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Do Ryanair's fares change over time? An empirical analysis on the 2006-2007 flights

by

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Do Ryanair's fares change over time? An empirical analysis on the 2006-2007 flights

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Abstract

The impressive growth of low cost carriers has been mainly exploited through low fares. One may ask whether after having obtained significant market shares, dominant low cost carriers are heading to a new pricing policy. This paper analyzes whether the pricing adopted by Ryanair changes over time. We consider fares relating to all Ryanair's European flights over a two-year period, from 1st January 2006 to 31th December 2007. We analyze variations on both average and dynamic pricing intensity linking each flight in 2006 with its correspondent in 2007 in order to obtain couples of flights temporally comparable in terms of departure time, day of the week, period of the year and the presence of bank holidays. By employing a panel data approach, we correlate price variations and the variations in the intensity of dynamic pricing to a set of variables related to single routes and their competitive conditions, connected airports and single flights. Our results show that on average both fares and the intensity of dynamic pricing decreased. More than one third of the considered flights saw a price reduction higher than 10%. After becoming the dominant low carrier in Europe, the Ryanair's strategy appears, on average, to soften its dynamic pricing activities on existing routes.

Keywords: Airline pricing, Low cost carriers, Ryanair, fares evolution

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1. Introduction

Ryanair growth continues to be astonishing with an annual passenger growth of 21.1% up to 49 million passengers transported during 2007, as shown figure 1. Revenues appear to be increasing too: overall, in 2007 revenues increased by 23% and revenues per passenger increased by 1.6%, as shown in figure 2. Ancillary revenues outpaced the growth in passengers with an increase of 41%, now accounting for 17.8% of the overall ancillary revenues in 2007 confirming the last three-year trend. Scheduled revenues are more controversial. During the last available accounting year from march 2006 to march 2007 scheduled revenues per passenger increased by 7.1% to an average of 44.1€ per passenger. However, looking at the calendar year, in the 2007 scheduled revenues per passenger appear steady with a slight decrease of 1.2% to 43.8 € per passenger. With an in depth analysis of all 2006 and 2007 fares offered on Ryanair flights we try to answer several questions: does such trend reflect an homogeneous change in the fares offered or does it cover difference between early buying passengers and last minute passengers? Which determinants are increasing their role in determining the price? Are fares more or less sensitive to the oil price trend?

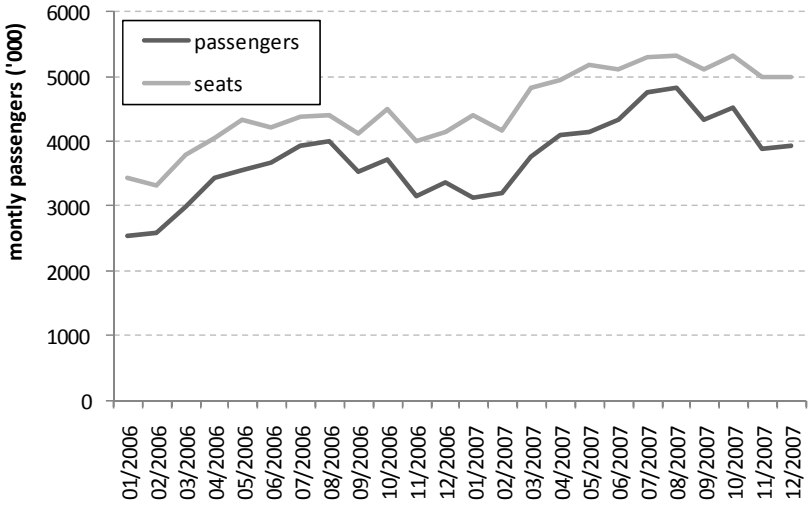

Figure 1. Ryanair monthly passenger and offered seats in 2006 and 2007.

1. Literature review

The increasing complexity and dynamicity of the airline network enhanced the role of pricing. Fares are one the main topics in the airline industry and are much debated by both academics and practitioners. Our research draws from the literature on airline pricing and dynamic pricing.

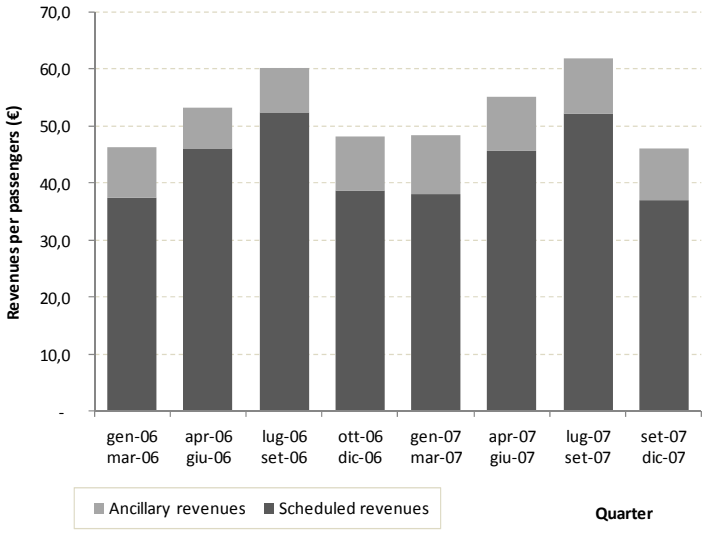

Figure 2. Ryanair revenues per passenger in 2006 and 2007.

