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Pricing Strategies of low-cost airlines: the Ryanair case

by

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Pricing Strategies of low-cost airlines: the *Ryanair* case

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Abstract

The aim of this study is to analyse the pricing policy adopted by *Ryanair*, the main low-cost carrier in Europe. The first part of the study reviews the results of literature addressing the subject of *dynamic pricing*, with specific reference to the air transport industry. The methodological section contains the models of reference for determining the optimal price and the demand function regarding the individual routes. The second part describes and analyses the data base that was used, giving price information relating to all *Ryanair*'s European flights from 1st July 2005 to 30th June 2006. In the empirical analysis section there is an estimation of the optimal pricing curve for each monitored route, by means of a family of hyperbolic curves as described in the literature. Subsequently, the parameters of the estimated price functions are connected with specific aspects relating to routes, competition, airports and served territories. The analysis shows that a positive correlation exists between the average price of each single route and its length, the frequency of flights operating on that specific route and the percentage of fully booked flights; greater the impact the carrier has on operations at the airports of departure and arrival, more negative is the correlation. With reference to the intensity of the *dynamic pricing* phenomena, the correlation to route length and frequency of flights is negative. Viceversa, greater the competition, higher are the discounts given on advance bookings, a variable which is not correlated to the level of average prices. Finally, the cost component relating to taxes and fares of the carrier is positively correlated to prices, to the degree of *dynamic pricing* activity and to the percentage of fully booked flights. To put it briefly, the study confirms the European low fare airline leader's attention to the latent demand in the air transport industry and to the context in which it operates.

Key words: air transport, low cost, pricing

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1. Introduction

In recent years, the air transport industry has been wholly revolutioned by the entry of low cost carriers. The low cost business model was introduced by *Southwest* in the United States from the beginning of the Seventies. However, the phenomenon has reached a world scale only in the last ten years. Indeed, the low cost business model was introduced in Europe only in the Nineties: *Ryanair* was one of the first airlines in Europe to adopt it in 1992, while *Easyjet*, *Ryanair*'s main competitor, was founded in 1995. Although the phenomenon is relatively recent, the stunning results obtained by low cost carriers have urged academics to study the reasons for this success.

At the core of low cost business model's operational and organisational choices there is the reduction of costs. This is aimed at offering lower fares, also by eliminating some comfort and additional services that are traditionally guaranteed (this is the reason why these flights are called *no frills*). These are only a few of the innovative choices made by low cost air transport: an on line booking system, no free catering service on board, the use of smaller airports connected with a point to point network and the use of fleets made up of only a few types of aircraft.

A lot of studies analysed low cost business and highlighted the key factors of its lower costs and the role played by entrepreneurial *alertness* (Cassia *et. al.*, 2006). Among these key factors, there is the understanding of the existence of a "latent demand", which is characterised by a different customer's willingness to pay and a distinct elasticity to prices compared with the attitude of the typical passenger. Indeed, the containment of costs is only one reason for the success of a carrier. In the airline business the maximisation of the profits obtained from single flights depends mainly on the maximisation of revenues, because after having planned the time table, many of the costs incurred are essentially fixed, at least in the short run. Pricing has always represented an important factor in carriers' choices, and also in this field the strategies adopted by low cost carriers distinguish themselves from those adopted by full cost carriers. The price discrimination techniques used by full cost carriers are based on a system of different fare classes, a complex system of discounts with limited access, the use of customer loyalty schemes and of *overbooking* techniques. Low cost carriers implement their optimisation strategies by using *dynamic pricing*. Thanks to the specific choices made by low cost carriers, it has become quite common for people to buy air tickets to European destinations for less than €10 (airport taxes excluded).

This study deals with low cost carriers' pricing, offering a detailed analysis of *Ryanair*, which is the main contributor and developer of the low cost model in Europe. In particular, the study analyses *Ryanair*'s pricing policies in correlation to the features of its airport network. The first results of the analysis show that the fare policy is innovative compared with traditional pricing strategies and that it is influenced by the competitive economic context in which the route is offered. Generally, fares tend to increase until the very last moment before the closing of bookings. Assuming that *Ryanair* maximises its profits, travellers are expected to have an increasing willingness to pay as the flight date approaches.

2. State of the art

This study refers to two main fields of literature: the analysis of the low cost business model and the study of *dynamic pricing* techniques.

First of all, the study refers to analyses on the low cost business model. This interest is justified by the extraordinary performance of the major low cost carriers, especially if we compare it with the trend and the average profitability of the air transport industry. Researchers focused on the understanding of the ways to control costs, the basis of low cost philosophy. Franke (2004) and Doganis (2005) estimated the cost benefits that low cost carriers can derive from their operational choices. These studies show that there is no single driver element responsible for the competitive advantage, but that all the choices significantly contribute to obtain the cost benefits. Given the delicate balance of the combination of elements that stands at the basis of the performance of carriers such as *Ryanair* and *Easyjet*, the literature does not make definitive statements about the future sustainability and the proportions of the low cost phenomenon. Beside carriers that have undoubtedly succeeded, there are carriers that failed.

On the one hand, the *first mover* competitive advantage could explain why the most successful airlines (which seemingly are able to maintain their market leadership in the short and medium run) are those airlines that gave rise to the phenomenon: *Southwest* in the USA, *Ryanair* and *Easyjet* in Europe; on the other hand, a good low cost strategy can never be replicated exactly in all its details: this could explain why some carriers succeed while others do not. The study by Alamdari and Fagan (2005) gives a quantification of the impact caused by the deviation from the original low cost business model.

The importance of the different strategic choices made by carriers suggests moving into other elements of the low cost business model. The revenue analysis is one of the less studied aspects so far. In fact, low cost airlines differ from full cost ones as regards the generation of revenues, also. Piga and Filippi (2002) analysed the role played by pricing policies in the low cost business model and showed that it differs from full cost airlines' *pricing* strategy. Coherent choices seem to be essential in *pricing* policies, too. For instance, the predominant use of the internet for selling tickets tends to decrease price dispersion. This phenomenon is partly ascribable to the "efficiency of electronic markets" defined by Smith (Smith *et. al.*, 2000).

The success of the low cost model is based on a delicate balance between fare levels, *load factor* and operating costs. The structure of revenues and the determination of prices are nearly as important as the minimisation of costs in the equation of profits.

Indeed, an excellent pricing strategy for perishable assets results in a turnover increase, *ceteris paribus*, which can be quantified between 2-5% according to Zhao and Zheng's study (2000).

The analysis of fare levels and policies is carried out with the aim of studying the key factors of some low cost carriers' achievements. Moreover, it makes it possible to value the effects of the competitive interaction between carriers (Pels and Rietveld, 2004). In fact, on the one hand the price choices and airlines' ability to understand the characteristics of demand, either in a condition of monopoly or in a competitive context, represent a decisive element in the balance of the business model itself. On the other hand, the analysis of fare dynamics is one aspect to be taken into account to value market competitiveness and the benefits travellers got from deregulation.

There are relatively few detailed analyses of the *pricing* strategies used by low cost airlines to determine their seat prices. This study analyses the pricing strategies adopted by *Ryanair* in conjunction with the characteristics of the context, such as the degree of competitiveness or the opening of new routes. Firstly, the study deals with the demand curve, by deriving it from *Ryanair*'s prices. The analysis is developed starting from the microeconomic principles of *dynamic pricing*. Generally speaking, airlines tackle a problem of maximisation of the profits, dealing with perishable goods sold in different time *steps*. The offering of seats on a flight can be compared to the selling of "*perishable assets*" with pre-determined capacity and in conditions of negligible marginal costs. The trend in the literature taken as reference here addresses two main themes: the *dynamic pricing* and the *yield management*.

