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Entry and Accommodation in Airline Markets: Easyjet Caught in the Middle on the London-Grenoble Route

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Entry and accommodation in airline markets: Easyjet caught in the middle on the London-Grenoble route

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ABSTRACT

Low cost carriers (LCCs) have recently proved that they can develop aggressive behaviour towards the threat of new entrants. This paper analyses the theoretical conditions under which a low cost carrier can deter or accommodate entry by means of product proliferation, using the example of Easyjet on the London-Grenoble route. Theoretical conclusions show that they can only deter entry if they launch a service with a quality that is superior to the entrant's and to their own previous one. Otherwise, they accommodate entry by improving their old product, when they face the entry of a full service carrier (FSC), or by launching a new service, if they are caught in the middle of a FSC and another LCC. Empirical findings about competition in the same route in monopoly, duopoly and oligopoly with three firms show that price competition depends on the existence and nature of rivals, and on the level of demand.

Keywords: low cost carriers, entry, accommodation
JEL Codes: L93, L13

1. Introductory notes and purpose of the paper

A few years after de-regulation in airline markets, much has been written about low cost carriers (LCCs). These companies have either launched new routes or entered in routes formerly dominated by full service carriers (FSCs), basically on a point- to-point basis.

Today, almost 20 years after Ryanair (FR) launched its first flight in the London-Dublin route where it competed with two FSCs, things have much changed and issues have become very different. LCCs have grown in number of routes and passengers and some of them have acquired a significant market power. In November 2004, FR announced that it had beaten Easyjet (EZ) and British Airways (BA) in the UK market. Considering only the largest companies, FR carried 36% of British passengers, while the others exhibited percentages of, respectively, 35% and 29% for EZ and BA. The largest LCCs' networks are no more point-to-point but they have established theirs bases that work as hubs. Examples are FR's and AirBerlin's networks, operating in hubs like London Stanstead, or Paris Beauvais[1], for Ryanair, or Palma de Maiorca for AirBerlin.

By acquiring market power these companies have developed an aggressive behaviour towards rivals, either FSCs or other LCCs and sometimes engage in predatory strategies as their former FSCs rivals used to.

The aim of this paper analyses such strategies, specifically those of entry deterrence and of accommodation. The route London-Grenoble is a good example of entry by different types of airlines, as described below, and will be taken as a base for analysing theoretical results and develop some empirical work.

With a theoretical model as explained below, I conclude first that, when a monopolist faces a potential entrant with the same quality, the incumbent can only deter entry if the costs of changing the product characteristics are high. If these costs are low, the entrant may force the incumbent to change its product's characteristics. But, if the monopolist faces an entrant with a higher quality, it can only deter entry by launching a new product, or service, that has a quality still higher than the entrant's. If this is not possible, the incumbent accommodates entry by improving its initial good, or by

[1] Ryanair has recently announced that it now disposes of twelve bases.

substituting it with a new one that has a higher quality. Keeping both the old good and launching a new one only accommodates entry if there is third firm in the market, with an inferior quality.

The paper is organised as follows. Section 2 deals with previous literature's findings, and points out the originality of this paper's thematic. Section 3 describes the story of the London-Grenoble route, while giving evidence of pre-emptive behaviour by LCCs. In Section 4 I develop two games of entry deterrence and accommodation and analyse the respective results. Section 5 includes an empirical study of the same route, namely about the nature of competition with one, two or three firms. The paper ends with a few concluding remarks in Section 6.

Results of the empirical study can be summarised in the following way. A monopolist LCC sets its fares according to the date of reservation. But when it faces competition from another LCC, the date of reservation becomes irrelevant and the rival's fare is the main explanatory variable. In a market with three firms and four services, competition depends on the demand level. With a peak demand, the date of reservation becomes significant again, and price competition less relevant. As demand decreases and comes back to its normal level, the opposite happens. Finally, a strong price interdependence is observed for flights operated by the same airline.

2. Previous research and methodological options

Theoretical research on entry deterrence in airline industry has focused mostly on hub and spoke networks together with code share alliances. Oum et all.(1995) find that changing the incumbent's network from linear to hub and spoke may deter entry if the entry cost falls within a certain range. Chen and Ross (2000) establish conditions under which a code share agreement can withdraw potential entrants. Lin (2005) analyses the importance of airline alliances in deterring entry showing that the result depends on the entrant's cost. If it is large enough, entry is deterred. If it is small enough the incumbent deters entry by making an alliance (code share) with another company. Morrison (2004) stresses that in air travel markets capacity expansion by the incumbent airline may become a credible threat for the entrant, as fixed inputs, like aircrafts, do not have to be permanently assigned to a particular route.

Empirical works agree on the fact that capacity expansion has no pre-emption effects and has not been used as an entry deterrence strategy, but they disagree on the effects of cutting fares. Goolsbee and Syverson (2004) analyse 838 routes between 61 airports to assess incumbents' strategies whenever a route is threatened by Southwest Airlines' entry. They find weak evidence of capacity expansion by incumbents before entry but a substantial pre entry drop in fares along with strategies directed to increasing consumer loyalty. With a sample of 370 LCCs' entry events in the US, Ito and Lee (2003) find little evidence of entry deterrence strategies by FSCs. Post entry prices were only modestly reduced, and the median statistic of capacity has decreased of 30% in immediate post entry, which shows that incumbents do not follow strategies of investment in capacity to deter entry. However, and this is an important finding, capacity responses to entry register a wide variation across airlines. Specifically for European airline markets, Roller and Sickles (2000) present an empirical study to account for the influence of an increase in capacity on airlines market power, applied to before the European de-regulation process. Using Fudenberg and Tirole (1984)'s taxonomy, they conclude that airlines are "puppy dogs" which means that increases in capacity reduce theirs profits.

A wide literature has focused on post entry effects[2], namely when entrants are low cost airlines. Basically, they conclude that prices decrease and traffic increases after entry, as it was expected. However, in these cases, there are no strategic actions by the incumbents to deter or accommodate entry, but mere reactions or adjustments to new competitors. Particularly in what regards strategic accommodation there are not any works, as far I am aware of.

The theoretical works quoted above diverge on "who" is the incumbent. While Goolsbee and Syverson (2004) and Ito and Lee (2003) analyse situations of LCC's entry on markets dominated by one or more FSC, in the other works, and all of theoretical basis, incumbent and entrant may be any airline, with no cost or service differences.

This paper analyses the case of a LCC (EZ)'s strategic behaviour when facing entry of another LCC (FR) and of a FSC (BA). This is quite new. As some LCCs, such as Ryanair and Easyjet in Europe, and Southwest or Jetblue in the US, have significantly increased their market shares and so their market power, and show aggressive behaviour, why should not they develop predatory strategies? In fact, they do, as will be shown below.

[2] For a brief survey of this literature see, for example, Gorin and Belobaba (2004).

Besides, none of those works referred above uses quality parameters for demand, which may introduce in models the reality of quality differentiation. The model in this paper uses the theoretical framework of vertical differentiation to account for different qualities. This is an important point, as both costs and demand depend on quality and this fact is crucial for a strategy of entry deterrence, as will be shown below.

Networks and alliances have been the basic strategies for studying conditions for entry deterrence. However, building hub and spoke networks versus point to point does not apply to the case study of this paper. Some LCCs, like Easyjet (EZ) and Ryanair (FR) are developing this kind of networks, with bases as hubs. Neither airline alliances are relevant in this case. And, as for now, none of these LCCs has signed code share agreements.