Among fare determinants, competition has been widely studied. Classical studies, starting from the Bornstein's analysis (1989), focused on airlines' average fare level and fares dispersion in relation with the competitive environment. The main findings correlate the airline dominance of the hub with a fare premium. Recent studies point out the need to further investigate the ability of an airline to apply a price premium on the light of a more complete picture taking into account the effect of variables like the passenger mix (Lee and Prado, 2005) and the plane size (Gerardi and Shapiro 2007).

On the other hand, airline fares deal with yield management practises. Yield management, which is also known as revenue management or dynamic pricing, is "a set of pricing strategies aimed at increasing profits" (Mcafee and Te Velde, 2006). Yield management particularly applies in the presence of a fixed amount of goods with production capacity typically predetermined in an early stage and low marginal costs, and when the goods expire at a certain point in time (likewise service planned in a certain date or perishable goods). These conditions apply very well to the airline industry: scheduling and aircraft size are predetermined, marginal costs are relatively low and the value of a seat drops to zero right after the departure of the flight. Yield management proves to be quite valuable since an excellent pricing strategy for perishable assets results in a turnover increase of about 2-5%, according to Zhao and Zheng's study (2000). A series of studies analyse the optimal structure of a set of pricing strategies. Gallego and van Ryzin (1994) explore a number of desirable properties including closed form solutions and sharp predictions; Zhao and Zheng (2000) determine the minimum conditions that are necessary for the dynamic pricing to be optimal.

For an exhaustive review of these studies see Talluri and van Ryzin (2004) and Mcafee and TeVelde (2006).

The recent spread of the low cost outside the domestic American market, where Southwest started its operation in the seventies, put again on the fore the dynamic pricing of low cost airlines. Low cost success in Europe has been astonishing. Low cost airlines offered in first half of 2007 almost 20% of the European flights (Eurocontrol, 2007). Their pricing strategies are undoubtedly a cornerstone of their results.

Low cost pricing strategies drive a new wave of airline pricing studies, which likewise more general fares studies, refer to airline behaviour and dynamic pricing.

Most of the empirical studies focus on the relationship between competition and pricing of low cost airlines (Alderighi et. al., 2004, Piga and Bachis, 2007, Pitfield, 2005, Pels and Rietveld 2004).

Their results are quite different. Alderighi et. al. find a reaction from traditional airlines when low cost carriers come into the market; Pels and Rietveld find a negative correlation between two low cost fares on the same route. Pitfield finds a correlation between fares offered by competing airlines with a one-day lag. Piga and Bachis find a positive relation between airport market share and low cost fares. These differences are due to the difficulties to take into account precisely the determinants of low cost pricing. Most of the studies employ a very limited number of observations with only one o few departing flights, only one departing airport, and only a limited set of advancing booking prices. The dynamic of low cost fares enhances the importance to trace the day-by-day decisions made by airlines. Our study considers the fare offered by Ryanair on a vast sample of flights for 90 days before departures.

Low cost airlines use a simplified dynamic pricing structure compared to traditional airlines. While the latter traditionally try to separate customers with different willingness to pay offering a set of fares with different services (VIPs lounge, business class, flexibility) and several restriction (weekend stay, frequent flyer program, age class discount), low cost airlines based their dynamic pricing strategies on a single fare structure depending mainly on time to departure. Since many tickets on low-cost flights are sold on a one-way basis, many of the rules and restrictions traditionally employed by network carriers do not apply.

Conventionally fares offered by low cost carriers are assumed to be monotonically increasing, following the rules “the earlier you book the cheaper the fare will be”. According to Mcafee and TeVelde (2006), the price increase approaching the flight date depends mainly on the

trade off between waiting for a lower price and the risk of not finding seats any more. Dana (1998) shows that an advance booking discount is the optimal choice in competitive markets with uncertain consumer demand.

Anjos et al (2005) present a family of continuous pricing functions for which the optimal pricing strategy can be explicitly characterised. Malighetti et. al. (2008) adopt a functional form belonging to the Anjos' family of curves analysing the pricing structure of all Ryanair flights. However, as noted by Malighetti et al. (2008) and Piga and Bachis (2007) the pricing strategy is not strictly monotonic over time. A review of the forms of the fare temporal curves can be found in Button and Vega (2007).

Koenigsberg et. al. (2008) analyse the pricing strategies of easyJet on 23 flights and derive the offered condition (capacity, duration of tickets offered) from which the strategy to not offer last minute deals is convenient. The rate of daily booking shown by Koenigsberg et al (2008) is consistent with the Stokey expectations (Stokey, 1979) and with the estimated daily booking in Malighetti et. al. (2008).

While a growing number of works are approaching to the pricing strategies of low cost airlines, only a few employ a wide sample of flights and routes and no one has yet approached empirically the issue of the dynamic pricing evolution. Both network and managerial practices are still evolving at a fast pace as the growth in low cost passengers indicates. It is thus feasible to think that also revenue management has not yet stabilized. To the best of our knowledge, this is the first attempt to analyze how the pricing strategy adopted by a European low cost carrier is evolving. The paper focuses on short-run dynamics and considers a wide range of flights offered by Ryanair, the main low cost carrier in Europe

2. Sample selection

Our sample includes prices of all Ryanair's flights from January 1st, 2006 to December 31st, 2007, covering a period of two years. The prices consider the full price paid by travellers and thus include the Ryanair's tariff, airport charges and other taxation or supplements. For each flight we collected prices from 90 days to the day before departure.

