\pi_L^F = T_L\left(T_F - \frac{T_L}{1-\Pi}\right) \quad \text{and} \quad \pi^F = \frac{K}{\Pi}\tilde{I} + T_F\left(1 - T_F\right),$$

and the optimal fares are

$$T_L^F = (1-\Pi)\frac{\Pi-K}{3(\Pi-K)+\Pi(1-K)} \quad \text{and} \quad T_F^F = 2\frac{\Pi-K}{3(\Pi-K)+\Pi(1-K)},$$

which, again by Lemma 2, are correctly ranked and properly define the demand function of Figure 1. The optimal subsidy $S_F^F$ is obtained as before and equals

$$S_F^F = \frac{K(1-\Pi)}{3(\Pi-K)+\Pi(1-K)}.$$

Finally, there is demand for Full Service flights only if (7) is satisfied, i.e.

$$Q_F \geq Q_F^F, \quad \text{with} \quad Q_F^F \equiv \frac{1+\Pi}{\Pi}\frac{\Pi-K}{3(\Pi-K)+\Pi(1-K)}. \tag{A3}$$

It is worth noticing that $Q_F^F < Q_F^C$: it is easier for the Full Service carrier to attract travelers when it cooperates with the Mall than under standard competition. In fact, because of the Mall's subsidy $S_F^F$, the Full Service airline can reduce its tariff ($T_F^F < T_F^C$) and this reduction is proportionally larger than the strategic reduction in flight fare of the Low Cost airline ($T_L^F < T_L^C$), inducing travelers to prefer a full service airline at lower quality levels.

Profits are reported in Table 1. Using Lemma 2 it can be easily shown that $\pi_F^F > \pi_F^C$, $\pi_L^F < \pi_L^C$ and $\pi_S^F < \pi_S^C$ for all values of the price indexes, i.e. cooperation with the Mall benefits the Full Service carrier to the expenses of both the Low Cost and the Mall. The first inequality is, again, quite intuitive. The second has to do with the fact that now the reduction of the Full Service carrier's fare erodes the demand of the Low Cost airline from above, causing a loss in equilibrium. Finally, the Mall's profits are negatively affected no matter the level of $\Pi$.

We can now complete the characterization of the optimal agreement between the Full Service airline and the Mall. The fixed part of the contract is clearly $Z^F = \pi_S^C - \pi_S^F$ and amounts to a transfer from the airline to the Mall. We have then established the next proposition.

**Proposition 4.** *Assume $S_L^F = Z_L^F = 0$. Then, the flight industry equilibrium exists and is characterized by tariffs $T_L^F = (1-\Pi)\frac{\Pi-K}{3(\Pi-K)+\Pi(1-K)}$ and $T_F^F = 2\frac{\Pi-K}{3(\Pi-K)+\Pi(1-K)}$, and by a quality level $Q_F \geq \frac{1+\Pi}{\Pi}\frac{\Pi-K}{3(\Pi-K)+\Pi(1-K)}$. The equilibrium contract between the Full Service carrier and the Mall prescribes a per-passenger transfer of $S_F^F = \frac{K(1-\Pi)}{3(\Pi-K)+\Pi(1-K)}$ and a fixed transfer $Z_F^F = \pi_S^C - \pi_S^F$, where equilibrium profits are given in Table 1. Equilibrium demand for flights and goods are those of Lemma 1.*

### 4.4 Comparing market structures

We now compare the market structures just characterized along several dimensions. The next corollary summarizes results discussed in the Sections 4.2 and 4.3.