Zhao and Zheng (2000) determined the minimum conditions that are necessary for the dynamic of prices to be optimal. Price trend is influenced by the demand structure; one part of the literature focuses on the study of optimal *pricing* policies by using specific functional forms of demand and of customer benefit. For example, it is quite typical to use an exponential demand curve (Gallego and Van Ryzin, 1994) and a mechanism "of customer arrival" into the market with a probability which is very similar to a *Poisson* process. The studies mentioned above hypothesise a continuous optimal price function. On the contrary other studies hypothesise the existence of a limited range of prices (Wilson, 1998). The present study adopts a continuous function, since *Ryanair*'s range of prices seems quite wide. The study of the dynamic of prices raises interesting questions. A lot of travellers have probably noticed that prices tend to increase as the flight date approaches. According to McAfee (2006), the price reduction in the period just before the flight date depends mainly on the *trade off* between the waiting for a lower price and the risk of not finding seats any more. Also in this case, the functional form of the demand curve and its adjustment over time are responsible for the determination of a series of minimum prices.

This study makes a contribution to literature by analysing the range of actual prices of all *Ryanair*'s routes; more generally, it aims to validate some of the assumptions made in the literature by studying a wide empirical sample: the prices offered by *Ryanair* on all its routes in a year. The estimated demand curve makes it possible to infer about the trend of bookings and the curve that corresponds to the fully booked aircraft. Stokey's studies (1979) determined an optimal constant filling curve in a context of monopoly. Similar results are obtainable by using a demand with functional forms belonging to the family of continuous functions presented by Anjos *et. al.* (2005). For this kind of functions it is possible to define and implement the optimal pricing strategy in the case of goods that are to be sold by a set deadline. The curves of reference adopted in this study belong to the Anjos family of curves.

The structure of demand determines the optimisation choices of the carrier and is influenced by the presence of competition and the passenger's chance to opt for a substitute service. Classical studies, starting from the Borenstein's analysis (1989), focus on airlines' average fare level. These studies show that the competitive structure influences full cost airlines' fares; for example, they found out that there is a *fare premium* correlated to the dominance of the *hub* of reference. Alderighi *et al.* (2004) pointed out that full cost airlines tend to decrease fares on routes operated by low cost carriers, too. However, the influence of the competitive structure on low cost carriers' *pricing* strategies has been studied less. Pels and Rietveld's studies (2004) examined the evolution

of fares on the London-Paris route taking into account a lot of minor airports; in this situation, characterised by a mix of direct and indirect competition, traditional behavioural models do not seem to apply.

Finally, it is not clear whether the presence of other airlines affects low cost carriers' pricing strategies in a crucial way. Pitfield (2004, 2005) analysed the routes starting from Nottingham East Midlands airport in 2003, when it was possible to observe low cost airlines competing directly amongst themselves. According to the results, the influence of the competitive structure on prices is weak, while the historical pattern of fares offered by each airline plays a more important role, as is usual in a situation of price *leadership*. Barbot (2006), for example, studied the London-Berlin and London- Amsterdam routes and found out that the low cost market and the full cost market are separated: low cost carriers compete "only" amongst themselves and so do full cost carriers. The approach adopted here focuses on the differences in the carrier behaviour on routes with distinct characteristics. In particular, the aim is to identify what competitive and context factors determine the total level and the dynamic of applied fares.

3. Methodological aspects

The main point of the study is to analyse the pricing behaviour of the major low cost carrier in Europe. Following what has emerged from the literature, the problem is to be related to *dynamic pricing*. In the specific case of low cost carriers, it is assumed that, after having planned the *scheduling* of flights, the marginal cost incurred in correlation to the number of passengers is practically zero. Therefore, the maximisation of profits depends on the maximisation of the revenue function. The unit of time taken as reference is the single day²; considering T days, the revenue of the operator R can be expressed this way:

$$(1) \quad R = \sum_{i=1}^T p_i q_i$$

Where p_i is the flight price in the day i of the year and q_i is the number of seats booked on the same day. The optimal pricing strategy results from the maximisation of the previous expression introducing the limit of capacity of the aircraft. This limit can be expressed in the following way:

$$(2) \quad \sum_{i=1}^T q_i \leq Q$$

Where Q is the capacity, that is the total number of seats on the aircraft. For the purposes of this study, it is assumed that the operator, with regard to the specific route operated and the typology of low cost flight customers, is not a price-taker. In other words, it is assumed that the structure of

² It is like hypothesising fixed demand and price figures during the space of a single day.

competition and the level of market and product differentiation enable the operators to modify the price variable. The maximisation problem can be solved by constructing the “lagrangian”.

”.

$$(3) \quad L = \sum_{i=1}^T p_i q_i + \mu \cdot (Q - \sum_{i=1}^T q_i)$$

In the previous expression μ represents the Kuhn-Tucker’s multiplier, which considers the aircraft limit of capacity. It follows that:

$$\mu \cdot (Q - \sum_{i=1}^T q_i) = 0$$

If the limit of capacity is reached, $\mu > 0$; if it is not reached $\mu = 0$. To determine optimal price p_i at time i , the derivative of the expression (3) with respect to p_i has to be zero, obtaining:

$$(4) \quad \frac{\partial L}{\partial p_i} = q_i + \sum_{j=1}^T (p_j - \mu) \frac{\partial q_j}{\partial p_i} = 0 \quad \text{for } i \in [1..T]$$

This expression maintains its validity even if the markets of the different days are not “separated”. In this case, for example, the price of a period can modify the quantity of one next period, that is $\partial q_j / \partial p_i \neq 0$ with $i \neq j$. Instead, for the purpose of this study and like many of the studies analysed in the literature, it is assumed that the markets for the buying of the air tickets are separated in time, that is $\partial q_j / \partial p_i = 0$ with $i \neq j$. A later development of this study will try to eliminate this hypothesis by verifying whether an interaction in the demand of different periods exists.

Hence, the expression (4) is simplified in the following optimal conditions:

$$(5) \quad q_i + (p_i - \mu) \frac{\partial q_i}{\partial p_i} = 0 \quad \text{for } i \in [1..T]$$

This study considers the functional form of demand proposed by Anjos et al. (2005), in which the requested quantity of air tickets depends both on the level of prices and on how long before the flight date tickets are purchased. This form is stated below:

$$(6) \quad q_i = A e^{-\alpha \cdot p_i \cdot F(i)} \quad \text{for } i \in [1..T]$$

Where A and α are two constants and $F(i)$ is a function positively correlated to how far in advance the purchase is made with respect to the flight date. In this case, the function of demand decreases exponentially as the time in advance increases.

An advance booking is less useful due to the fact people are less sure to want/ have to fly on that date. Given the functional form of the demand reported in the expression (6), it is possible to identify the optimal pricing strategy by substituting this form in the expression (5):

$$(7) \quad p_i = \mu + \frac{1}{\alpha \cdot F(i)} = 0$$

The multiplier μ can be viewed as the extra charge assigned to the fully booked flights³. In the next section some $F(i)$ forms will be tested on Ryanair’s actual prices. The parameters of the price function will be estimated minimising the quadratic error compared to the actual prices. The assumption is that *Ryanair* operates maximising its revenues and using a demand function similar to

function (6). Therefore, the accuracy obtainable by using the model for the estimation of prices allows to assess specific form of demand curves that has been chosen.

Substituting the optimal price expression (7) in the expression (6), we have:

$$(8) \quad q_i = A e^{-1}$$

This means that, after applying the optimal price, the quantity of expected demand is steady over time. This property represents a simple rule to deviate from the optimal price. More specifically, if in a certain period the sold quantity is greater than the steady expected quantity, the operator can decide to raise prices. In the same way, he can decide to reduce prices to gain demand when the latter is scarce. In the empirical working-out that has been carried out, two particular functions for the estimation of prices have been used. The first expression is:

$$(9) \quad p_i = \mu + \frac{1}{\alpha \cdot (1 + \beta \cdot i)}$$

Where i is the number of days in advance the booking is made. The form of the optimal price is an hyperbole in which the price goes up as the flight date approaches. By applying this functional form it is not possible to obtain price reductions as the flight date approaches.