	January, 2006	December, 2007	Variation
N° of served airports	102	127	25%
N° of daily flights (average)	642	994	55%
N° of routes	469	1,030	120%
Average daily frequency	1.37	0.97	-30%

Table 1. Comparison between the Ryanair's network in January 2006 and December 2007.

Table 1 and figure 3 show how the Ryanair's network changed in the two-year period. In particular, they compare the network related to the initial month, January 2006 with that of the final month, December 2007. Table 1 portraits a two-year period of huge growth for Ryanair. The number of routes more than doubled from 469 to 1,030. Interestingly, Ryanair abandoned just 26 routes it served in January 2006 and introduced 587 new routes to the end of 2007. The number of daily flights in the same period had a 55% increase. Therefore, the average number of daily flights per route dropped from 1.37 to 0.97. Ryanair's strategy has been to extend its network even if the density of single routes decreased.

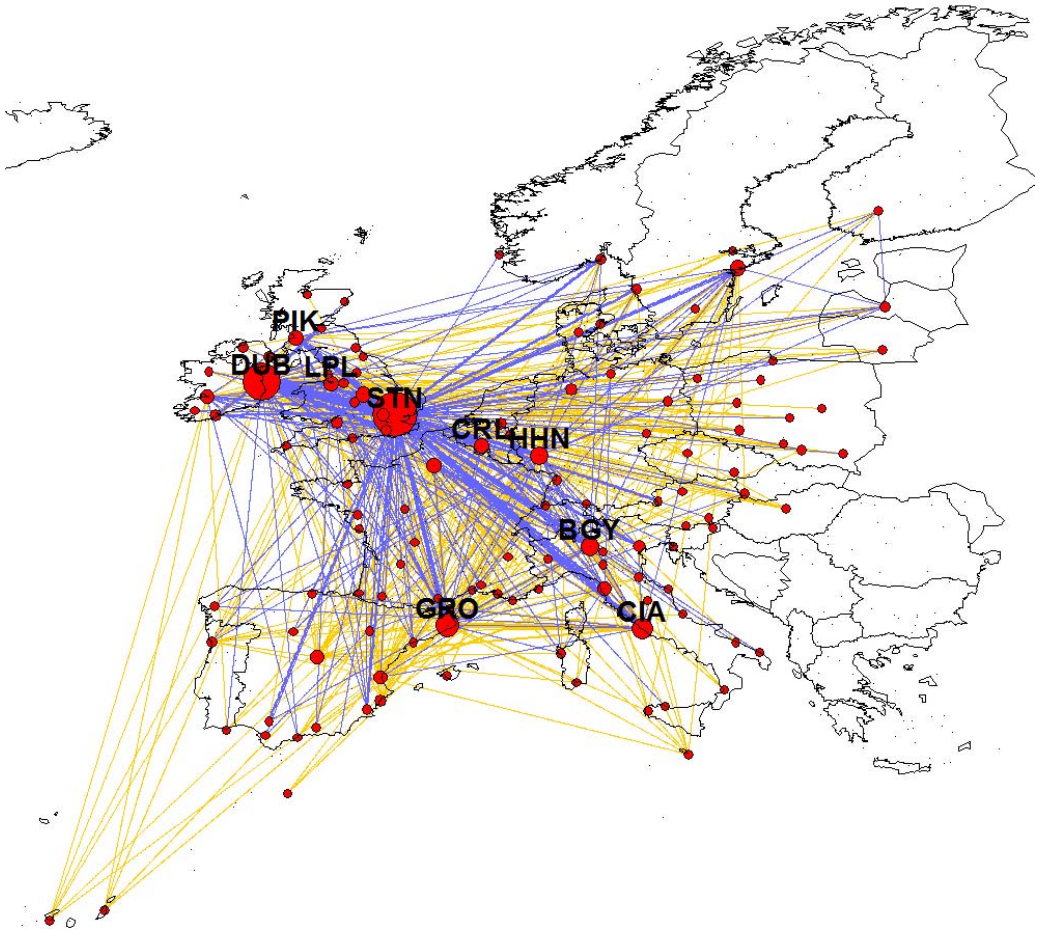

Figure 3. Comparison between the Ryanair's network in January 2006 and December 2007. Orange lines indicate new routes.

In figure 3, orange lines indicate new routes. It is possible to recognize that most of the new routes are from the main Ryanair's bases to destinations in Southern and Eastern Europe.

Our final objective is to compare prices for comparable flights in 2006 and 2007 in order to evaluate changes in the Ryanair's pricing policy. We employed a four-step methodology.