Rather, the case analysed in this paper suggests entry deterrence or accommodation through product proliferation. This strategy has been widely analysed for other industries, since Schmalensee (1978)'s paper on ready-to-eat cereals, and for cases of horizontal differentiation, but it has not been analysed in airline industry and not in the context of quality product differentiation.

3. The story of entry and accommodation in the London-Grenoble route: evidence on pre-emption in airline markets

The London-Grenoble route is an interesting example of entry and accommodation. This route serves French business or leisure travellers to London but mainly British passengers who go to Grenoble for leisure motivations, and, in particular, winter sports. Grenoble airport enjoys a good situation near winter sports areas, and so the route has a demand peak from December to March. Table 1 shows the movement of passengers from Grenoble in London airports.

Table 1: Movements (arrivals+departures) from Grenoble to London

2004		2005	Luton	Stanstead	Gatwik	2005 Total
January	0	January	11947	0	0	11947
February	0	February	11070	0	0	11070
March	0	March	11706	0	0	11706
April	0	April	6293	0	0	6293
May	0	May	5556	0	0	5556
June	0	June	5937	0	0	5937
July	0	July	7620	0	0	7620
August	0	August	7715	0	0	7715
September	0	September	5356	1471	0	6827
October	0	October	5199	5194	0	10393
November	0	November	na	na	na	na
December	6431*	December	5381	8862	4640	18883

* chater; all others are scheduled
na: non available
Source: CAA (Civil Aviation Authority, UK) webpage

This route was previously operated by charter companies. EZ started operating this route from Stanstead on the beginning of January 2005, with daily flights. However its monopoly as a regular carrier did not last for long. FR announced, in June 2005, the launch of this route, also departing from Stanstead, and with the same frequency, operations beginning on the following month of September. Meanwhile, Easyjet had moved the departure from Stanstead to Luton two months before. It is impossible to know which company did the first move, if Easyjet changed first and then Ryanair entered, or if Easyjet knew about Ryanair's intentions and moved to Luton before its rival starting operating the route. What is clear is that Ryanair had advantages in departing from Stanstead, its largest London base, while Easyjet operates in both airports, so it would not be too costly to move[3]. This paper examines the second hypothesis, as it is much more interesting, from a strategic point of view.

Then, this route became a duopoly with differentiated goods. On July 12th 2005 British Airways announced the launching of seasonal (winter) flights from London Gatwick to Grenoble. Their flights started on December 16th 2005 and, according to the company's Head of Sales, they were established to serve a growing weekend skiing market for British skiers (BA's website, 2005). The new BA's service would last till the end of March 2006, and operate five times a week, with a lower frequency than its low cost rivals.

As a reply, EZ announced on July 14th (two days after BA's announcement) the launch of a new flight to Grenoble departing from Gatwick, while keeping its flight from Luton. This event may be considered either as an increase in capacity or as the launching of a new product (product proliferation) and a choice between the two alternatives is crucial for theoretical purposes. An increase in flights' frequency is more likely to be considered as a capacity expansion, and this was not the case. Indeed, a flight from Gatwick is a different service from one departing from Luton, even if they serve the same destination. Then, the model in this paper is more adequate to study the case of product proliferation. An alternative type of model might study the case of capacity expansion in order to deter or accommodate entry by LCCs, which is an interesting suggestion for further research.

This is not the only pre-emptive event involving these two no-frills companies. To mention a recent example, the story of the London-Shannon route suggests a strategic behaviour, this time by FR. The Irish carrier stood as a monopoly in the route with flights from Stanstead since1992. In September 2004 EZ announced a new route from Gatwick to Shannon, effective from the end of January 2005. In November 2004 FR replied by announcing two new routes to Shannon, one departing from Gatwick (and replicating EZ's) and another from Luton, both starting in early March 2005. If FR had linked the two cities with only one route for thirteen years, it is hard to believe that demand growth was high enough to justify the supply of three additional services in the same year.

[3] It is costly to move to an airport where an airline does not operate. The airline has to pay infrastructures like check in desks. But the main problem is with transaction costs, namely in what concerns handling and catering operations.

There is other evidence that leads to suspect that low cost airlines are using excess capacities or product proliferation strategies to either deter or accommodate entry, which comes from aircrafts manufacturers' point of view. Embraer, the Brazilian aircraft manufacturer, forecasts an excess supply of seats in the next four or five years. According to the firms' President, there is an excessive demand for aircrafts, as LCCs are buying only for the purpose of increasing their market shares (Reuters, 2005).

4. Games of entry deterrence and accommodation

4.1. Hypotheses of the model

In order to analyse the next games of entry and accommodation I first recall two trivial results from differentiation theory:

R_1: In a horizontal differentiation context with consumers uniformly distributed and n firms, if marginal costs are constant and identical, all firms set the same price.

R_2: With vertical differentiation, let q_i be the quality of good i, and p_i its price. Then, for any i and j in the product space, if $q_j > q_i$, $p_j > p_i$ and the same holds for revenues, R, so that $R_j > R_i$. [4].

Moreover, I suppose that firms compete in prices, and that incumbent firms have time to deter or accommodate entry. Games are developed in two stages. In the first stage the incumbent decides to use (or not) pre-emption or accommodation strategies. In the second stage the entrant decides to enter or not.

Results are compared with airlines' behaviour in the London-Grenoble route. To identify each firm in the model and in the case study, a qualification of airlines and airports has to be established.

According to a well know passengers' ranking of airlines (Skytrax, 2005), BA is considered as a four stars airline, while EZ is ranked with three stars and Ryanair with two stars. Based in this ranking, we can establish that Easyjet, a former and short-lasting monopoly in the route, was caught in the middle, between an airline with inferior quality, which would be active all through the year, and a higher quality airline, with a seasonal entry.

[4] See Shaked and Sutton (1982), lemma 3.

Only London Heathrow is currently ranked by Skytrax (as a three stars airport). It is widely recognised that Gatwick is a main hub airport serving London while Stanstead and Luton are secondary airports[5].

I use two classifications. In the game with horizontal differentiation, I consider EZ from Stanstead or Luton and FR from Stanstead as two carriers with the same quality. If vertical differentiation were to be introduced here, with EZ holding the high quality, the game would be identical to one of the others. In the vertical differentiation game, I consider with descending quality: BA from Gatwick, EZ from Gatwick, EZ from Luton and FR from Stanstead.

4.2. The game with horizontal differentiation

I use the Hotelling framework to study this case. Consumers are uniformly distributed according to their taste parameter, **t**, along a line with length equal to the unit. Each consumer buys one unit of the good. There are only two possible locations, on the extremes of the line. First only one firm (firm 2, EZ) is in the market, and is located at the extreme left of the line. Firm 2 faces the threat of entry of firm 1. Both firms have constant marginal costs equal to **c**.

If firm 1 may choose its location, it would choose the right extreme. Choosing the same location of the incumbent would mean Bertrand competition with homogeneous goods and zero profits. The further it locates away from firm 2, the largest its market share.

Proposition 1: In a horizontally differentiation setting, when a monopolist faces a potential entrant firm, which can locate anywhere along the line of products, and firms have identical marginal costs, the incumbent cannot deter entry by creating a new product. If the potential entrant can only choose the same location of the incumbent, this latter will not deter entry, but accommodate it moving to the opposite extreme, if costs of changing location are low. If such costs are high, there will be no entry.

Proof: If the incumbent would launch a new good or service (good i) anywhere along the line, to deter entry, it had to set a price p_i that leads to π_i =0. But that would mean that p_1 would be such that p_i-c<=0. As p_i= p_2, the incumbent would make losses in

[5] This classification is questionable, specially in what concerns Stanstead, an airport that is becoming very large (21 million passengers in 2004) and provides as ample set of amenities.

both its old and its new product. Then the incumbent could only deter entry if it had a cost advantage. Without cost advantage there is a unique Nash equilibrium: the entrant enters and each firm locates on one of the extremes of the line.