The second functional form, more complete than the previous one, is the following:

$$(10) \quad p_i = \mu + \frac{1}{\alpha \cdot (1 + \beta \cdot i + \gamma \cdot i^2 + \theta \sqrt{i})}$$

In this case, it is possible for the flight price to decrease as the departure date approaches. The degree of accuracy of these two functional forms will be discussed in the next section. The hypothesis is that *Ryanair* has a pricing strategy based on specific routes; in other words, it is assumed that *Ryanair* has specific values of the parameters in (9) and in (10) for each route. An estimation of the parameters of the price functions will be made for all *Ryanair's* routes using information regarding the 90-day period before the flight date. After having estimated the parameters of the price functions, the functions of the average individual route filling will be shown by using the demand curves that result from (7).

4. Sample and descriptive analysis

4.1. Data of reference

The general aim of this study is to analyse the determining factors of *Ryanair's* pricing policy, the low cost air transport leader in Europe. To achieve this aim, the collected database provides the

³ Fully booked flights are flights on which there are no more available seats the day before the departure date.

daily fare of each route⁴ operated by *Ryanair* considering the 4-month period prior to the flight date. This price information is given about all the flights that *Ryanair* scheduled from 1st July 2005 until 30th June 2006.

This database enables us not only to compare the fares of *Ryanair*'s different routes, but also to study how the individual route's fare varies as the flight date approaches.

4.2. Characteristics and evolution of the network operated by *Ryanair*

Ryanair's network is very dynamic and keeps expanding. This study wants to describe briefly its characteristics, by comparing the dimensions it had as of 1st July 2005 (first data gathering) to the ones it had as of 30th June 2006 (last data gathering).

In July 2005 *Ryanair* served 95 airports; in the space of one year, the number of served airports reached 111. Routes increased by 34.4%, reaching the total number of 594. In the months to come, the opening of 32 new routes and the linking of 5 new airports are expected.

However, 25 of the routes operated in July 2005 were cancelled; on 6 routes the flight frequency was halved and on 16 routes it decreased by more than 10%. *Ryanair* operates on many routes with a low frequency; indeed, on 70.8% of routes there is only one flight a day. By and large, *Ryanair* serves its routes each day of the week. However, in 2005-2006 this trend seemed to change: the number of routes on which at least one flight a day is not guaranteed rose from 14 to 77. By using information about the scheduled flights and the distance between connected airports, it is possible to estimate⁵ *Ryanair*'s ASK⁶ (Available Seat Kilometres) distribution. From a geographical point of view, *Ryanair*'s main business area is the connection between England, Ireland and the rest of Europe (44.2% of the routes and 49% of the flights start at British or Irish airports). The major flow (measured in ASK) is generated by the connection between Italy and England (14.6%). Without considering the British Isles, the main flow is generated by the connection between Italy and Spain (3.1% of the whole business). Smaller is the role played by domestic routes, which account for less than 5% of the scheduled air traffic considering both the number of flights and that of routes. Apart from the British Isles, Italy is the only country in which *Ryanair* has decided to operate domestic routes, too.

⁴ At the beginning of July 2005 the total number of routes was 442, while at the beginning of July 2006 it was 594.

⁴ The definition of route this study refers to is directional. The outbound and inbound routes between two airports are considered two different routes.

⁵ *Ryanair* uses fleets made up of Boeing 737 only (different versions). In the asset and liability statement, almost all the aircrafts were Boeing 737-800 (maximum capacity of 189 seats) and recently all the Boeing 737-200 have been substituted. Therefore, the ASK (Available Seat kilometres) level has been estimated considering a capacity of 189 seats for all the flights.

⁶ ASK (Available Seat kilometres) accounts for the number of available seats on a flight multiplied by the route's length (in kilometres).

Variation of <i>Ryanair's</i> flight offering (2005-2006)			
Variable	Situation as of 1/7/2005	Situation as of 30/6/2006	Δ %
N° of served airports	95	111	16.8%
N° of daily flights (average)	650.2	820.7	26.2%
N° of routes	442	594	34.4%
Percentage of routes with at least daily flight frequency	70.1%	70.8%	1.0%
Percentage of routes with no daily flight frequency	6.3%	25.8%	
N° of new airports whose linking is already planned*	0	5	
N° of new planned routes*	1	64	

**Routes on which it was already possible to book a flight with departure within 120 days on the dates written above.*

Table 1. Variation of the network operated by Ryanair from July 2005 to June 2006.

Main flows between Nations (as of 30th June 2006)			
Rank	Flows between Nations*	ASK	%
1	England - Italy	22,301,303	14.6%
2	England - Spain	19,538,299	12.8%
3	England - Ireland	11,175,029	7.3%
4	England - France	10,620,722	6.9%
5	England - Sweden	6,754,428	4.4%
6	England - Poland	6,160,721	4.0%
7	England - Germany	5,353,365	3.5%
8	Ireland- Spain	5,228,941	3.4%
9	Italy - Spain	4,796,374	3.1%
10	Italy - Germany	4,680,690	3.1%

**The average daily flow (in ASK) offered on the route that links the two nations.*

Table 2. Main flows on the routes between nations operated by Ryanair (as of 30th June 2006).

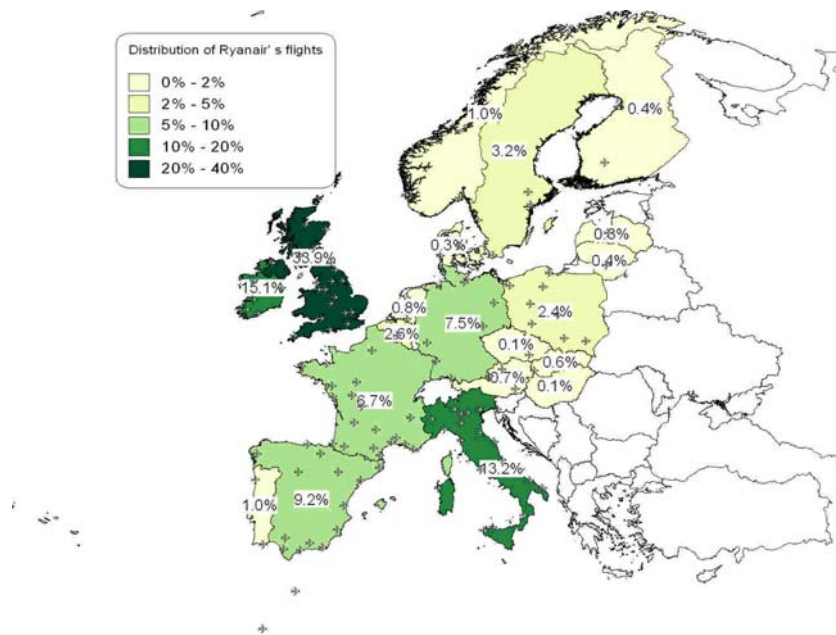


Figure 1. Distribution of Ryanair's flights and served airports (as of 30th June 2006).