Firstly, for each flight in the two-year period, we calculate i) the average fare during the three months before departure and ii) a coefficient of dynamic pricing, computed following Malighetti et al. (2008). This coefficient, called beta, is derived according to the following price function:

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

Where i is the number of days between the advance reservation and the flight date and p_i is the related price. The form of the price function is a hyperbola with the price going up as the flight date approaches. A low β value will show a steady price trend as the number of advance booking days increases. On the contrary, a high β value indicates a significantly discounted fare, with respect to the highest fare ever offered, on advance purchases.

Secondly, we linked flights in 2006 with their comparable ones in 2007. Two flights to be considered as analogous must satisfy the following conditions:

- Departure airports and arrival airports are the same;
- Their departure times are within 30 minutes from each other; for example, if the 2006 flight took off at 8:30 a.m. and the 2007 flight at 8:55 a.m. then the two flights would satisfy this condition.
- Departure days are equivalent.

In order to apply the last condition, we link each day in 2006 with its equivalent in 2007. First we link the respective holidays and bank holidays, as Eastern, Christmas and New Year's Day, together with their preceding and following day. Then, we link the remaining days, taking care that they are the same days of the week and in the same week of the year. For example, Wednesday 4th, January 2006 is linked to Wednesday 3rd, January 2007.

By applying this procedure we obtain couples of equivalent flights, which started roughly in a year one after the other. In order to carry on the comparison we do not consider 2007's new flights. Neither do we consider dismissed flights in 2006 nor flights that changed starting times for more than half an hour, according to the above conditions. After applying this selection, we remain with 126.002 couples of equivalent flights, covering all departures and destinations offered by Ryanair.

3. Econometric model

The third step of the methodology is to understand how prices and betas changed from 2006 to 2007. Prices and betas may change due to several factors. In the first place, they may change as a response to changes in some the characteristics of the routes, as the number of direct competitors or their daily frequency. They may also change as a reaction to variations in demand or input factor costs, as oil prices. However, prices and betas may also change due to changes in the Ryanair dynamic pricing strategy. For example, Ryanair may decide to increase price sensibility related to oil prices, or to the presence of direct competitors or of alternative routes. Our objective is eventually to determine structural changes in the Ryanair pricing strategy.

In order to do so, we need to create econometric models allowing to distinguish the two possible sources of pricing changes. Firstly, we create econometric models correlating prices and betas to a set of determinants for 2006 and 2007 separately. To solve the models we employ a two-stage procedure. In the first place, we create a panel for the two dependant variables, i.e. average fares in the three months before departure and beta coefficients. These models for 2007 are as follows:

$$P_{i,t,2007} = \boldsymbol{\alpha}\, \mathbf{X}_{,i,t,2007} + u_i + \varepsilon_{i,t} \qquad [1]$$

$$\beta_{i,t,2007} = \boldsymbol{\alpha}'\, \mathbf{X}_{i,t,2007} + u'_i + \varepsilon'_{i,t} \qquad [2]$$

where $P_{i,t,2007}$ is the price of the i-observation starting the t-day in 2007. $\beta_{i,t,2007}$ is the dynamic pricing coefficient for the i-observation starting the t-day in 2007. Departure and arrival airports being equal, different starting times could determine very different outcomes in terms of pricing strategy. For this reason an observation is identified as the triple i) departure airport, ii) arrival airport and iii) departure time. The $\mathbf{X}_{i,t,2007}$ vector represents the set of *n* independent variables, which will be introduced later in the empirical section. Solving the equations employing the fixed-effects methodology, allows us to estimate the specific effects u_i for each observation. In the second stage, we correlate the specific effects u_i to a second set of specific explanatory variables, characteristic of single routes, such as distance and importance of the connected airports, and characteristic of starting times, such as dummies for each hour of the day.

The above-described procedure can be employed separately for the 2006 and 2007 flights. Then, significant variations in the Ryanair's pricing strategy can be derived by comparing the related estimated coefficients for each explanatory variable. By employing this methodology, one could see which explanatory variable becomes more or less statistically significant passing from 2006 to 2007.

However, since we create couples of comparables flights in 2006 and 2007, a more precise and specific approach may be employed. For each observation and each day of the year we calculate the difference between prices and betas of equivalent flights. The differences are adjusted to take into account changes in supplements and taxation. Then, these differences are correlated to a set of explanatory variables.

Given the above described price models estimated over the generic year y, it is possible to derive the variation model from year y to y+1:

$$\Delta \mathbf{P}_{\mathbf{i,t,y\rightarrow y+1}} = \boldsymbol{\alpha} \Delta \mathbf{X}_{\mathbf{i,t,y\rightarrow y+1}} + \Delta \boldsymbol{\alpha} \mathbf{X}_{\mathbf{i,t,y}} + \Delta u_i + \Delta \varepsilon_{i,t} \qquad [3]$$

By applying this model we can distinguish price variations due to changes in explanatory variables $\Delta \mathbf{X}$ from changes in price sensibilities $\Delta \boldsymbol{\alpha}$. By using the fixed-effects panel methodology we can also estimate the specific effect changes Δu_i. These effect changes can be employed as dependent variables in the second stage of the analysis and correlated to a second set of specific independent variables and their variations from y to y+1.

In the empirical section, we will show the estimated models for prices and betas related to 2007 and the model on their 2006-2007 variations.