Now suppose that the entrant can only enter at the left extreme of the line, for any reason, for instance because it would be too costly to locate at the extreme right. Then, the incumbent keeping its original location is not a credible threat for the entrant if its costs of changing (to the opposite extreme) are not too high. If those costs are high, the threat is credible, as firm 2 would not move and firm 1 would not enter.

Proposition 1 illustrates the case of FR's entry in the London-Grenoble route. The two airlines are LCCs and, as it is supposed in this game, their services are much alike, so that their flights, from the same airport, may be considered as homogeneous services. FR preferred a departure from Stanstead, its London's largest base[6]. First, EZ departed from Stanstead. Then, FR announces the new route, departing from the same airport. FR knows that moving to Luton is not very costly to EZ, as Luton is an EZ's base. The company has wide infrastructures and services at this airport and one more flight a day would mean a small extra (marginal) cost[7]. Staying at Stanstead is not a credible threat from EZ, as this would mean a price war and zero profits for both airlines. Then, FR believes that EZ will move to Luton and starts operating from Stanstead. Indeed, FR forces EZ's move.

In these situations, a firm "steals" one product from another firm, forcing it to create a different good or service. This entrant's strategy is only possible if the cost of moving for the incumbent is low.

4.3. The game with vertical differentiation

In the second game a monopolist operates in a vertically differentiated market. The monopolist faces a threat of entry. Consumers are uniformly distributed according to their marginal evaluation of quality, $\mathbf{v}$, $\mathbf{0<v<1}$. The monopolist supplies product 1, with quality $\mathbf{q_1}$ and price $\mathbf{p_1}$. There is a potential entrant, which intends to enter with product 3, of quality $\mathbf{q_3}$, $\mathbf{q_3>q_1}$. Normalising $\mathbf{q_1}$ to the unit, $\mathbf{q_3= a}$ and $\mathbf{q_3 = aq_1}$.

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[6] Ryanair flies to 11 destinations from Luton and to 75 destinations from Stanstead.

For simplicity, assume that there are only quality costs, so that prices may be taken as price cost margins. This is a usual procedure in vertical differentiation models. Quality costs are linear in quality and equal to $\mathbf{cq_i}$, where $\mathbf{i}$ stands for the quality of product i.

In the first stage the incumbent chooses to launch (or not) a new product of quality $\mathbf{q_k=k}$, $\mathbf{k>1}$, which has a quality cost of $\mathbf{cq_k = ck}$. In the second stage the other firm decides to enter or not, and, if it does, the two firms compete in prices.

If entry is not deterred or accommodated by launching good $\mathbf{k}$, second stage competition will be as follows. The consumer indifferent between buying good **1** or good **3** has a marginal evaluation of quality, $\mathbf{v_0}$, such that $\mathbf{v_0q_1\text{-}p_1 = v_0q_3\text{-}p_3}$, or $\mathbf{v_0\text{-}p_1 = av_0\text{-}p_3}$, which yields $\mathbf{v_0= (p_3\text{-}p_1)/(a\text{-}1)}$. Demands will be, respectively, $\mathbf{y_1= (p_3\text{-}p_1)/(a\text{-}1)}$ and $\mathbf{y_3= (p_3\text{-}c_3)(1\text{-}(p_3\text{-}p_1)/(a\text{-}1))}$. Costs are expressed both by the magnitude of the constant marginal quality cost, $\mathbf{c}$ and by a quality entry cost. This last cost is sunk for firm 1, and equal to $\mathbf{A}$ for firm 3. Profits of both firms are: $\mathbf{\pi_i= p_1(p_3\text{-}p_1)/(a\text{-}1)\text{-}c}$ and $\mathbf{\pi_e= p_3(1\text{-}(p_3\text{-}p_1)/(a\text{-}1)) - ca\text{-}A}$.

Proposition 2: An incumbent firm can only deter entry if it launches a good of quality superior to the potential entrant's. In this case, if quality entry costs are low enough to launch the good, and both qualities **k** and **a** are set under certain conditions, entry will be deterred. Otherwise, the entrant will effectively enter the industry.

Proof:

Suppose first that the incumbent launches a product of quality **k**, identical to the entrant's, so that $\mathbf{k=q_3=a}$. All the same, the incumbent keeps the product of quality $\mathbf{q_1}$. It is straightforward that entry cannot be deterred. If the incumbent threatens a price war, both $\mathbf{\pi_k}$ and $\mathbf{\pi_3}$ will be zero.

If the new good has a quality $\mathbf{k<q_3}$, the value of $\mathbf{v}$, $\mathbf{v_0}$, that divides consumers who buy goods **1** and **k** will be $\mathbf{v_0\text{-}p_1 = v_0k\text{-}p_k}$, $\mathbf{v_0=(p_k\text{-}p_1)/(k\text{-}1)}$. And $\mathbf{v_1}$ divides those who buy **3** and **k**, $\mathbf{v_1}$**:** $\mathbf{v_1k\text{-}pk=v_1a\text{-}p_3}$, $\mathbf{v_1= (p_k\text{-}p_3)/(k\text{-}a)}$.

These values of **v** provide demands for the three goods: $\mathbf{y_1=(p_k\text{-}p_1)/(k\text{-}1)}$, $\mathbf{y_k=(p_k\text{-}p_3)/(k\text{-}a)\text{-}(p_k\text{-}p_1)/(k\text{-}1)}$, and $\mathbf{y_3=1\text{-}(p_k\text{-}p_3)/(k\text{-}a)}$, and profits, respectively for the incumbent and the entrant, are: $\mathbf{\pi_i=p_1(p_k\text{-}p_1)/(k\text{-}1)\text{-}c+ p_k((p_k\text{-} p_3)/(k\text{-}a)\text{-}(p_k\text{-}p_1)/(k\text{-}1))\text{-}ck}$ and $\mathbf{\pi_e=p_3 (1\text{-}(p_k\text{-}p_3)/(k\text{-}a))\text{-}ca\text{-}A}$. In the second stage, the entrant maximises profits and follows a best reply function is: $\mathbf{p_3=1/2(a\text{-}k)+1/2p_k}$. In order to deter entry, the incumbent should set its prices so that $\mathbf{y_3 = 0.}$ Using the best reply function, and after a few manipulations, for $\mathbf{y_3 = 0}$, $\mathbf{p_k = k - a < 0}$ (recall that prices are taken as price cost margins). As $\mathbf{p_1 < p_k}$, by R_2, $\mathbf{p_1 < 0}$. The incumbent has losses in both markets and so this strategy is not a credible threat.

Now suppose that **k>a**. The incumbent keeps products **1** and **k**, while the entrant supplies product **3**. There is a value, $\mathbf{v_0}$, that divides consumers who buy **1** and **3**: $\mathbf{v_0 - p_1 = v_0 a - p_3, v_0 = (p_3 - p_1)/(a-1)}$. On the other hand, $\mathbf{v_1}$ divides those who buy **3** and **k**, $\mathbf{v_1}$**:** $\mathbf{v_1 k - pk = v_1 a - p_3, v_1 = (p_k - p_3)/(k-a).}$

Demands are: $\mathbf{y_1 = (p_3 - p_1)/(a-1)}$, $\mathbf{y_3 = (p_k - p_3)/(k-a) - (p_3 - p_1)/(a-1)}$, and $\mathbf{y_k = 1 - p_k - p_3)/(k-a)}$, and profits, respectively for the incumbent and the entrant, are: $\mathbf{\pi_i = p_1(p_3 - p_1)/(a-1) - c + p_k(1 - p_k - p_3)/(k-a) - ck}$ and $\mathbf{\pi_e = p_3\ (\ (p_k - p_3)/(k-a) - \ (p_3 - p_1)/(a-1))\ - ca.}$

In the second stage, the entrant's best reply function is: $\mathbf{p_3 = ((p_1(k-a) + \ p_k a(a-1))/2(k-1)}$.