Variation of <i>Ryanair's</i> offering (2005-2006)						
Variable	Situation as of 1/7/2005			Situation as of 30/6/2006		
	N° of routes	N° of daily flights (average)	Flight distribution	N° of routes	N° of daily flights (average)	Flight distribution
AT	5	6.0	0.9%	5	6.0	0.7%
BE	11	16.6	2.6%	16	21.7	2.6%
CZ	1	1.0	0.2%	1	1.0	0.1%
DE	41	50.6	7.8%	48	61.5	7.5%
DK	2	2.7	0.4%	2	2.9	0.3%
ES	52	65.3	10.1%	61	75.1	9.2%
FI	3	3.0	0.5%	3	3.4	0.4%
FR	30	40.1	6.2%	46	55.3	6.7%
HU	-	-	-	1	1.0	0.1%
IE	50	91.8	14.1%	80	123.7	15.0%
<i>Of which domestic</i>	-	-	-	2	6.0	0.7%
IT	69	94.4	14.5%	78	108.0	13.2%
<i>Of which domestic</i>	6	10.0	1.5%	6	12.0	1.5%
LT	-	-	-	3	3.0	0.4%
LV	4	4.0	0.6%	6	6.6	0.8%
NL	5	5.7	0.9%	6	6.7	0.8%
NO	5	6.3	1.0%	7	8.3	1.0%
PL	1	1.0	0.2%	18	19.4	2.4%
PT	3	4.0	0.6%	7	8.0	1.0%
SE	17	23.0	3.5%	20	26.0	3.2%
SK	-	-	-	4	5.0	0.6%
UK	143	234.8	36.1%	183	278.1	33.9%
<i>Of which domestic.</i>	10	21.5	3.3%	14	25.4	3.1%
TOTAL	442	650.2	100%	594	820.7	100%

Table 3. Distribution of *Ryanair's* flights considering their country of origin (as of 30th June 2006) and their variation with respect to July 2005.

The significant increase in new routes and markets occurred in a surprisingly balanced way; as a matter of fact this year's geographic distribution is the same as last year's. Only a slight decrease in the UK's role in *Ryanair's network* has been recorded (as shown in table n.3). *Ryanair's network* comprises mainly short-length journeys, with all its routes *ranging* between 200 and 2000 kilometres with a *median value* of 1040 kilometres (as shown in figure 2). The distribution is symmetrical with respect to the median value, forming basically a bell-shape chart apart from two peak levels at 450 and 1800 kilometres.

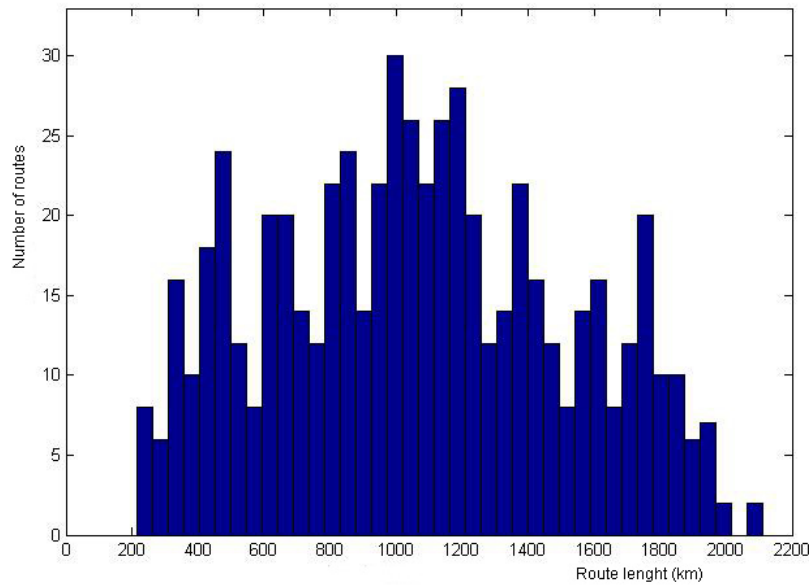


Figure 2. Routes distribution according to their length (as of 1st July 2006).

Figure 3 shows the distribution by percentile of ticket prices relative to days booked in advance. It is clear that prices depend also on some other parameters such as route specificity. Yet the role played by advance booking in *Ryanair's pricing* policy is so significant that average figures also provide important information about *Ryanair's pricing* strategies. For instance, the figures demonstrate that in 75% of cases (75th percentile in figure 3) the price⁷ does not exceed €50 for bookings made more than 20 days earlier the actual date of the flight. On the contrary, during the last week all prices go up sharply: ticket price exceeds €75 in 50% of cases within 3 days of the date of flight and in 5% of cases it exceeds €200. The curve in the percentiles seem also to suggest a non-steady price trend by highlighting a certain period of time in which minimum fares are offered.

⁷ The price mentioned throughout this work, apart from different indications, refers to the “net” fare indicated on Ryanair’s website which excludes other cost categories such as airport taxes security fees and credit/debit card handling fees.

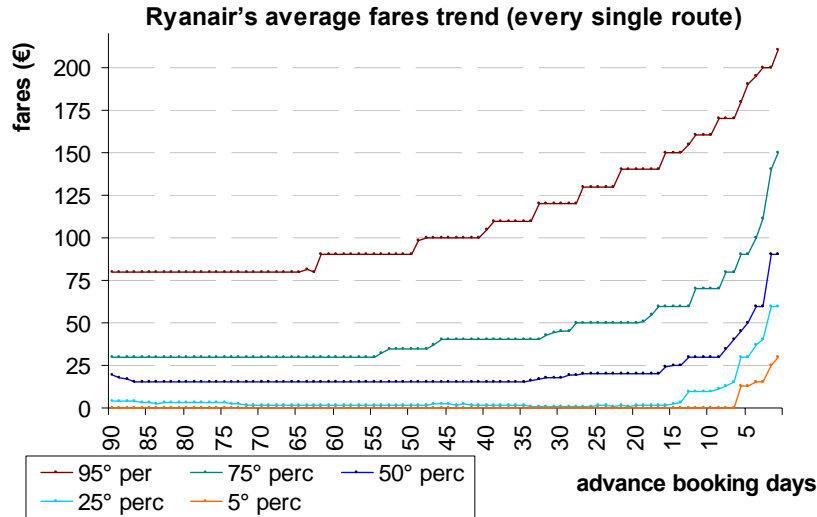


Figure 3. Fares trend distribution according to advance booking days. Percentiles are calculated on data which includes fares applied on each route and monitored during a twelve month period . The n^{th} percentile curve shows that in $n\%$ of cases prices are lower than those indicated.

The steady increase in prices as the date of the flight approaches is generally verified only on average. Basically *Ryanair* provides “special offer” periods in which fares are lower than those prior to those periods. Such periods of time do not seem to have any particular recurrence in terms of length and time. By restricting the comparison to flights on the same route only, it is not possible to mark a specific interval on which special fares are offered; on most routes prices seem to increase slightly and this steady upward trend is similar to that shown in figure 3. In figure 4 the average price trend on the Ciampino-Stansted route is shown while figure 5 shows the exact price trend on specific dates. The example compares two price trends pertaining to two dates neither of which fall on holidays (such as bank holiday or religious feast); as shown in the figure below, in both cases there is no steady price trend since, starting from 90 days in advance, lower fares can be found approaching to the departure day, but during different periods of time, with different lengths and intensities. By assuming that this phenomenon occurs often in *Ryanair*’s pricing policy the result is that passengers’ expectancy should include a probability (p) for price to fall in the following days.