4. Empirical analysis

We start our analysis with price information collected from the Ryanair's web site covering all flights from January 1st, 2006 to December 31st, 2007, with approximately 47 million single prices. By applying the process of sample selection described in the methodology section, we set up a date base with 126.002 couples of 2006-2007 flights. One would ask how many times the average price over the 90-day period before departure changed. Table 2 shows the number of times prices increased and decreased by a given range.

Price variation range (€)	No. of changes	Percentage
Less than -100	280	0.22%
From -100 to -50	2,602	2.07%
From -50 to -20	13,606	10.80%
From -20 to -10	15,427	12.24%
From -10 to -5	12,764	10.13%
From -5 to -2	10,306	8.18%
From -2 to -1	4,077	3.24%
From -1 to -0.5	2,210	1.75%
From -0.5 to 0.5	4,850	3.85%
From 0.5 to 1	2,405	1.91%
From 1 to 2	4,609	3.66%
From 2 to 5	11,043	8.76%
From 5 to 10	16,095	12.77%
From 10 to 20	15,694	12.46%
From 20 to 50	8,414	6.68%
From 50 to 100	1,404	1.11%
More than 100	216	0.17%
Total	126,002	100%

Table 2. Statistics on average price variations of comparable flights between 2006 and 2007

It is possible to see a great dispersion of price changes. However, taking into account changes greater than 0.5 €, on 48.63% of cases prices decreased and on 47.52% prices increased. On average, there is a slim predominance in price decreases. By comparing the most relevant positive and negative ranges of price variations, it is possible to see that in 25.33% of cases prices decreased by more than 10€ and in only 20.42% prices increased by more than 10€. Figure 4 maps with yellow lines the routes where prevailed price increases, and with green lines the routes where prevailed price decreases. The majority of price increases corresponds to routes from the predominant airports of Dublin and London Stansted to minor destinations in Southern and Eastern Europe.

Table 3 shows the statistics related to beta changes. To give a reference to the scale of beta variations, if $\beta = 0.1$, the fare 10 days prior to departure is half of the final fare. It β becomes 0.2, with $\Delta\beta = 0.1$, the price 10 days before departure becomes a third of the final fare.

In this case, there is stronger evidence that on average betas decreased from 2006 to 2007. By comparing related positive and negative beta variations, positive variations are less frequent than negative variations. This means that on average dynamic pricing activities became less intensive.

Figure 4 maps with yellow lines routes where prevailed beta increases, and with green lines routes where prevailed beta decreases. Beta increases are predominant in routes from or to London Stansted. The geographical distribution does not show other particularly evident tendencies.

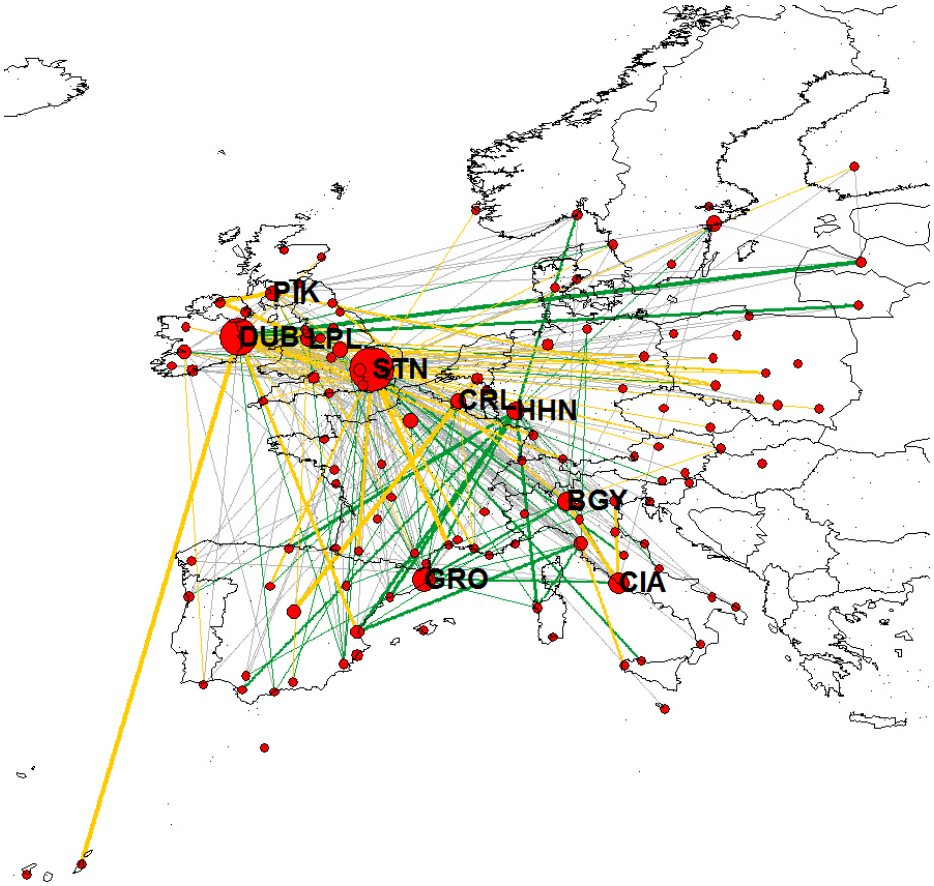

Figure 4. Price variations from 2006 to 2007. Yellow lines indicate routes where prices increased in at least 70 out of 100 offered flights. Green lines indicate routes where prices decreased in at least 70 out of 100 offered flights.