To make the entrant's demand equal to zero, the incumbent should set both $\mathbf{p_k}$ and $\mathbf{p_1}$ so low that no consumer will buy the entrant's good and then $\mathbf{y_3 = 0}$. This means that $\mathbf{v_0 = v_1}$, and that the incumbent gets all the market on the left and on the right of $\mathbf{v_0}$ or $\mathbf{v_1}$. Setting $\mathbf{v_0 = v_1}$, using the expressions above, and solving for $\mathbf{p_k}$: $\mathbf{p_k = (k-a)(p_3 - p_1)/(a-1)}$. Substituting $\mathbf{p_3}$ by its expression in the entrant's best reply function, and solving again for $\mathbf{p_k}$, the equality $\mathbf{v_0 = v_1}$ becomes $\mathbf{p_k = ((k+a-2)(a-k)p_1)/((k(2-a)+a^2-2)(a-1))}$.

Now, $\mathbf{p_k}$ and $\mathbf{p_1}$, the incumbent's price cost margins, should be positive or, at least, zero. Solving the expression for $\mathbf{p_k > 0}$ yields $\mathbf{k < (2-a^2)/(2-a)}$. But it is supposed that **k>a**. Then, for $\mathbf{a < k < \ (2-a^2)/(2-a)}$ it must happen at least that **a>2**. Thus, if $\mathbf{k < (2-a^2)/(2-a)}$ and **a>2**, there is a $\mathbf{p_k}$ that makes $\mathbf{y_3 = 0}$ for any $\mathbf{p_1 > 0}$. The entrant's quality must be high enough, and the incumbent's new quality must not be too much above **a**. In this case, deterrence is possible. However, the costs of quality **k** should not be too high. Otherwise, the gains the incumbent would obtain with the limit price $\mathbf{p_k}$ might be offset by the quality cost, **ck**, and this firm would experiment losses.

In the case we are analysing, Proposition 2 applies to BA's entry in Gatwick. For reasons of simplicity, I suppose that FR is not in the market. First, EZ is the only airline operating the London-Grenoble route and departing from Luton. To deter BA's entry, EZ had to launch a new flight from an airport that might be considered as superior by consumers, and to improve the quality of this flight so that it becomes superior or, at least, equal to BA's, the difference stated by the airport. Suppose that

Heathrow is considered as better than Gatwick, and that EZ intends to launch a flight from Heathrow. This would be too costly for EZ. First, improving its flight's quality up to BA's would lead to a large increase in costs. And the same happens with a new flight departing from Heathrow, an airport from where EZ does not operate and where it has no infrastructures like offices and check-in desks. The cost of starting operating at Heathrow with a unique flight to Grenoble would be too high. Then, EZ could not deter BA's entry.

But it could accommodate it. When BA announced a new flight from Gatwick starting on December 15, at the beginning of the high season for that route, it happened that EZ launched a new flight from Gatwick, an airport where it currently operates, starting on December 16, and kept flying from Luton. The new Gatwick flight suggests an accommodation strategy towards BA's unavoidable entry. If not, would not EZ do better by increasing the frequency from Luton, in presence of a higher demand? Following the theoretical model, is this the best strategy for the incumbent?

Proposition 2 shows that it is possible to deter entry by launching a quality that is higher than the entrant's. If the incumbent can do so, it will deter (and not accommodate) entry. But with a lower quality, it cannot prevent entry. The question now is if the incumbent, having time and experience in the market, would accommodate entry by launching a new product with an equal or a lower quality. A new good equalling the entrant's quality would lead to a Bertrand game with homogeneous products, with $\mathbf{R_k=R_3=0}$, and $\mathbf{R_1<0}$. Then, the only hypothesis left is launching an intermediary quality good, between the incumbent's former good and the entrant's.

Proposition 3: If a new firm enters the market with a quality that is higher than the incumbent's, the latter accommodates entry by launching a new good with a quality that is lower than the entrant's, but higher than the incumbent's previous quality. However, the incumbent is better off if it does not keep supplying both goods, but only the new one. The same applies to improving the old good's quality.

Proof: Suppose that the new firm enters the market with quality $\mathbf{a}$, and that the incumbent launches a new good of quality $\mathbf{k}$, $\mathbf{k<a}$, and $\mathbf{k>1}$. Now, the incumbent's profits are[8]: $\boldsymbol{\pi_i=p_1(p_3-p_1)/(k-1)-c+p_k((p_3-p_k)/(a-k)-(p_k-p_1)/(k-1))-ck}$.

[8] I deliberately omit part of the calculus, as it is repetitive. Calculus details may be supplied under request.

Maximising profits in $\mathbf{p_1}$ and $\mathbf{p_k}$ and solving for prices yields the incumbent's best reply functions: $\mathbf{p_1=1/2p_3}$ and $\mathbf{p_k=1/2p_3}$. Then, the best the incumbent can do is to set $\mathbf{p_k=p_1}$. But this means that no one would buy the lower quality good. Then, it is better to abandon the old quality and to launch a higher new quality.

Does this strategy accommodate entry? If the incumbent does not invest in the new good and keeps only good **1**, second stage competition will involve the two firms, with qualities equal to **1** and to **a**. Solving the model, the incumbent's profits are: $\boldsymbol{\pi_i^1=(a-1)/9-c}$.

If the new good is launched (or the old one is improved) it will have quality **k**. It will compete in the second stage with the entrant's good of quality **a**. The model shows that the incumbent's profits will be: $\boldsymbol{\pi_i^2=((a-k)/9-ck}$. It is easy to show that $\boldsymbol{\pi_i^2> \pi_i^1}$ for any **k>1**.

This vertical differentiation game has a unique Nash equilibrium, but the solution depends on the values of **a** and **k**:

- If **k** and **a** follow the conditions of Proposition 2, the Nash equilibrium is entry deterrence with the highest quality good;
- If not, the unique Nash equilibrium is launching a good with a quality that is higher than the initial good, but lower than the entrant's, and to supply only this new good.

Then, the incumbent does better by keeping only the good with higher quality. However, in the London-Grenoble route, EZ did not abandon Luton and kept only Gatwick, as the model predicts. Two reasons may explain this decision. One is that BA's entry is seasonal, its activity lasting for two months and a half. Then, the game with competition is played in 7/24 of the period (year), while in the other 17/24 EZ is a monopolist.

But EZ would rather keep only the higher quality, Gatwick, for the rest of the year. It was shown above that during the competition period EZ makes more profits with only the higher quality, **k**. Now will EZ be better as a monopoly with only one quality, **k**, than as a monopoly with two qualities, **1** and **k**? In this last case, profit maximisation yields $\mathbf{p_1=p_k}$, or that $\mathbf{y_1=0}$, then only the good with quality **k** should be in the market. That means that EZ should keep only Gatwick during the monopoly and the competition period.

The second reason for EZ keeping flights both from Luton and Gatwick, even while BA is not in the market, may be the presence of FR. How does the model account for this presence?