**Corollary 1.** *For all admissible values of $c$, $\rho$, $\varphi$ and $M$ the next inequalities hold:*

$$T_L^C > T_L^F > T_L^L, \qquad T_F^C = T_F^L > T_F^F, \qquad Q_F^L > Q_F^C > Q_F^F, \qquad \pi_L^L > \pi_L^C > \pi_L^F, \qquad \pi_F^F > \pi_F^C = \pi_F^L.$$

Most intuitions behind Corollary 1 have been discussed above. We remark here that the tariffs of both carriers are highest in the benchmark scenario, when no agreements are signed. In fact, when a carrier strikes a deal with the Mall, the latter subsidizes the former so as to allow the carrier to charge lower tariffs and embark a larger number of potential customers. Absent a deal with the Mall, the carrier does not internalize this 'platform externality' and charges higher tariffs which discourage consumers from traveling. This has neat implications for the flights' demand — i.e., the number of travelers — as detailed in the next corollary.

**Corollary 2.** *For all admissible values of $c$, $\rho$, $\varphi$ and $M$ the next inequalities hold:*

$$\mathcal{D}_F^i > \mathcal{D}_L^i \quad i \in \{C, L, F\}\,; \quad \mathcal{D}_F^F > \mathcal{D}_F^C = \mathcal{D}_F^L; \quad \mathcal{D}_L^L > \mathcal{D}_L^C > \mathcal{D}_L^F; \quad \mathcal{D}_L^L + \mathcal{D}_F^L > \mathcal{D}_L^F + \mathcal{D}_F^F > \mathcal{D}_L^C + \mathcal{D}_F^C.$$

The first inequality confirms a standard vertical differentiation result: the quality leader enjoys a larger market share. And this is true regardless of the market structure: the Full Service carrier has higher demand than the Low Cost carrier. The second and third inequalities confirm the basic intuition that cooperation with the Mall allows a carrier to reduce fares and thereby increase his market share of flights. The last inequality states that overall flights' demand increases when a carrier deals with the Mall and is maximized when it is the Low Cost carrier to do so.

## 5 Endogenous market structure

In Section 3 we have characterized the equilibrium of the flights industry taking the market structure as given. We now relax this assumption allowing the market structure to be determined endogenously. In particular, we assume that contracts between an airline and the Mall are signed under exclusivity — i.e. $S_L \cdot S_F = Z_L \cdot Z_F = 0$. This assumption is natural on two grounds: first, under non exclusivity carriers would clearly form a cartel to maximize the grand coalition profits, triggering the intervention of antitrust authorities; second, the type of contracts Ryanair has on its bases are never observed between an airport and more than one carrier. Hence, the Mall chooses which contract to accept, if any, between the two offered by the airlines.

We wish to understand which market structure emerges in equilibrium among those characterized and how this depends on the relevant parameters of the model. Propositions 3 and 4 have proved that cooperation with either airline always increases the joint profits of the cooperating parties *vis-à-vis* the standard competition scenario. Hence, in the equilibrium market structure the Mall cooperates with a carrier. Clearly, the Mall chooses the carrier which guarantees the largest increase in total profits to the cooperating parties: in fact, cooperation with the other airline generates a smaller increase in profits and is vulnerable to a proposal from the rival airline to the Mall which, trough appropriate side payments, would induce the Mall to switch partner.

Denote by $\Delta_L^L = \pi_L^L - \pi_L^C$ the profit change for airline $L$ between the Low Cost–Mall cooperation scenario and the competition benchmark, and define similarly $\Delta_S^L$, $\Delta_F^F$ and $\Delta_S^F$, where the subscript identifies the player and the superscript the market structure — closed form expressions are in Table 2. Then, writing $\xi(\Pi, K) \equiv (\Delta_L^L + \Delta_S^L) - (\Delta_F^F + \Delta_S^F)$ and relegating to Table 3 in the Appendix its cumbersome expression, it is clear that cooperation with the Low Cost (resp. Full Service) is the equilibrium outcome if, and only if, $\xi(\Pi, K) > 0$ (resp. $<$). The following proposition gives conditions under which $\xi(\Pi, K)$ is greater or smaller than zero and characterizes the equilibrium market structure.