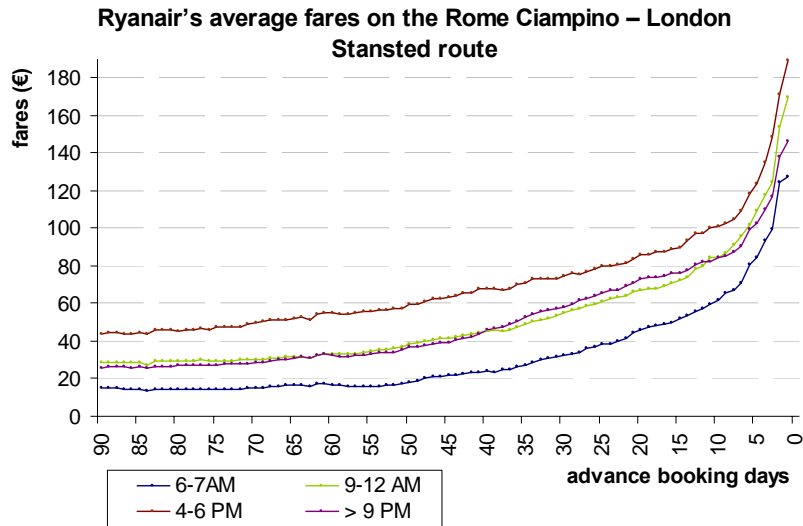
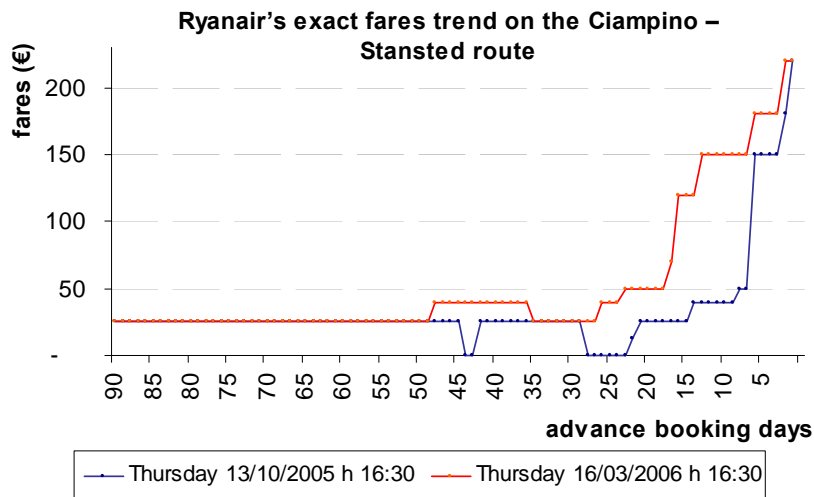


Figure 4. Average price trend on the Rome Ciampino- London Stansted route according to different departing time.



Graph 5. Exact price trend on the Rome Ciampino- London Stansted route according to two specific dates (Thursday 13th October, 2005 and Thursday 16th March, 2006).

The database at our disposal enabled us to investigate the recurrence of special offers in *Ryanair*'s pricing policy. More precisely we have calculated, for each single flight, the percentage of days on which price offered was lower than levels already reached at that specific date. Data has been gathered according to the route and we subsequently analysed the distribution of those percentages. Figure 6 shows the distribution by percentiles (ratio of days in a row with a lower price) on the Rome Ciampino – London *Stansted* route. On this route, in 50%⁸ of flights monitored ('percentile 50%' in figure 6), there was no downward price trend within 30 days of the date of the flight. In the case of 30-day advance bookings, for 25% of cases (percentile 75% curve) there were

⁸ Referred to 691 out of 1,382 flights monitored on the route analysed.

at least 6 days on which price was lower than levels reached at that specific date whilst in 2,5% of cases there were at least 18 days with a lower price.

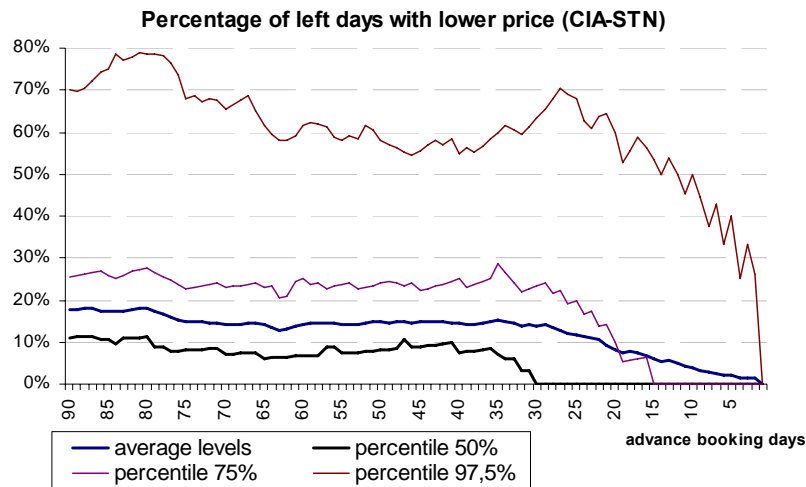


Figure 6. Percentage of remaining booking days on which fares has been lower than fares applied at that specific time. (figures refer to Rome Ciampino – London Stansted route). In 50% of cases (50th percentile line) price trend was never downward within 30 days of the date of flight.

Data gathered does not include information about the actual number of seats booked per individual flight, as inferences with regards to volumes will be drawn in the following part of the empirical analysis. These figures show the number of flights fully-booked within the last 24 hours before the scheduled departure date. Since *Ryanair* adopts both a non-refundable ticket policy and a no *overbooking* policy, a flight is considered fully-booked when its website indicates that there are no available seats. For each individual flight we calculated the fully-booked flight ratio (considering fully-booked flights defined for our purpose as those with no available seats within the last 24 hours). Figure 7 shows the distribution of routes according to the fully-booked flights ratio. The period monitored is the same for all routes and it covers all months considered. The figures show a particularly strong ability in filling all seats available on different routes. As a matter of fact, most of *Ryanair*'s routes are fully-booked 10-20 times out of 100.

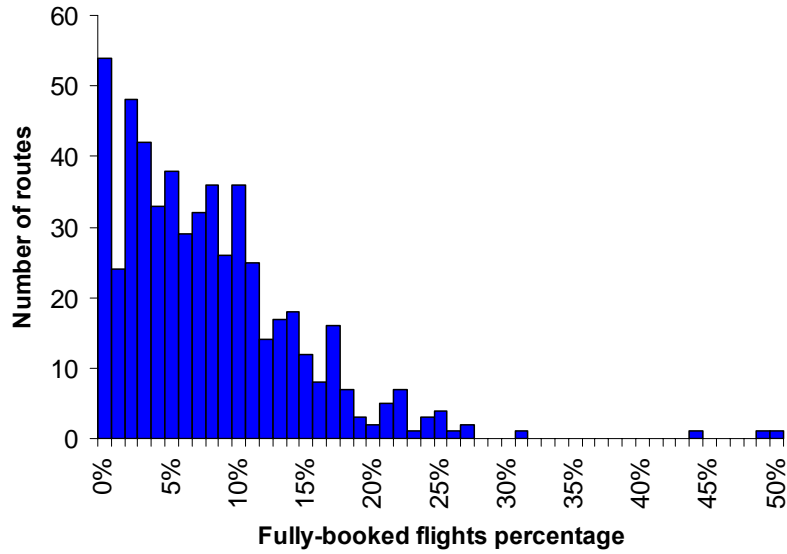


Figure 7. Distribution by number of routes according to fully-booked flights percentage.

5. Empirical analysis

In the empiric analysis price trends for individual route have been estimated utilising equation (9). According to this equation, obtained from an exponential demand function subject to *Ryanair*'s profit maximisation, price trend, as the date of flight approaches, is similar to an hyperbole driven by parameters α and β . More precisely, parameter α indicates the maximum level price could reach during the last days before scheduled departure. The lower α is the higher the fare will be on the day before departure. Parameter β , instead, indicates how much fares decrease when advance booking days increase. A low β parameter shows a steady price trend as the number of advance booking days increases. On the contrary, a high parameter β indicates a significant discounted fare with respect to highest fare for tickets purchased in advance. Finally, parameter μ , indicates the average surcharge in the case of flight already fully-booked on the day before scheduled departure.

The estimation of these parameters refers to all routes whose fares are published at least three months before the actual date of flight. Routes number just 550 out of 594 monitored. The remaining routes, recently introduced, have not been taken into consideration because they have been monitored for less than a three-month period. The estimations have been produced by minimising the standard error of estimation with respect to the actual fares of individual routes.