The following part of the empirical section will describe the variables employed in the models introduced in the methodology section and the related results.

We employ a two-stage methodology. At the first stage, prices and betas are correlated with variables changing day by day in the considered periods. We build a panel whose single observations are indentified by a given couple of connected airports and starting at a given time of the day. The explanatory variables employed at this stage are as follows:

- FirstDay represents the closest day to departure after which tickets are no longer available and thus the flight is to be considered fully booked. It is used as a proxy for demand intensity for the specific flight.

- Frequency is the daily frequency of the flight.
- OilPrice is the daily price of oil barrel in euro terms.
- GDPEurope is the Gross Domestic Product of 25-members EU in real terms.
- Month1-Month12 are dummies for each month in which the flight may occur. For example, dummy Month1 is 1 if flight occurs in January and zero otherwise.
- Day1-Day7 are dummies for each day of the week in which the flight occur. For example, dummy Day1 is 1 if the flight occurs in Sunday and zero otherwise.
- BankHoliday is a dummy which is 1 if the day of the flight is a bank holyday and 0 otherwise.

Beta variation range	**No. of changes**	**Percentage**
Less than -1	1,424	1.13%
From -1 to -0.5	769	0.61%
From -0.5 to -0.2	3,430	2.72%
From -0.2 to -0.1	5,909	4.69%
From -0.1 to -0.01	35,552	28.22%
From -0.01 to -0.001	18,074	14.34%
From -0.001 to -0.0001	2,300	1.83%
From -0.0001 to -0.00001	241	0.19%
From -0.00001 to 0.00001	4,656	3.70%
From 0.00001 to 0.0001	276	0.22%
From 0.0001 to 0.001	2,237	1.78%
From 0.001 to 0.01	14,438	11.46%
From 0.01 to 0.1	26,903	21.35%
From 0.1 to 0.2	5,033	3.99%
From 0.2 to 0.5	2,959	2.35%
From 0.5 to 1	699	0.55%
More than 1	1,102	0.87%
Total	*126,002*	*100%*

Table 3. Statistics on beta variations of comparable flights between 2006 and 2007.

After solving the first stage using a fixed-effect methodology, in the second stage we correlate the specific effects u_i on the following set of explanatory variables depending on some specific characteristics of each observation:

- Distance is the route length.
- DirectCompetition represent the number of competitors on the same route.

- IndirectCompetition is the number of alternatives routes departing and arriving in airports within the range of 100 kilometres from the route's origin and destination airports.
- DepartureDominance represents the dominance in the departure airport by Ryanair. It is defined as the ratio between the offered ASK by the Ryanair in the airport and the airport's total ASK volume.
- ArrivalDominance represents the dominance in the arrival airport by Ryanair. It is defined as the ratio between the offered ASK by Ryanair in the airport and the airport's total ASK volume.
- LOGDepartureGDP is the logarithm of the Gross Domestic Product generated in the departure airport region. Source Eurostat, 2004.
- LOGArrivalGDP is the logarithm of the Gross Domestic Product generated in the arrival airport region. Source Eurostat, 2004.
- Hour1-Hour24 are dummies for each hour of the day in which the flight may occur. For example, Hour8 is 1 if the flight starts from 8.00 a.m. to 8.59 a.m. and zero otherwise.

In the second stage of the analysis, the number of observations, identified by the triples departure airport, arrival airport and departure time, is 2,088.

Table 4 shows the determinants for both prices over the 90-day period before departure and the dynamic coefficient beta, related to 2007, solving equations [1] and [2]. Even if the main objective of the paper is to compare 2006 and 2007 prices, the analysis of the determinants over a single year carries elements of novelty. With respect to Malighetti et al. (2008) which analysed Ryanair's fares over a shorter period between 2005 and 2006, this analysis is more specific since is takes into account pricing information of single flights and not just their average values over specific routes. In other words, it allows evaluating the effects related to departure times, and the weekly and annual seasonal trends on prices and betas.

One of the most significant variables affecting the average price for each route is the route length. Of similar importance is the variable FirstDay referring to demand intensity. This confirms that the higher the demand, measured in terms of number of the days before departure when the flight becomes fully booked, the higher the average prices. Surprisingly, daily frequency of the flight does not significantly affect prices. Regarding the variables