**Proposition 5.** *Assume that cooperation contracts between the Mall and airlines are exclusive. Then, the optimal market structure of the airline industry features cooperation between the Mall and the Low Cost carrier and the optimal contract is characterized in Proposition 3 if, and only if,* $\sigma$*,* $\tau$*,* $c$ *and* $M$ *are such that*

$$K < f(\Pi) \tag{13}$$

*where* $f(\Pi)$ *— illustrated in Figure 2 and reported in Table 3 — is increasing in* $\Pi$ *and is such that* $f(\Pi) < \Pi$ *for all* $\Pi$ *lower than 1, with* $f(\Pi) = 0$ *for* $\Pi \approx 0.24512$.[24] *If condition (13) holds with the opposite sign, then the optimal market structure is cooperation between the Mall and the Full Service carrier and the optimal contract is characterized in Proposition 4.*

[24] A closed form expression for $\Pi$ such that $f(\Pi) = 0$ cannot be obtained. Indeed, from now on, some of the proofs will be graphical and/or will use computational software.

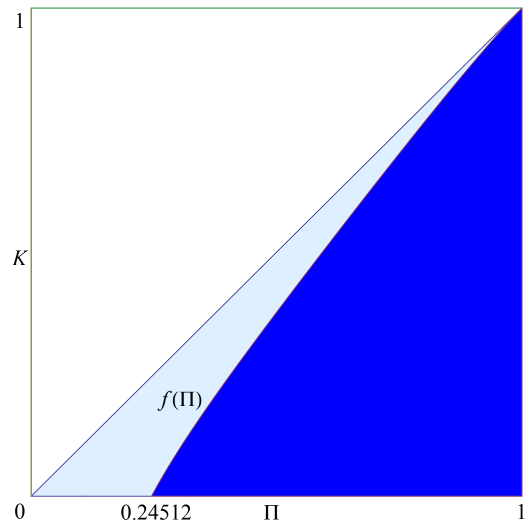



Figure 2: Market structure and parameter regions.
Full Service – Mall; Low Cost – Mall.

Hence, the equilibrium market structure is cooperation with the Full Service carrier if $\sigma$, $\tau$, $c$ and $M$ are such that $(K, \Pi)$ falls in the area between the $45^\circ$ line and $f(\Pi)$, while cooperation with the Low Cost airline is the equilibrium outcome in the opposite case.

It is apparent that the area corresponding to the market structure in which the Low Cost carrier cooperates with the Mall — i.e., what happens in most real world contracts — is much larger than the area corresponding to cooperation between the Mall and the Full Service carrier — which, in fact, is rarely observed. However, because $K$ and $\Pi$ are complex functions of the parameters of the model, it is difficult to properly interpret Figure 2.

To provide more intuition, we perform some comparative statics on the parameters $\sigma$, $\tau$, $c$ and $M$ and study their implications at the locus of points implicitly defined by $K = f(\Pi)$. To understand the contribution of the underlying parameters to the equilibrium outcome we run the following exercise: we let parameters vary one by one and show that, for each of them, $K$ and $\Pi$ move in opposite directions. This allows us to draw neat conclusions on which market structure emerges when $(K, \Pi)$ is located on the edge $K = f(\Pi)$ and a parameter changes. To see this, suppose that we increase a parameter and this causes $K$ to decrease and $\Pi$ to increase (resp. $K$ to increase and $\Pi$ to decrease): then we can say that the set of the remaining parameters under which cooperation between the Mall and the Low Cost airline is the equilibrium market structure is larger (resp. smaller).

The next proposition illustrates the relevant comparative statics of the model.