The distribution of routes according to parameters α and β is shown in figure 8 and 9 respectively. Parameter α distribution shows a higher frequency of routes with parameter α levels around 0.008-0.01, estimating a maximum average price higher than €100. As regards parameter β , there is a maximum relative frequency with levels slightly greater than zero; the frequency slightly decreases as parameter β increases. Some routes show a significant higher β level: approximately 50% of routes register a parameter β greater than 0.1. In these cases, on average, by purchasing the

ticket three months in advance, it is possible to pay less than one tenth of the highest fare available a few days before the date of flight. Parameter β distribution indicates the presence of a *cluster* of routes whose dynamic pricing intensity is significantly different. Tests carried out by gathering routes according to the presence of *competitors* on these routes, do not highlight any significant difference.

Yet it is important to note that routes in competition with one another present particular features such as a high concentration of areas with an high GDP. For these reasons, in order to distinguish and isolate single variable effects, we employ regression models.

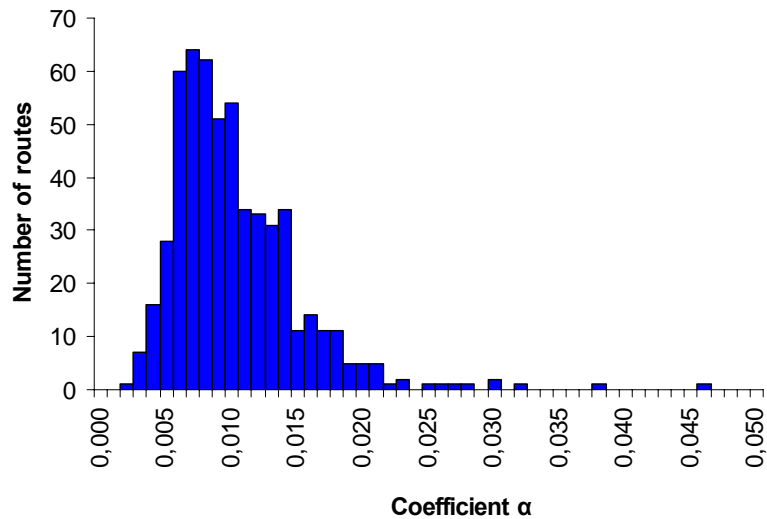


Figure 8. Distribution by number of routes according to coefficients α estimated by analysing flight fares.

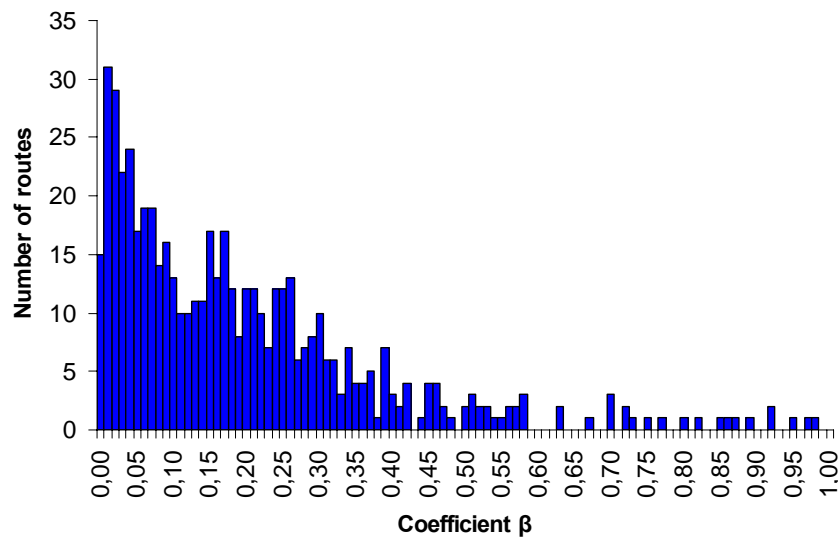


Figure 9. Distribution by number of routes according to coefficients β estimated by analysing flight fares.

Once *Ryanair*'s the optimum price demand curve parameters are obtained it is possible to estimate the average number of daily bookings for individual routes by using equations (6) and (8). Figure 10 referring to the high-frequency Rome Ciampino – London Stansted route, shows the average ticket price, the estimated price calculated by using equation (9) and, on the right, the estimated number of daily bookings. It is notable that, thanks to the optimal pricing strategy adopted, the number of daily bookings as the date of flight approaches is a steady trend. Such a result is coherent in respect of literature results.

There are different reasons why the estimated price does not equal the actual price. Firstly, the demand curve is not known with certainty day by day. Sometimes you can have more bookings than expected and vice versa. If the quantity of bookings outnumbers the expected number of bookings, carriers are likely to raise price in order to reduce the number of additional bookings and return back to the optimum situation. Secondly, *Ryanair*'s fares do not vary constantly but rather in a discrete fashion, due to operative reasons. As a matter of fact *Ryanair* raises price only by small increments (generally by €5) in order to reach the higher fare bracket. Finally, the parameters utilised for the estimation have been calculated by considering every single flight on every single route so as to provide sufficient amounts of data. Nevertheless, time of the day and day of the week are likely to significantly affect pricing strategy. Subsequently, a future development of the analysis will be to estimate these parameters not only according to individual routes but also according to the day of the week and the time of day, thanks to the broad database at our disposal.

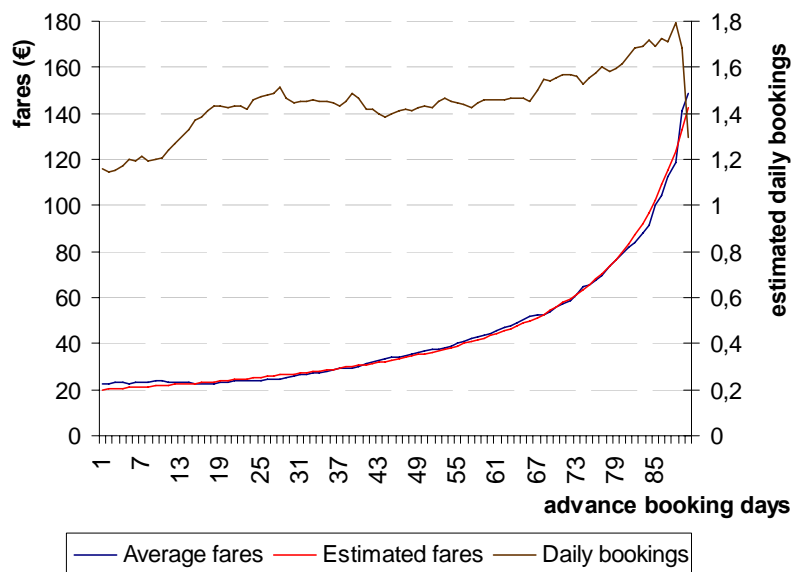


Figure 10. Rome Ciampino – London Stansted route. Comparison between the daily average price and the estimated price. It also shows estimated average daily bookings based on a hypothesis 180 passengers as the maximum seating capacity of the aircraft.

After estimating price curve levels and the “flight-filling” function for each route, a regression analysis has been carried out. The aim of the analysis was to study the possible determinants in *Ryanair*’s pricing strategy.

The first regression analyses the “temporal” average price as a dependent variable. This is the arithmetic mean of prices related to a specific route from no more than three months prior to departure up until the day before departure. If the fare-filling curve is an optimal one, which means that the expected number of average daily bookings is steady over time (Stokey, 1979), the average price weighted on the total number of purchased tickets equals the temporal average price.

Basically there are two kinds of explanatory variables which have been used:

- route specific variables
- airports and linked areas specific variables

The route specific variables include: the length of the route, the daily frequency of the route, the percentage of fully-booked flights, the number of carriers in direct competition on the route, as well as the overall taxation level to which ticket fares are subject.