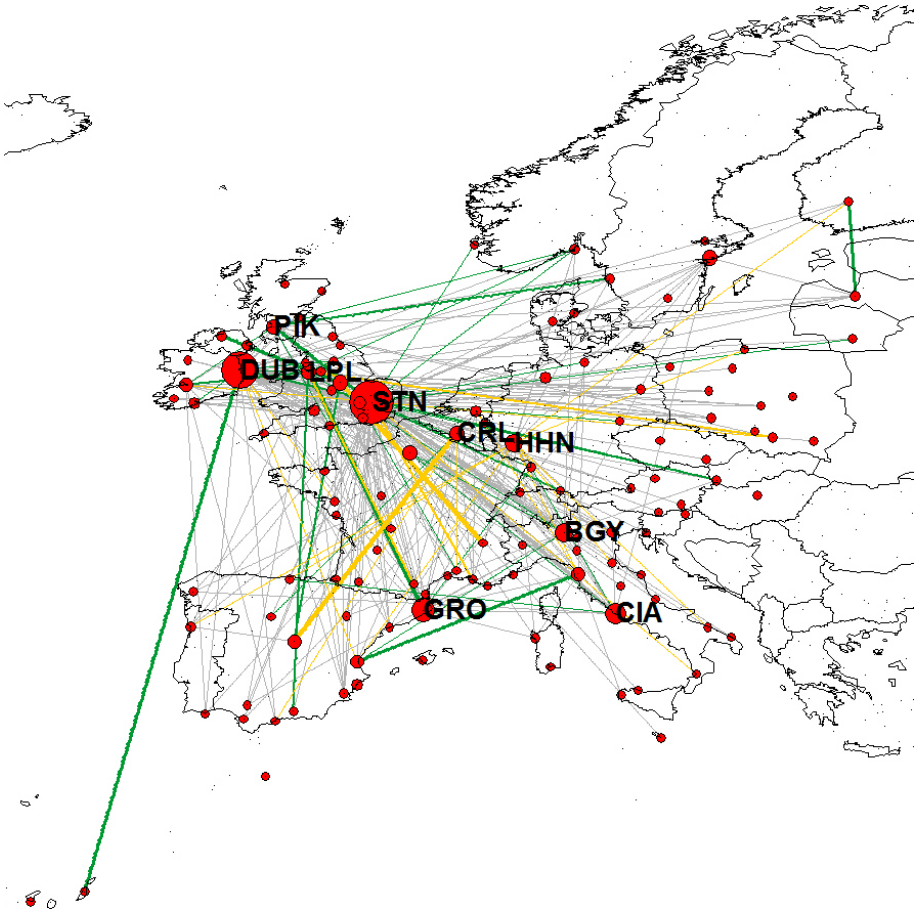

Figure 4. Beta variations from 2006 to 2007. Yellow lines indicate routes where betas increased in at least 70 out of 100 offered flights. Green lines indicate routes where betas decreased in at least 70 out of 100 offered flights.

conveying Ryanair's importance in the departure and destination airports, on average, the greater the importance of Ryanair, the lower will be the fare. This correlation is stronger for dominance in departure airports. A possible explanation is that the analysis considers full prices for passengers including charges by the departure airport. The higher the influence of Ryanair over the departure airport to put charges down, the stronger the effects on prices of departing flights. Fares also show a positive and statistically significant correlation with oil prices. Interestingly, prices show a positive correlation with the number of competitors operating over the same route. As widely recognized, the Ryanair's strategy is to operate mainly on medium-small routes with no other competitors. In the relative low number of cases when Ryanair operates with competitors, either the demand is high, such as in the flights London Stansted-Dublin or the competitors are traditional carriers. In the latter case, one would argue that there is not an effective competition of prices between the carriers. The results also show a strong seasonal effect during the year. Prices tend to be higher during the

first part of the year until August. From September to December they steadily decrease. As one would guess, the effect of festivity and bank holydays is strongly positive. During the week, the higher prices occur on Sunday, followed by Saturday and Friday. The lowest fares occur on Tuesday and Wednesday. Surprisingly, average fares over the 90 days before departure are not much significantly affected by the starting time even if morning flights often show higher fares then evening flights.

I stage regression	Price		Beta		II stage regression	Price		Beta	
FirstDay	2.57	***	3.18E-03	***	Distance	0.02	***	-2.43E-05	***
Frequency	-0.22		-2.95E-03	***	DirectCompetition	3.88	**	-3.76E-03	
OilPrice	1.92	***	4.81E-03	***	IndirectCompetition	0.37	*	-7.16E-04	
GDPEurope	0.03		2.71E-02	***	DepartureDominance	-10.73	***	1.75E-02	***
Month2	4.98	***	-4.74E-04		ArrivalDominance	-4.26	*	-7.32E-03	
Month3	4.68	***	-9.60E-03	***	LOGDepartureGDP	-12.89		2.89E-03	
Month4	14.36	***	-2.50E-02	***	LOGArrivalGDP	-10.37		1.71E-03	
Month5	4.59	***	-2.47E-02	***	Hour6	-11.53		9.32E-03	
Month6	-0.10		-2.71E-02	***	Hour7	-10.35		2.66E-03	
Month7	4.23	***	-3.83E-02	***	Hour8	-5.73		1.27E-02	
Month8	8.10	***	-4.82E-02	***	Hour9	-3.34		8.71E-03	
Month9	-6.12	***	-6.53E-02	***	Hour10	-4.21		-2.13E-03	
Month10	-11.08	***	-6.61E-02	***	Hour11	-4.27		5.23E-03	
Month11	-24.87	***	-7.92E-02	***	Hour12	-6.17		-5.22E-03	
Month12	-26.27	***	-1.20E-01	***	Hour13	-5.66		4.30E-03	
WeekDay2	-11.06	***	1.51E-02	***	Hour14	-6.52		9.59E-03	
WeekDay3	-18.37	***	-1.29E-03		Hour15	-0.44		8.52E-03	
WeekDay4	-18.40	***	-4.75E-03	***	Hour16	-3.12		8.98E-03	
WeekDay5	-14.40	***	4.93E-03	***	Hour17	-10.45		7.84E-03	
WeekDay6	-4.42	***	6.50E-03	***	Hour18	-10.84		1.78E-02	*
WeekDay7	-4.04	***	-4.24E-03	***	Hour19	-10.94		1.29E-02	
BankHoliday	9.11	***	-1.27E-02	***	Hour20	-12.92	*	1.53E-02	
					Hour21	-0.69		1.83E-03	
					Hour22	2.71	***	-3.04E-03	*
					Hour23	-2.06	***	5.58E-03	***
					Constant	-12.96		2.19E-03	