**Proposition 6.** *Assume that $M \geq 3$ and $P < e^{-\frac{1}{e}}$. Then $K$ (resp. $\Pi$) is decreasing (resp. increasing) in $c$, $\rho$ and $\varphi$ and increasing (resp. decreasing) in $M$.*

Proposition 6 implies that, loosely speaking, cooperation between the Mall and, say, the Low Cost carrier — i.e., $K < f(\Pi)$ — is more likely the higher the production cost $c$ of destination goods and the higher the degree of substitution between destination goods, $\rho$, and between home and destination consumption, $\varphi$. Cooperation with the Full Service is instead more likely when the number of shops at destination is larger.

A higher marginal cost of production of destination shops pushes up the retail price of destination goods, $p = \frac{c}{\rho}$, increasing both the destination ($P$) and the global ($\Pi$) price indexes. Through the carriers' tariffs, this affects consumers' incentives to travel.[25,26] In particular, the number of travelers diminishes in all market structures when prices increase. However, when the Low Cost carrier cooperates with the Mall, the demand of high quality flights is not affected while that of low cost flights diminishes.[27] *Vice versa*, the demand of high quality flights diminishes while that of low cost flights increases when the Full Service carrier cooperates with the Mall. In fact, when the Mall cooperates with the Low Cost, the Full Service does not internalize the downstream price increase. The opposite is true if the Full Service deals with the Mall: a higher price of destination goods invites the carrier to charge a higher tariff. Because consumers prefer high quality flights if they can afford them (see condition (7)), this asymmetry implies that, under Low Cost–Mall cooperation the negative impact of a price increase on the travelers' spending power is attenuated because the Full Service carrier does not revise upward its tariff. In other words, by cooperating with the Low Cost carrier, the Mall minimizes the impact of higher prices on the spending power of travelers because the Full Service does not respond by increasing tariffs under Low Cost – Mall contracting. Hence, the higher the marginal cost $c$, the more convenient it is for the Mall to deal with the Low Cost carrier.

Changes in $M$, $\rho$ and $\varphi$ do not affect retail prices at destination. They rather impact a consumer's utility through the price indexes $P$ and $\Pi$. These, by the properties of CES utility functions, denote the cost of a unit of utility.[28] An increase in the number of shops, $M$, makes dealing with the Full Service carrier more convenient. The intuition is as follows: because consumers love variety ($\rho < 1$ and $\varphi < 1$), the larger the number of different products, $M$, the larger the utility a consumer attains with a given budget. Or, which is equivalent, the lower the cost of a unit of utility. Hence, a higher $M$ implies a lower destination price index $P$ and, *a fortiori*, a lower global price index $\Pi$. This, in turn, increases overall flights' demand and triggers: *i*) a tariff reduction and demand increase of high quality flights and a decrease of low cost flights' demand under Full Service–Mall cooperation; *ii*) an increase in low cost flights' demand under Low Cost–Mall contracting. It turns out that the gains under Full Service–Mall contracting at the intensive margin — more money to spend because of a lower tariff — are larger than

[25]The sign of derivatives w.r.t. $P$ is the same of those w.r.t. $\Pi$ as both indexes co-move.

[26]Note that, for $j = L, F$, it holds $\partial T_F^j/\partial\Pi > 0$, while $\partial T_L^j/\partial\Pi$ can be either positive or negative depending on parameters. In particular, $T_L^j$ increases with $\Pi$ if $K/\Pi$ is sufficiently high — i.e., when the shops' profitability is sufficiently large. Moreover, the per–passenger transfer from the Mall to the cooperating carrier increases with the price index in both market structures — i.e., $\partial S_j^j/\partial\Pi > 0$

[27]In fact, $\mathcal{D}_F^L = \frac{1}{2}$, while $\mathcal{D}_i^j$ is a function of $\Pi$ and $K$ in all other cases $(i, j) \neq (F, L)$.