Suppose now that there is another firm with the lower quality, $\mathbf{q_1=1}$, while the former incumbent decides between having qualities **k** and **b**, **b>1** and **k>b** and only quality **k**. BA is absent. This happens for 17/24 of the year, but, for simplicity, we suppose the situation holds all through the year.

Proposition 4: In a duopoly where the new entrant supplies the lower quality good and the incumbent supplies quality **b**, the incumbent accommodates entry by launching a superior good of quality **k**, **k>b**, and will be better off keeping both products.

Proof: The incumbent knows that the entrant will supply quality $\mathbf{q_1}$, normalised to the unit so that $\mathbf{q_1=1}$. Suppose first that the incumbent abandons the good of quality **b** and produces only the new good of quality **k**. There will be price competition with vertical differentiation, the entrant's supplying product **1** and the incumbent product **k**, with quality **k >1**. Demands for both goods are, respectively: $\mathbf{y_1=(p_k-p_1)/(k-1)}$ and $\mathbf{y_k= 1-(p_k-p_1)/(k-1)}$. Profits are $\mathbf{\pi_i^1= p_k(1-(p_k-p_1)/(k-1))-ck}$ and $\mathbf{\pi_e=p_1\ (\ (p_k-p_1)/(k-1)-c}$. Maximising profits, solving the best reply functions and substituting the solutions for prices in the expression of the incumbent's profits yields $\mathbf{\pi_i^1=4/9(k-1)-\ ck}$.

If the incumbent keeps both products with qualities, respectively, **b** and **k**, the expressions of profits for both firms are: $\mathbf{\pi_i^2=p_2((p_k-p_2)/(k-b)-(p_2-p_1)/(b-1)-cb\ +p_k((1-(p_k-p_2))/(k-b))-ck}$ and $\mathbf{\pi_e=p_1\ ((p_2-p_1)/(b-1)-\ c}$.

Now the incumbent maximises its profits, obtaining to best reply functions $\mathbf{p_k(p_1)}$ and $\mathbf{p_b(p_1)}$. With the entrants best reply function, equilibrium solutions are computed and the incumbent's profit is: $\mathbf{\pi_i^2=1/4k-7/36b-ck-cb-4/9.}$

Profits with two goods for the incumbent are higher if **k>b(1-36/7c)**. As **k>b**, the condition holds for any **c>0**, as **1-36/7c <1**. Then, it is always better to keep both goods.

It is interesting to notice that the incumbent is better off with only one good (one quality) when it is a monopolist or when it faces competition from a firm with a higher quality. If its rival has a lower quality then the incumbent will prefer to keep the two goods. The intuition is that with the two goods there will be more competition on the left side of the segment, pushing $\mathbf{v_0}$ leftwards and so reducing the low quality entrant's demand. With a high quality entrant, all the demand on the left side belongs to the incumbent. In this sub-segment, it is better off with only one good.

Then the presence of FR may account for EZ's option of keeping flights from Luton and from Gatwick. With the entry of BA and FR, EZ was caught in the middle, with one lower quality competitor and one higher quality seasonal rival. If it were only for BA, EZ would better change to Gatwick and abandon Luton. But this would mean to leave the low-income (or low marginal valuation of quality) consumers[9] to FR.

The games' solutions have some important implications for airlines' markets:

- Proposition 1 shows that a carrier which intends to enter a market where an incumbent of the same type (LCC or FSC) operates, can replicate the incumbent's service if it knows that the incumbent has an alternative and the costs of changing are low.
- Proposition 2 shows that a LCC can never avoid the entry of a FSC in a route it dominates, but a FSC can deter a LCC from entering a market. However, it had to launch a product with a quality that is higher than its former quality, and this quality may not be available (for instance, in what concerns airports).
- Proposition 3 means that when a LCC dominates a route, if a FSC enters, the LCC should improve its service or launch a flight from a better airport. But if another LCC enters, the incumbent does better by launching the new service and keeping the old one. Product proliferation is then more likely to happen in routes dominated by LCCs.

5. Pricing strategies and the nature of competition: The London-Grenoble route

In this section, I analyse EZ's pricing strategies in the London-Grenoble route, covering a period that includes monopoly, competition with two firms and competition with three firms and four services.

The purpose of this empirical study is to detect changes in price competition, focusing on several hypotheses, which depend on the number of firms operating in the route. Fares were collected from the companies' websites for at least 31 days before the flights' dates. I watched prices for seven flights taking place in periods with different competition conditions. The ideal method would be to watch prices for all the days

[9] Or passengers from the North of London, or those living in Northeastern areas but with a preference for Easyjet.

during the period from September 2005 to the end of March 2006, but this was not possible due to time and budget constraints. Therefore the sample is small and conclusions should be considered carefully, and taken as hints or hypotheses for further research.

Theoretical conclusions suggest that EZ's fighting is not a credible strategy for FR and that accommodation was the unique Nash equilibrium. The first action of EZ's accommodation (changing from Stanstead to Luton) was already accomplished at the dates of the observed flights as the company departs from Luton in all of them. Then the focus of the analysis is mainly on two points. One is the change of EZ's pricing strategy from monopoly to duopoly. The other point is on the nature of competition during three phases of the duopoly period: a first phase of initial competition, about one month after FR's entry, a second one expressing some experience of duopoly competition, two months after FR's entry, and a third phase that intends to encompass both more experience of duopoly and some accommodation of BA's entry.

To analyse changes in competition in the Grenoble-London[10] route, I watched fares for one flight during EZ's monopoly, on September 20th and three flights during the period of rivalry with FR, on October 24th, November 21st, and December 14th. The first flight's date is one month after FR's entry, while the last one is two days before BA's entry. Then I introduce the new competition framework, with BA, as well as the new EZ's route from Gatwick, which is analysed for January 2nd, 9th and 16th. All of the observed dates are Mondays, except for December 14th, as this last date was observed to account for any eventual accommodation of BA's entry.

Airlines change prices of a particular flight according to the date of booking. This procedure usually consists in increasing fares as the date of the booking approaches the date of the flight. FSCs often use a RMS (revenue management system) in order to maximise the revenue of the flight, once that the majority of costs are fixed. They develop sophisticated algorithms aimed to match a set of fares and restrictions (booking classes) with a set of seats in aircrafts. However, as Holloway (2003) observes, LCCs relay on more simple practices by opening the entire inventory of seats for a given flight and then increasing prices in various date thresholds (as, for example, 21, 14 and 7 days before the flight). Indeed, there are no fare classes in LCCs

[10] I choosed Grenoble-London and not London-Grenoble because in the first case prices are shown in euros and this avoids currency changes.

reservations. This means that all seats in the aircraft are sold at the same price in a particular date.

Basically, the fare of an LCC's flight booked in day k depends on: (i) forecasted overall demand, (ii) bookings up to day k; (iii) number of days from k to the day of the flight; and (iv) rivals' fares, if there is competition in that route.

Forecasted demand usually relies on past data. Flights to and from leisure destinations are cheaper on midweek days and more expensive on weekends, while the opposite happens with business flights. The former are also higher during holidays. For instance, in the route Grenoble-London, and thirty days before the flight, EZ sold tickets at 207.99 euros (both in Luton and Gatwick) for a flight on January 2nd, at 26.99 euros (Luton) and at 47.99 euros (Gatwick) for a flight on January 9th, and at 16.99 euros (Luton) and 19.99 euros (Gatwick) for a flight on January 16th. Grenoble is mainly a tourist destination based on winter sports for British tourists. January 2nd is a return date for Christmas holidays' tourists, and for flights further away from holidays prices are lower. In the empirical analysis this fact was taken in account by choosing these three dates in January with different expected demands.