The airport and hinterland areas specific variables on the other hand include information about the linked areas’ GDP and their relative population density. Moreover, two other variables have been considered in order to understand *Ryanair*’s importance in the departure and arrival airports: *Ryanair* ASK/Departure available seat kilometres (ASK) and *Ryanair* ASK/Destination ASK. Such variables have been calculated as the ratio between the total ASK provided by *Ryanair* on a specific route and the total ASK provided by departure and destination airports. The results of the regression analysis are shown in table 4.

Determinants of average price analysis			
Variable	Coefficient	(Std Error)	Statistic T
Length	0.021	(0.0010)	19.98***
Route frequency	0.100	(0.0496)	2.02**
<i>Ryanair</i> ASK /Departure ASK	- 9.013	(3.4414)	- 2.62***
<i>Ryanair</i> ASK /Destination ASK	- 8.822	(3.2156)	- 2.74***
Overall taxation	0.298	(0.1119)	2.67***
Departure GDP	- 0.71·10 ⁻⁰³	(0.0002)	- 2.71***
Destination GDP	- 0.46·10 ⁻⁰³	(0.0002)	- 1.74*
% of fully-booked flights	24.116	(7.4912)	3.22***
Departure population density	0.43·10 ⁻⁰³	(0.0008)	0.52
Destination population density	0.001	(0.0008)	1.74*
Total number of competitors	0.038	(0.5403)	0.07
Constant	1.849	(2.6235)	0.71

*** significance level <0,01;

** significance level between 0,01 and 0,05;

* significance level between 0,05 and 0,1.

Table 4. Results of the regression analysis on average price for individual route. The first column indicates the level of estimated coefficients, the second shows the standard error of estimation and the third column indicates statistic T level and the significance level.

The most significant variable affecting the average price for individual routes is, as predicted, the route length. As a matter of fact variables referring to demand, such as route frequency and percentage of fully-booked flights, are less significant and with positive coefficients. This definitely confirms that the higher the demand is, both in terms of percentage of fully-booked flights and daily route frequency, the higher average prices are. Interesting results are related to variables which denote *Ryanair*'s importance in the departure and destination airports. Generally, the greater this importance is, as in the case of minor airports, the lower the price will be. By using minor airports *Ryanair* is able to offer discounted fares which consequently also encourages consumers to use these minor airports. Moreover, the price is positively correlated to the population density of the destination airport. Interpreting those variables related to the airport's linked areas' GDP is slightly

more difficult. Results seem to indicate a strategy which aims to foster demand in those areas with a high GDP. In light of this information *Ryanair's* strategy seems to aim to attract latent demand for extra flights typical of the middle classes (concentrated in high GDP areas) who are willing to pay more for unnecessary trips, but at the same time still quite sensitive to price changes.

The overall taxation level on the route seems to be also positively correlated to *Ryanair's* average price. This could be a *proxy* variable of the service provided by the airport.

Finally, the average price does not seem to be particularly affected by the presence of *competitors*, which confirms the complexity and difference in the air transport industry's competitiveness. As we will see in the following pages, the analysis suggests that dynamic pricing is likely to be affected more by competitiveness.

Determinants analysis of parameter β			
Variable	Coefficient	(Std Error)	Statistic T
Length	$-0.22 \cdot 10^{-03}$	$(0.016 \cdot 10^{-03})$	-13.50***
Route frequency	$-0.15 \cdot 10^{-03}$	(0.0007)	-2.04**
<i>Ryanair</i> ASK /Departure ASK	0.111	(0.0524)	2.13**
<i>Ryanair</i> ASK /Destination ASK	0.042	(0.0490)	0.86
Overall taxation	$3.26 \cdot 10^{-03}$	(0.0017)	1.91*
Departure GDP	$1.65 \cdot 10^{-06}$	$(4.040 \cdot 10^{-06})$	0.41
Destination GDP	$2.95 \cdot 10^{-06}$	$(4.088 \cdot 10^{-06})$	0.72
% of fully-booked flights	-0.078	(0.1142)	-0.69
Departure population density	$-0.01 \cdot 10^{-03}$	$(0.012 \cdot 10^{-03})$	-0.81
Destination population density	$-0.01 \cdot 10^{-03}$	$(0.012 \cdot 10^{-03})$	-0.99
Total number of <i>competitors</i>	0.016	(0.0082)	2.03**
Constant	0.326	(0.0400)	8.17***

*** significance level $<0,01$;

** significance level between 0,01 and 0,05;

* significance level between 0,05 and 0,1.

Table 5. Results of the regression analysis on coefficient β for individual routes. The first column indicates the level of estimated coefficients, the second shows the standard error of estimation and the third column indicates statistic T level and the significance level.

The average price is certainly an important piece of information as regards to the individual route but it is not revealing of how price might change within three months before the actual date of flight. In order to study the variables on which dynamic pricing depends a regression analysis has been carried out using parameter β as dependent variable, estimated for individual routes. The results of the analysis are shown in table 5.

Length and route frequency are the most significant variables with negative coefficients. As a matter of fact, the longer and more frequent the route is, the steadier price trend we have within three months before the date of the flight. In other words, *Ryanair* tends not to apply big discounts despite an advance purchase, in the case of long-haul and high-frequency routes. The first assumption may be justified by considering the fact that *Ryanair* aims to cover fuel costs on advance purchases also. On the contrary, the second assumption, suggests that the higher the level of demand, the less significant discounts are, because more frequent flights are provided. The percentage of fully-booked flights also registered a negative coefficient, though with a low level of significance.

The importance of the departure airport is a variable directly correlated to parameter β . This means that if *Ryanair* plays a dominant role in the departure airport, average prices are lower and there are likely to be significant discounts for tickets purchased in advance.

As a result the variable identifying the number of *competitors* on the same route shows a positive relation and with a high level of significance. This means that fierce direct competitiveness on the same route does not lead to a decrease in average ticket prices. It does however induce *Ryanair* to grant greater discounts when advance bookings are made.

The next section of empirical analysis aims to study in depth the determinants of two variables already analysed in the previous regressions, which are the percentage of fully-booked flights and the overall route taxation level. Table 6 shows the results of the regression analysis as regards the percentage of fully-booked flights, indicating only explanatory variables which have registered a higher level of significance.

Determinants analysis of percentage of fully-booked flights			
Variable	Coefficient	(Std Error)	Statistic T
Length	$-0.03 \cdot 10^{-03}$	$(7.810 \cdot 10^{-03})$	-3.49***
Route frequency	$0.25 \cdot 10^{-03}$	(0.0003)	0.68
<i>Ryanair</i> ASK /Departure ASK	0.062	(0.0253)	2.46**
<i>Ryanair</i> ASK /Destination ASK	0.015	(0.0238)	0.65
Overall taxation	$0.92 \cdot 10^{-03}$	$(0.829 \cdot 10^{-03})$	1.11
Departure GDP	$5.07 \cdot 10^{-06}$	$(1.72 \cdot 10^{-06})$	2.94***
Destination GDP	$8.30 \cdot 10^{-06}$	$(1.71 \cdot 10^{-06})$	4.88***
Total number of <i>competitors</i>	0.006	(0.0039)	1.55
Constant	0.050	(0.0192)	2.60**

*** significance level $<0,01$;

** significance level between 0,01 and 0,05;

* significance level between 0,05 and 0,1.

Table 6. Results of the regression analysis on the percentage of fully-booked flights on individual routes. The first column indicates the level of estimated coefficients, the second shows the standard error of estimation and the third column indicates statistic T level and the significance level.

Routes with a higher percentage of fully-booked flights, on average, are short-haul routes to dominant airports. The GDPs of areas linked with airports also contribute to increasing the percentage of fully-booked flights.

Table 7 shows the result of the regression analysis on the overall level of taxation to which ticket prices on individual routes are subject.