[28]More precisely, $P$ is the monetary cost of a unit of utility derived from the equilibrium consumption of a bundle of destination goods, while $\Pi$ is the monetary cost of a unit of utility derived from the equilibrium consumption of a composite bundle of the home (numéraire) and destination goods. This property derives from the homogeneity of degree 1 of CES functions.

the loss at the extensive margin — more travelers fly with the Full Service than with the Low Cost carrier at a tariff higher than that of cheap flights — and that the net gains are larger than the gains at the extensive margin [29] under Low Cost–Mall cooperation. Hence, reverting the argument made above, an increase in the number of varieties of destination goods makes dealing with the Full Service carrier relatively more convenient: consumers derive a larger utility from the same money spent at destination and optimally substitute some shopping with higher quality flights. Put differently, the need to spare money on flights is less acute when shopping at destination avails consumers a higher utility.

Finally, an increase in $\rho$ and/or in $\varphi$ makes goods less differentiated in the consumer's eyes.[30] Hence, consumers derive less utility from a given products' bundle or, equivalently, the price of utility increases — i.e., $P$ and $\Pi$ increase. A higher $\rho$ has the additional effect of reducing the spot price of destination goods, $p = \frac{c}{\rho}$. This is a natural consequence of monopolistic competition between shops at destination: the more their products substitute one another, the tougher is competition, the lower are prices. This pushes $P$ down. However, the net effect of a higher $\rho$ on the price index $P$ is positive. The increase in $P$ and $\Pi$ following a drop in the love for variety makes consumers eager to spend more money on goods' purchases saving on flights quality to balance their overall consumption choices. While, again, overall flights' demand drops, cooperation with the Low Cost carrier allows the Mall to contain the loss on the intensive margin that would be caused by the Full Service carrier raising his tariff under Full Service–Mall cooperation. Hence, cooperation with the Low Cost carrier is more efficient when products become more substitutes.

## 6 Conclusion

We have developed a simple model of the air travel industry which rationalizes the extremely low tariffs practiced by the (ultra) low cost carrier Ryanair. Our model does so by recognizing that Ryanair exploits the two-sided nature of air traveling: bringing potential buyers closer to potential sellers. Pricing both sides of the market rather than focusing just on cost containment and quality competition — as standard low cost carriers in regular vertically differentiated markets — Ryanair has been able to further reduce the cost of flying to potential travelers inducing higher demand and allowing lower income people to travel. These findings of the model correspond to facts that have been observed in practice. Further, we show that it is more likely that low cost carriers adopt platform pricing rather than full service carriers whenever deriving utility from goods' consumption becomes more costly so that saving on flight's quality become more important — e.g., because the production cost of destination goods increases or due to changes in preferences. To the contrary, we show that it is relatively more likely that full service carriers use platform pricing whenever travelers derive more utility spending a given budget on destination goods — e.g., because their variety increases making destination consumption more appealing.

[29] A decrease in $\Pi$ may cause a gain as well as a loss at the intensive margin. This is because the sign of $\partial T_L^j/\partial\Pi$, $j = L, F$ depends on the specific values of the parameters.

[30] The love for variety diminishes and the elasticities of substitution $\sigma$ and $\tau$ increase.

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# Appendix

The missing proofs will be soon available at www.giovanniursino.eu/papers.

**Marshallian demand:**

$$\begin{aligned}
\frac{\partial}{\partial q_{ik}}\left(\theta Q_{Ik}+\left(\sum_{i=1}^{M} q_{ik}^{\rho}\right)^{\frac{1}{\rho}}+\lambda\left(I_k-T_I-\sum_{i=1}^{M} p_i q_{ik}\right)\right) &= 0\\
\frac{1}{\rho}\left(\sum_{i=1}^{M} q_{ik}^{\rho}\right)^{\frac{1}{\rho}-1}\rho q_{ik}^{\rho-1}-\lambda p_i &= 0\\
\left(\sum_{i=1}^{M} q_{ik}^{\rho}\right)^{\frac{1-\rho}{\rho}} q_{ik}^{\rho-1} &= \lambda p_i\\
\frac{\left(\sum_{i=1}^{M} q_{ik}^{\rho}\right)^{\frac{1}{\rho}}}{q_{ik}} &= \lambda^{\frac{1}{1-\rho}} p_i^{\frac{1}{1-\rho}}\\
q_{ik} &= \frac{\left(\sum_{i=1}^{M} q_{ik}^{\rho}\right)^{\frac{1}{\rho}}}{\lambda^{\frac{1}{1-\rho}} p_i^{\frac{1}{1-\rho}}} \qquad \text{(Ax.1)}
\end{aligned}$$