As for the other three flights, there was no reason to expect differences in demand. There are no school holidays during the period from September 20th to December 14th,

Data for the reservations up to the day when the price was observed is obviously unavailable, as companies never release this information. Though this is an important omitted variable, it was impossible to include it. To account for the third factor, I chose the variable **DAYS**, which is simply the number of days between the date of the observation and the date of the flight. This variable acts as a proxy of the omitted one, as, if there were data for bookings up to the day, the two variables would quite possibly be correlated. This procedure seems to be adequate for LCCs, but not so much for airlines that use RMS.

Finally, competitors' prices, collected in the same day, for 31 observations of fares, are included as explanatory variables.

Regressions were performed with OLS using Eviews. Autocorrelation was present in all regressions, as it was expected, according to the nature of data. It was corrected by assuming an AR(1) process. No heteroscedasticity problems were found, in any of the cases, but independent variables correlation was frequent, which leads to multicollinearity.

5.1. From monopoly to duopoly

Table 2 shows some statistics on flights' prices for monopoly and duopoly situations.

Table 2: Prices in monopoly and duopoly

	Monopoly	Duopoly	Duopoly	Duopoly
Date of flight	20.09.05	24.10.05	21.11.05	14.12.05
Airline	EZ	EZ	EZ	EZ
Variance	790.30	168.65	339.52	278.27
Standard deviation of own price	28.11	12.99	18.43	16.68
Firs price (euros)	8.99	24.99	8.99	4.99
Last price (euros)	107.99	107.99	77.99	77.99
Average price (euros)	28.64	41.60	21.41	24.38
First price change				26.99
(days before flight)	17	25	30	30

Notes:
1.For 31 observations before the day of the flight
2. Source: company's websites

EZ's average price is lower in duopoly, except for the first flight, soon after FR's entry. For the other two flights, both average and first and last prices are lower than in monopoly. It seems that, and using Fudenberg and Tirole (1984)'s taxonomy, EZ started to behave like a "fat cat", but ended as a "puppy dog". Prices are more often changed in a competitive situation, and the first price change is made earlier, suggesting a more stable price trend in monopoly, but also a larger price interval. This is confirmed by much larger variances and standard deviations in monopoly. It is interesting to notice that the flight operating on December 14th starts with the lowest of all prices, and this may be a sign of accommodation of BA's entry, or of EZ's new service from Gatwick, which started two days later. The average price is low, but not as much as the one of November 21st. However, the second date is nearer Christmas holidays and has probably a higher demand.

To account for differences in pricing strategy in monopoly and in competition, regressions were performed for each one of the flights. Results of these regressions for monopoly and duopoly cases are presented in Table 3. In the monopoly situation, the equation to estimate is:

$$\mathbf{ez = C + \beta_1\, DAYS + \mu},$$

where **ez** stands for EZ's fare (from Luton) and **DAYS** is as explained before. This variable is significant at 0% level, and seems to explain satisfactorily price behaviour (R^2=0.954). This coefficient is high enough to suggest that LCCs (or, in the case, EZ) merely increase price as the date of the flight approaches, and do not account much for bookings up to the day of the observation. But this conclusion holds only for a particular airline, route and flight, so further research would be needed in order to confirm the result.

In the duopoly situation, I tested the following equations, where **ez** and **fr** stand for EZ's and FR's fares:

$$\mathbf{ez = C + \beta_1\, DAYS + \beta_2\, fr + \mu}$$

$$\mathbf{fr = C + \beta_3\, DAYS + \beta_4\, ez + \mu}$$

White test revealed the inexistence of heteroscedasticity problems in all regressions. However multicollinearity was to be expected, as the other airline's price also should depend on the difference between the date of booking and the date of the flight. Correlation matrixes showed partial correlation coefficients between explanatory variables that range between 0.71 and 0.6. Then, multicollinearity could be present, though not very strongly. To check this, individual regressions between both prices and **DAYS**, for the three flight dates, were performed. Table 3 shows the coefficients of these regressions. Except for EZ in the first flight, the variable **DAYS** is not significant. This allows withdrawing of the hypothesis of multicollinearity.

Table 3 Regressions results (monopoly and duopoly)

	Monopoly	24.10.05	24.10.05
Dependent variable: EZ			
DAYS	-6.39	-0.4	
	0.000	0.513	
Constant	212.7	43.2	35.3
	0.000	0.001	0
FR		0.290	0.45
		0.028	0.001
R^2	R^2=0.95	AdjR^2=0.75	R^2= 0.66
F-Statistic	291.9	31.5	27.7
Dependent variable: FR			
DAYS		-5.92	
		0.324	
Constant		50.1	9972.5
		0.228	0.998
EZ		0.52	0.56
		0.044	0.039
R^2		AdjR^2=0.91	R^2=0.90
F-Statistic		97.4	127.7

	21.11.05	21.11.05	14.12.05	14.12.05
Dependent variable: EZ				
DAYS	-16.9		-0.15	
	0.904		0.414	
Constant	-864.4	5.7	20.1	17.1
	0.963	0.344	0.000	0.000
FR	0.17	0.14	0.46	0.49
	0.027	0.043	0.000	0.000
R^2	AdjR^2=0.96	R^2=0.97	AdjR^2=0.9	R^2=0.91
F-Statistic	241.2	385.4	93.8	141.9
Dependent variable: FR				
DAYS	0.79		0.09	
	0.157		0.758	
Constant	-32.700	-16.92	-25.5	-26.9
	0.021	0.074	0.007	0.000
EZ	1.69	1.41	1.76	1.72
	0.000	0.000	0.000	0.000
R^2	AdjR^2=0.91	R^2=0.92	AdjR^2=0.89	R^2=0.91
F-Statistic	108.6	156.9	124.1	149.3

Table 3 (cont.)

Flights	24.10.05	21.11.05	14.12.05
Dependent variable: EZ			
DAYS	-1.41	0.910	6.76
prob	0.033	0.566	0.843
Dependent variable: FR			
DAYS	-11.1	43.230	-18.57
prob	0.565	0.914	0.741

While in monopoly **DAYS** seems to explain quite well price changes, in all regressions for the three flights in duopoly this variable is clearly non-significant. Then, regressions were than performed dropping the variable **DAYS**. Also, and except for **ez** in the first flight, the values of R^2 are only marginally lower, while **fr** significance does not change much, and is sometimes improved.

All fares' coefficients are significant at 5% level. Then, in duopoly the two LCCs' fares are not a mere function of the time lag between the day of the booking and the day of the flight. What seems to account more for these airlines is competition, or the other firm's price. FR reacts more strongly to changes in the other airline's fares than EZ. Analysing the results for the three flights sequentially, it happens for both companies that the coefficients fall from the first to the second flight, and then get higher again.

5.2. Oligopoly with three firms and four services

Next I analyse the changes in competition induced by BA's entry and by the immediate EZ's reply of accommodation, with a new service from Gatwick. After less than three months of duopoly, the Grenoble-London route is now operated by three airlines and four different flights. One of the airlines, BA, uses RMS, while the others do not.

Table 4 clearly shows that all fares (first, last and average) increase as flights' dates approach Christmas holidays' peak period, and the same happens with standard deviations. Airlines should expect a high demand for the flight of January 2nd, as it is a return from Christmas holidays. All airlines start with high fares, even higher than the last price (except for FR), which may mean that expectations were much above real demand.