Determinants analysis of the overall level of taxation			
Variable	Coefficient	(Std Error)	Statistic T
Departure ASK	$6.29 \cdot 10^{-09}$	$(2.210 \cdot 10^{-09})$	2.85***
Destination ASK	$-1.40 \cdot 10^{-09}$	$(2.060 \cdot 10^{-09})$	-0.68
Length	$-0.53 \cdot 10^{-03}$	$(0.514 \cdot 10^{-03})$	-1.04
Route frequency	0.079	(0.0275)	2.91***
<i>Ryanair</i> ASK /Departure ASK	6.274	(1.7833)	3.52***
<i>Ryanair</i> ASK /Destination ASK	4.159	(1.6993)	2.45**
Departure GDP	$0.391 \cdot 10^{-03}$	$(0.113 \cdot 10^{-03})$	3.47***
Destination GDP	$-0.16 \cdot 10^{-03}$	(0.0001)	-1.38
Total number of <i>competitors</i>	0.067	(0.2845)	0.24
Constant	15.812	(0.9431)	16.77***

*** significance level $<0,01$;

** significance level between 0,01 and 0,05;

* significance level between 0,05 and 0,1.

Table 7. Results of the regression analysis on the overall level of taxation on individual routes. The first column indicates the level of estimated coefficients, the second shows the standard error of estimation and the third column indicates statistic T level and the significance level.

The importance of the departure airport (in terms of ASK), the area's GDP, the route frequency and *Ryanair*'s dominance of the airport served appear to be all positively correlated to the overall taxation level.

Every analysis mentioned above has been carried out by estimating an optimum price function obtained from equation (9). Such an equation has been drawn by considering an exponential demand curve, as shown in equation (6), with respect to price and to advance purchase time. For the same price, potential customers' utility decreases, the longer the advance. The optimal price function thus is steady and it does not decrease as the date of flight approaches. This does not mean that special fares are not likely to be offered on specific routes. As a matter of fact, if the number of bookings is below the expected, the carrier is likely to reduce price in order to encourage people to book tickets and keep pursuing a fully-booked flight strategy. Yet, on average, these effects correlated to demand variability do not seem to affect price trend and as a result no downward trend is expected..

The assumption above however seems to clash with price trends on some of *Ryanair*'s routes. In particular, figure 11 shows the average price for the Rome Ciampino – Shannon route. It is clear how average price reaches the lowest level between 50 and 60 days before the date of the flight. Such a trend has also been recorded on other routes, although the downward trend is not too marked

and it does not affect the average upward price trend, typical of the last month before scheduled departure.

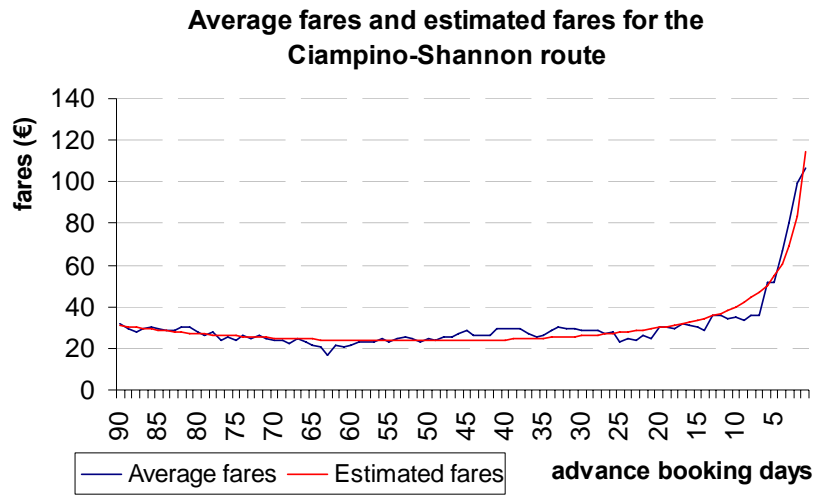


Figure 11. Compares the daily average price and the estimated price (using the most complete statistical model) for the Rome Ciampino – Shannon route. Most notable is the minimum price between 55 and 60 days before the date of flight.

In order to improve the statistical model, we have used a demand curve equation with a different dependence with respect to advance booking, which leads to the optimal price shown in equation (10). Such a formulation presents a higher level of generality with respect to previous analyses'. As a matter of fact this equation is obtainable, as a particular case, when coefficients γ and θ equal zero. According to this assumption, the potential customers' utility (for the same price) does not increase steadily as the date of flight approaches. In other words we admit the possible existence of an optimal period of time in which minimum price is offered, as shown in equation (10).

This new model has been tested on each route previously analysed in order to verify the actual improvement of price estimations. Results confirmed a significant improvement in the estimation, especially in the period between 60 and 90 days before the date of flight. In particular, on 391 out of 550 routes, new estimations have pointed out the presence of an optimal purchase period of time in which price reaches the minimum level within 90 days of scheduled departure. Figure 12 shows the distribution of optimal purchase periods of time for the 391 routes. On average, the optimal purchase period of time ranges between 50 and 70 days before the date of flight, as shown below.

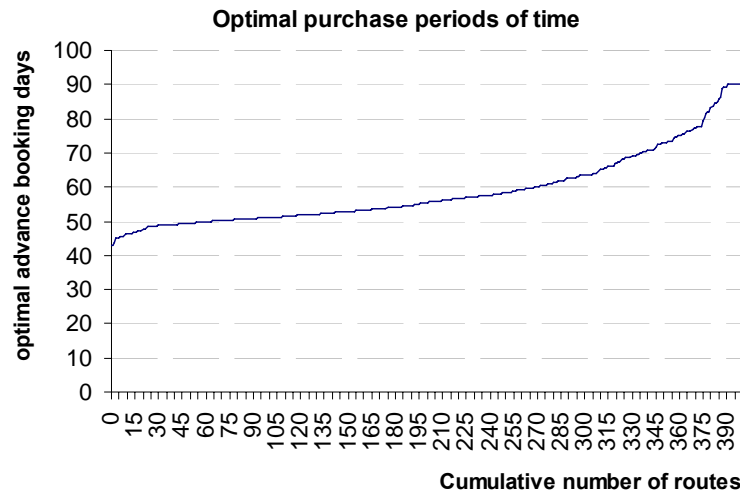


Figure 12. Distribution by the optimal purchase periods of time for the 391 routes analysed. The remaining 159 routes have pointed out a steady non-downward price trend as the date of flight approaches. For those remaining routes the optimal purchase period of time is 90 days before the date of flight, which is the first available day for purchasing.

6. Conclusions and future developments

This work studied in depth the analysis of *low cost carriers' pricing strategy*. The empirical analysis was based on an original database composed of *Ryanair's* fares available on its website on each single route operated during the past year until 30th of June 2006. Data confirms the leading role played by advance purchase in pricing strategy. By considering the main assumptions presented in the literature, we focused on the features of demand curve by hypothesising *Ryanair's* ability to maximise profits. The comparison between estimated parameters and routes specificity revealed the importance of socio-economic factors, as well as competitiveness, as regards both average fares and their structures, not broadly analysed in the literature so far. The work represents a first effort towards such a direction, though there are a series of other factors whose role needs to be studied more in depth. The introduction of the temporal location of the flight (such as time of the day and day of the week), amongst explicative parameters, as well the improvement of the measurement of competitive pressure by considering fares applied by *Ryanair's competitors*, might be seen as a first development step.

In the last section of the work, we chose to modify the optimum price model adopted initially, in order to describe more precisely the actual price trend. Results obtained significantly improve the estimations and generate, on some routes, an unsteady optimal price function, which enabled us to calculate a minimum price interval. Some interesting questions arise from the interpretation of these results about the real trend of the demand curve and the role played by passengers' expectations on the curve itself.

To conclude, the work succeeded in studying in depth the knowledge of leading low cost carriers' dynamic pricing; it tested the role of context factors both on average fares applied and price trends. At the same time it represents the application of some assumptions and theories (such as the shape of the demand curve), used in the literature, to an empirical study.

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