from which, calling $y \equiv \left(\sum_{i=1}^{M} q_{ik}^{\rho}\right)^{\frac{1}{\rho}}$, we can plug (Ax.1) into the budget constraint (2) and obtain

$$\lambda^{\frac{1}{1-\rho}} = \frac{\sum_{i=1}^{M} p_i^{\frac{\rho}{\rho-1}}}{I_k-T_I} y$$

and, plugging this back into (Ax.1),

$$q_{ik} = \frac{I_k-T_I}{\sum_{i=1}^{M} p_i^{\frac{\rho}{\rho-1}}} p_i^{\frac{1}{1-\rho}}$$

which, substituting $\sigma = \frac{1}{1-\rho}$, becomes

$$q_{ik} = \frac{I_k-T_I}{\sum_{i=1}^{M} p_i^{1-\sigma}} p_i^{-\sigma}.$$

*Q.E.D.*

**Proof of Lemma 2:** Clearly $K>0$, $\Pi>0$ and $P>0$.
*Proof that* $K<\Pi$. Suppose not. Then, substituting for $K$ and $\Pi$ it must be:

$$\frac{c(1-\rho)}{\rho M^{\frac{1-\rho}{\rho}}}\left(1-\left(1+\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}}\right)^{-1}\right)^{\frac{1}{\varphi}} > \left(1+\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}}\right)^{\frac{\varphi-1}{\varphi}}. \qquad \text{(Ax.2)}$$

Take first the power of $\varphi$ and then multiply by $\left(1+\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}}\right)$ both sides of (Ax.2). Simplify the left hand side and get

$$(1-\rho)^{\varphi}\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi^2}{\varphi-1}} > \left(1+\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}}\right)^{\varphi}. \tag{Ax.3}$$

Now thake the power of $\frac{1}{\varphi}$ on both sides of (Ax.3) and simplify to get the following condition

$$-\rho\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}} > 1,$$

which is clearly impossible given the admissible parameter values. Hence, it must be $K < \Pi$.

*Proof that* $\Pi < 1$. Suppose not, then it must be $\Pi^{-1} < 1$. Substituting for $\Pi$, this implies

$$\left(1+\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}}\right)^{\frac{1-\varphi}{\varphi}} < 1. \tag{Ax.4}$$

Thake the (positive) power of $\frac{\varphi}{1-\varphi}$ on both sides of (Ax.4) and simplify to get

$$\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}} < 0,$$

which is clearly impossible. Hence, it must be $\Pi < 1$.

*Proof that* $\Pi < P$. Suppose not, then, substituting for $P$ and $\Pi$, it must be

$$\frac{c}{\rho}M^{\frac{\rho-1}{\rho}} < \left(1+\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}}\right)^{\frac{\varphi-1}{\varphi}}. \tag{Ax.5}$$

Take the power of $\frac{\varphi}{1-\varphi}$ on both sides of (Ax.5) and rearrange to get

$$\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{1-\phi}}\left(1+\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{\varphi-1}}\right) < 1. \tag{Ax.6}$$

Expand and simplify (Ax.6) to get

$$\left(\frac{c}{\rho}M^{\frac{\rho-1}{\rho}}\right)^{\frac{\varphi}{1-\phi}} < 0,$$

which is never satisfied. Hence, it must be $\Pi < P$. *Q.E.D.*

Table 1: Equilibrium profits under different scenarios.