Table 4: Prices with three firms and four services

Date of flight Airline	02.01.06 EZ Luton	02.01.06 EZ Gatwick	02.01.06 FR	02.01.06 BA
Variance	352.38	240.36	1097.85	10288.61
Standard deviation of own price	18.77	15.50	33.13	101.43
Firs price (euros)	207.99	207.99	99.99	306.00
Last price (euros)	192.99	192.99	199.99	194.00
Average price (euros)	183.55	191.78	163.86	367.71
First price change (days before flight)	28	29	30	30
Date of flight Airline	09.01.06 EZ Luton	09.01.06 EZ Gatwick	09.01.06 FR	09.01.06 BA
Variance	247.83	194.95	1087.54	1307.03
Standard deviation of own price	15.74	13.96	32.98	36.15
Firs price (euros)	26.99	32.99	69.99	66
Last price (euros)	107.99	107.99	99.99	165
Average price (euros)	43.67	46.70	42.60	87.68
First price change (days before flight)	28	30	20	9
Date of flight Airline	16.01.06 EZ Luton	16.01.06 EZ Gatwick	16.01.06 FR	16.01.06 BA
Variance	239.38	209.96	708.32	1223.49
Standard deviation of own price	15.47	14.49	26.61	34.98
Firs price (euros)	16.99	19.99	9.99	66
Last price (euros)	77.99	77.99	99.99	165
Average price (euros)	25.86	27.89	20.47	86.68
First price change (days before flight)	28	28	12	9

Notes:
1.For 31 observations before the day of the flight
2. Source: company's websites

EZ always charges higher fares from Gatwick, expressing a better quality perceived by customers for this service, when compared with Luton. However, in the end both prices are equal and match monopoly (January 2nd) or duopoly last prices (January 9th and 16th). EZ's fares variances and standard deviations are still lower than in monopoly, probably expressing that the airline is more careful with price changes when it competes with others.

This new competitive setting raises a few questions:

1) Does price competition between EZ and FR change when BA enters and EZ launches a new route? In particular, does the variable DAYS keep loosing significance, as it happened in duopoly?

2) How does EZ manage fares for Luton and for Gatwick? It is expected that, when one firm has two goods, “best reply functions” between these two goods have higher coefficients than if they were produced by different firms (Barbot, 2001). Then, there should be a strong interdependence between EZ’s Gatwick and EZ’s Luton fares.

3) How do firms compete in prices? It is expected that each service compete with its neighbouring quality service[11].

4) How does price competition change with the demand level?

5) Do airlines using RMSs compete with others in prices?

Data was collected from the airlines’ websites for 31 days before the flights’ dates, as in the previous cases. Regressions were performed again with OLS, assuming an AR(1) process in every case. Tests revealed the absence of heteroscedasticity, but multicollinearity was sometimes found and then this will be discussed when necessary. For each price, I first performed one regression using all the other firms prices and DAYS as explanatory variables. Now**,** $\mathbf{ez_l}$, $\mathbf{ez_g}$ and **ba** stand for, respectively, EZ’s fares from Luton and from Gatwick, and BA’s fare. For example, for $\mathbf{ez_l}$, the equation is:

$$\mathbf{ez_l = C + \beta_1\, ez_g + \beta_2\, fr + \beta_3\, ba + \beta_4\, DAYS + \mu}$$

<u>A flight with a very high demand level: January 2nd</u>

Data of airlines’ prices and the variable **DAYS** for this flight showed very low values in the correlation matrix. This allows concluding that multicollinearity is absent.

The first regression, where the dependent variable is EZ’s fare for the Luton route, shows that only $\mathbf{ez_g}$ and **DAYS** are significant. The second regression, performed with only these two variables, shows no meaningful differences in significance and adjusted R^2. BA’s and FR’s fares are not significant and do not explain $\mathbf{ez_l}$.

EZ’s price at Gatwick, $\mathbf{ez_g}$, also depends on $\mathbf{ez_l}$ and on **DAYS**, and not on any of the other airlines’ fares. However, the value of the adjusted R^2 (0.52) is now much lower than it was in the previous regression (0. 79). This suggests that EZ’s fare from

[11] For a theoretical development, see Barbot (2005).

Luton effectively depends on the fare from Gatwick, but the latter depends on other factors. Among these factors, one of the most important ones must be the number of reservations up to the date of the observation. Probably, EZ sets its price for the Gatwick route according to this number, and then chooses the fare for the Luton route depending on Gatwick route's price.

Table 5: regressions results for January 2nd

Date of the flight Dependent variable	02.01.06 Ezl	02.01.06 Ezg	02.01.06 fr	02.01.06 ba
DAYS	-1.36	-0.81	-1.21	10.45
probability	0.015	0.049	0.403	0.656
Ezl		0.81	-0.40	0.39
probability		0.000	0.537	0.789
EZG	0.48		0.19	-0.12
probability	0.001		0.699	0.903
FR	-0.03	0.01		-0.04
probability	0.680	0.890		0.935
BA	0.02	-0.02	-0.01	
probability	0.500	0.450	0.897	
Constant	108.18	36.86	227.43	221.06
probability	0.000	0.400	0.030	0.440
R^2	$AdjR^2$=0.79	$AdjR^2$=0.49	$AdjR^2$=0.25	$AdjR^2$=0.59
F-Statistic	22.73	6.66	2.97	9.54
probability	0.000	0.001	0.032	0.004
Dependent variable	Ezl	Ezg		
DAYS	-1.41	-0.82		
probability	0.000	0.029		
Ezl		0.78		
probability		0.000		
Ezg	0.470			
probability	0.000			
Constant	111.67	36.82		
probability	0.000	0.299		
R^2	$AdjR^2$=0.80	$AdjR^2$=0.52		
F-Statistic	39.8	11.53		
probability	0.000	0.000		

Neither FR's nor BA's regressions have any significant explanatory variable, neither the time to the flight, nor any of the other airline's prices.

Then, for a flight in a peak demand period, the main conclusions are that:

- EZ sets each one of its fares taking on account the date of booking, as it did in monopoly, and its own fare in the other route. The variable **DAYS** becomes relevant (as it was in monopoly), and FR's price is not considered any more. Besides, the fare on the Gatwick route must be the first one to be set, probably depending on reservations. Then, the fare from Luton is determined.

- Prices of the three airlines are independent. This could be expected from BA, as it uses a pre-determined RMS, but not from FR and EZ.

A flight with a high demand level: January 9th

Table 6: regressions results for January 9th

Date of the flight Dependent variable	09.01.06 Ezl	09.01.06 Ezg	09.01.06 fr	09.01.06 ba
DAYS	-0.99	0.55	-13.4	-4.89
probability	0.002	0.1	0.862	0.087
Ezl		0.89	0.1	0.0
probability		0.000	0.819	0.978
EZG	0.86		0.13	0.13
probability	0.000		0.814	0.756
FR	0.04	0.03		0.09
probability	0.342	0.576		0.608
BA	-0.11	0.09	0.01	
probability	0.062	0.166	0.967	
Constant	27.21	-9.65	-158.58	144.85
probability	0.009	0.391	0.957	0.001
R^2	AdjR^2=0.93	AdjR^2=0.90	AdjR^2=0.79	AdjR^2=0.91
F-Statistic	72.60	54.16	23.24	9.54
probability	0.000	0.000	0	0.004
Dependent variable	Ezl	Ezg		
Ezl		0.84		
probability		0.000		
Ezg	0.890			
probability	0.000			
Constant	3.07	10.16		
probability	0.627	0.019		
R^2	R^2=0.89	R^2=0.87		
F-Statistic	115.1	98.64		
probability	0.000	0.000		

An inspection of the correlation matrix of this flight's price data shows that there can be multicollinearity present in equations. **DAYS** shows a considerable value of its correlation coefficient with **ba** (-0.79), with $\mathbf{ez_g}$ (0.56) and with $\mathbf{ez_l}$ (-0.74), and $\mathbf{ez_l}$ and

ez_g are, as expected, strongly correlated (0.93). Only **fr** is not correlated with any other variable.

EZ's regression for Luton's fare shows that the relevant variables (with more than 5% significance) are **ez_g** and **DAYS**, just as it happened in the previous flight. Then **ba** and **fr** are withdrawn, and **ez_l** is regressed alternatively against **DAYS** and **ez_g**. The T-statistic probability for DAYS alone is now 0.50, while it has a value of 0.00 for **ez_g** alone. Individual regression with **fr** shows that there this variable is only significant at 9% level. This procedure allows concluding that EZ's fare for the Luton route is only influenced by EZ's Gatwick's price.

The same problem arises for the regression of **ez_g**. As it can be seen in Table 6, in the multiple regression only **ez_l** is significant. Individual regressions of **ez_g** with any of the other variables alone proved that all of them were non-significant. Then, only **ez_l** explains **ez_g**. However, now the value of the adjusted R^2 is not too low (0.80), indicating that there are not important missing variables.

Both FR's and BA's fares keep not depending on other variables, except for **ba**, which depends on **DAYS**, though this variable is only significant at 9.5% level.

In this high demand level flight, the variable **DAYS** is no more important for **EZ**. This airline exhibits price interdependence between its two route's fares, but not from any other carrier's fares. The other airlines set their fares independently from each other.

<u>A flight with a normal demand level: January 16th</u>

Again, in this case the correlation matrix shows that there may exist some multicollinearity problems. Correlation coefficients are quite high in this case, and for almost all variables.

When considering **ez_l** as the independent variable, individual regressions with all other variables shows that only **ez_g** is significant.

But the same does not happen with **ez_g**. As it may be seen in table 7, individual regressions show that **ez_g** is independent of **DAYS**, but that it is correlated with **fr** (though at 7% level), **ba** and **ez_l**. Though it is not possible to measure the weight of each one of these variables, as the multiple regression is not adequate because of multicollinearity, results are useful to interpret EZ's strategy. In fact, they suggest that EZ sets first its fare for the Gatwick route, depending on FR's and BA's prices, and then sets the fare for the Luton route, depending on Gatwick's.

Table 7: regressions results for January 16th

Date of the flight Dependent variable	16.01.06 Ezl	16.01.06 Ezg	16.01.06 fr	16.01.06 ba
DAYS	-0.07	0.04	-0.01	-969
probability	0.331	0.599	0.990	0.535
Ezl		0.93	-0.1	-0.7
probability		0.000	0.958	0.748
EZG	1.00		1.80	0.98
probability	0.000		0.383	0.668
FR	0.01	0.02		0.25
probability	0.837	0.538		0.322
BA	0.00	0.00	-0.09	
probability	0.831	0.739	0.573	
Constant	-1.59	2.52	-18.79	145.93
probability	0.507	0.298	0.540	0.288
R^2	$AdjR^2$=0.99	$AdjR^2$=0.99	$AdjR^2$=0.89	$AdjR^2$=0.91
F-Statistic	1613.64	54.16	49.55	59.04
probability	0.000	0.000	0.000	0
Dependent variable	**Ezl**	**Ezg**	**Ezg**	**Ezg**
Ezl				
probability				
Ezg	1.05	0.95		
probability	0.000	0.000		
fr			0.090	
probability			0.072	
ba				0.390
probability				0.000
Constant	-3.26	3.45	18.37	-5.22
probability	0.000	0.000	0.000	0.080
R^2	R^2=0.996	R^2=0.99	R^2=0.96	R^2=0.88
F-Statistic	4302.1	4180.11	351,602	99.73
probability	0.000	0.000	0.000	0.000

In the multiple regression for **fr** none of the variables is significant. FR's price was regressed against all the other variables individually. Only $\mathbf{ez_g}$ and $\mathbf{ez_l}$ are significant. This means that, when there is no more high demand, FR sets its fare according to EZ's fares, as it did in the duopoly case.

As for BA, both multiple and individual regressions proved that there are no significant variables to explain its fares, not even **DAYS**.

Then, when demand comes back to its normal level, **DAYS** becomes not significant, and the competition between EZ and FR comes back.

Tough all the limitations imposed by the small number of observed flights and missing data (namely, the number of bookings) have to be born in mind, with these results it is possible to answer to the questions about this new competitive setting, which were asked above.

Price competition changes with more firms and more services. EZ's fare from Luton does not depend more on FR's, and conversely, but EZ's price from Gatwick does. EZ elects the Gatwick route to set its fare first, and then adjusts Luton's fare to Gatwick's. This last price ($\mathbf{ez_g}$) depends on the other airline's prices when demand is not high. In this case, EZ competes both with FR and with BA. But for very high demand dates, what seems to influence prices is the number of days to the flight and not the other airlines' fares.

BA always shows a total independence from other airlines when setting its prices.

6. Concluding remarks

This paper is intended to explore entry deterrence and entry accommodation by LCCs. It is based on the fact that LCCs are no more mere entrants in airline markets, but that they often are incumbents with enough market power to develop strategies towards potential entrants.

Both from a theoretical and from an empirical point of view, I have analysed a markets with only LCCs and a market where they compete with a FSC.

In the first case, theoretical results suggest that an LCC can never deter the entry of another LCC. This may explain Embraer's concerns about excessive aircraft demand from this type of companies. If LCCs started by competing in routes dominated by FSCs and by routes linking cities that were not linked before, now they face the challenge of entering in routes dominated by other LCCs, where they may come across pre-emptive behaviour.

In the second case, the theoretical model shows that an airline (or any other firm) can only deter entry of other airlines by launching a service with a quality that is higher than her own and higher than the entrant's. FSCs could follow this strategy, but it would be costly to launch flights with higher quality. Quite on the contrary, they are trying to lower their costs and so their quality. As a wide set of evidence shows, FSCs have lowered their costs and prices, in a strategy of accommodation, but, as they face financial constraints, it is difficult for them to improve their quality in order to prevent entry. Then, LCCs effectively enter in markets dominated by FSCs.

According to the model's results, product proliferation may be found in markets where the incumbent faces an existing rival with an inferior quality and a potential rival with a superior quality. When the incumbent is a LCC, if another LCC (with a lower quality) were not in the market, then there would not be product proliferation. A higher quality for an LCC may be a set of characteristics that define consumers' preferences. For example, in the London-Shannon route, Ryanair may believe (and be right) that it has a higher quality just because Irish customers may prefer an Irish airline.

In brief, entry deterrence and accommodation by product proliferation must be analysed in the real context of the market, and airline markets are becoming more complex in what regards the number and the quality of the companies operating in them.

The empirical study on the Grenoble-London route provides some insights on price competition, and on the price strategy of one airline (Easyjet) when operating under different competitive settings.

A LCC's fare under monopoly conditions is only influenced by the number of days from the date of booking to the date of the flight. When competition is present, this variable is no more relevant, and the rival's fares become significant explanatory variables. This is true except for flights operating in peak demand dates. In these dates, price competition is relaxed and a simple form of revenue maximisation, by increasing price as the date of the flight approaches, is used. A peak demand date means that there is demand enough for all airlines, and that there is no need to follow each others' prices.

As for Easyjet, its fares are quite interdependent. Results suggest that the best quality service (the Gatwick route) is the first one to be determined, often according to other companies' prices, and that then the fare for Luton follows the former.

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