| | Comp. | Low Cost/Mall coop. | Full Service/Mall coop. |
|---|---|---|---|
| $\pi_L$ | $\frac{1-\Pi}{16}$ | $\frac{(1-\Pi)\Pi^2(1-\Pi+K)^2}{4(\Pi+(1-2\Pi)(\Pi-K))^2}$ | $\frac{(1-\Pi)(\Pi-K)^2}{(3(\Pi-K)+\Pi(1-K))^2}$ |
| $\pi_F$ | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{(K-2\Pi+K\Pi)^2}{(3(\Pi-K)+\Pi(1-K))^2}$ |
| $\pi_S$ | $\frac{K}{\Pi}\frac{2\Pi+5}{32}$ | $K\frac{K(2\Pi-1)\left((\Pi-K)(1-\Pi(2+\Pi))+\Pi\left(3-\Pi^2\right)\right)+\Pi^2(2\Pi+3)(1-\Pi)^2}{8\Pi(\Pi+(1-2\Pi)(\Pi-K))^2}$ | $K\frac{\Pi^2(6\Pi+1)-\left(\Pi^2+4\Pi+2\right)(2\Pi-K)K}{2\Pi(3(\Pi-K)+\Pi(1-K))^2}$ |

Table 2: Profit differentials with respect to the competition benchmark.

| $i$ | $\Delta_i^L$ | $\Delta_i^F$ |
|---|---|---|
| $L$ | $K(1-\Pi)\frac{(1-\Pi)(4\Pi-K)+3K\Pi}{16(\Pi+(1-2\Pi)(\Pi-K))^2} > 0$ | $-K(1-\Pi)^2\frac{7(\Pi-K)+\Pi(1-K)}{16(3(\Pi-K)+\Pi(1-K))^2} < 0$ |
| $F$ | $0$ | $K(1-\Pi)\frac{5(\Pi-K)+3\Pi(1-K)}{4(3(\Pi-K)+\Pi(1-K))^2} > 0$ |
| $S$ | $K\frac{-(1-2\Pi)K^2+4\Pi(1-2\Pi)(1-\Pi)K-8\Pi^2(1-\Pi)^2}{32\Pi(\Pi+(1-2\Pi)(\Pi-K))^2}$ | $K(1-\Pi)\frac{2K^2\Pi^2+56K\Pi-64\Pi^2+16K\Pi^2+3K^2\Pi-13K^2}{32\Pi(3(\Pi-K)+\Pi(1-K))^2} < 0$ |

Table 3: Joint profit differentials with respect to the competition benchmark and their difference.

| |
|---|
| $\Delta_L^L+\Delta_S^L=\frac{K^2}{32\Pi(\Pi+(1-2\Pi)(\Pi-K))} > 0$ |
| $\Delta_F^F+\Delta_S^F=K^2(1-\Pi)\frac{8(\Pi-K)+(1-\Pi)(5(\Pi-K)+\Pi(3-2K))}{32\Pi(3(\Pi-K)+\Pi(1-K))^2} > 0$ |
| $\xi(\Pi,K)\equiv K\frac{K\left(2K^2\left(\Pi\left(\Pi^3-8\Pi+12\right)-1\right)+K\Pi(9-\Pi(\Pi(\Pi(2\Pi+7)-45)+61))+8\Pi^2(\Pi((\Pi-4)\Pi+5)-1)\right)}{16\Pi(\Pi+(1-2\Pi)(\Pi-K))(3(\Pi-K)+\Pi(1-K))^2}$ |
| $f(\Pi)\equiv\frac{\Pi}{4}\frac{61\Pi-45\Pi^2+7\Pi^3+2\Pi^4-9-\sqrt{(1-\Pi)^3(41\Pi-5\Pi^2-41\Pi^3+24\Pi^4-4\Pi^5+17)}}{12\Pi-8\Pi^2+\Pi^4-1}$ |