*Table 4. Determinants of the price and of the dynamic pricing level (beta) for the 2007 flights. *** indicates a statistical significance lower than 0.001; ** lower than 0.01 and * lower than 0.05.*

One of the most significant variables affecting the average price for each route is the route length. Of similar importance is the variable FirstDay referring to demand intensity. This

confirms that the higher the demand, measured in terms of number of the days before departure when the flight becomes fully booked, the higher the average prices. Surprisingly, daily frequency of the flight does not significantly affect prices. Regarding the variables conveying Ryanair's importance in the departure and destination airports, on average, the greater the importance of Ryanair, the lower will be the fare. This correlation is stronger for dominance in departure airports. A possible explanation is that the analysis considers full prices for passengers including charges by the departure airport. The higher the influence of Ryanair over the departure airport to put charges down, the stronger the effects on prices of departing flights. Fares also show a positive and statistically significant correlation with oil prices. Interestingly, prices show a positive correlation with the number of competitors operating over the same route. As widely recognized, the Ryanair's strategy is to operate mainly on medium-small routes with no other competitors. In the relative low number of cases when Ryanair operates with competitors, either the demand is high, such as in the flights London Stansted-Dublin or the competitors are traditional carriers. In the latter case, one would argue that there is not an effective competition of prices between the carriers. The results also show a strong seasonal effect during the year. Prices tend to be higher during the first part of the year until August. From September to December they steadily decrease. As one would guess, the effect of festivity and bank holydays is strongly positive. During the week, the higher prices occur on Sunday, followed by Saturday and Friday. The lowest fares occur on Tuesday and Wednesday. Surprisingly, average fares over the 90 days before departure are not much significantly affected by the starting time even if morning flights often show higher fares then evening flights.

While average prices provide important information on the single flights, beta coefficients show how prices changed during the 90-day period before departure. Length and route frequency are variables with significantly negative coefficients. This means that the price trend will acquire steadiness as the route becomes longer, and more frequently travelled. In other words, Ryanair grants fewer discounts on long haul and high-frequency routes, despite advance purchase. Betas are significantly and positive related to FirstDay, the closest day to departure when the flight becomes fully-booked. Other things being equal, when Ryanair offers higher discounts on advance booking, the flight tends to be fully-booked earlier. The degree of importance of the departure airport is directly correlated to parameter β, which means that if Ryanair plays a dominant role in the departure airport, average prices are lower, and significant discounts are more likely on tickets purchased in advance. During high

demand periods, such as bank holidays, betas are lower since Ryanair does not need to stimulate demand by discounting fares for advance booking.

Table 5 shows the average values related to 2006 and 2007 for the dependent and explanatory variables employed in the regression models. The last column reports the significance of the statistic tests on the difference between 2006 and 2007 average values. As inferred above, both prices and betas significantly decreased over 2007. The values of the last five variables reported in the table were considered invariant from 2006 the 2007.

Average	2007	2006	Difference significance
Prices	54.4	56.2	0.000
Betas	0.005686	0.006281	0.000
FirstDay	1.56	1.44	0.000
Frequency	2.51	2.44	0.000
OilPrices (€/barrel)	51.6	52.7	0
GDPEurope (index)	114.3	111.3	0.000
DirectCompetition	0.17864	0.152299	0.048
IndirectCompetition	1.857759	1.641762	0.001
Distance	925.93		
DepartureDominance	0.58		
ArrivalDominance	0.58		
LOGDepartureGDP	4.73		
LOGArrivalGDP	4.70		

Table 5. Comparison between 2006 and 2007 average values for variables employed in the regression models.

Table 6 shows the main results of the empirical analysis. Equation [3] is solved employing the two-stage procedure for determining changes in Ryanair's pricing strategy regarding both average prices over the 90-day period before departing and dynamic pricing coefficients. As explained in the methodology section, prices and betas could change due to two different factors:

1) the characteristics of the flight change, for example daily frequency, demand intensity, the level of competition, etc. In this case, since some of the determinants change, prices and betas change too, accordingly with the underling models. The effect of changes on the explanatory variables is estimated by the coefficients multiplying the variable changes from 2006 to 2007. They are indicated with pre prefix Δ. For example, Δfrequency is the difference between the 2007 and 2006 daily frequency.

2) the sensibility of the Ryanair's pricing strategy related to the explanatory variables change. In this case, explanatory variables being equal, prices and betas change since Ryanair modifies its pricing policy. For example, it may decide to decrease pricing or to make sharper discount for advance booking when there are direct competitors operating on the same route. The effect of changes in the Ryanair's pricing policy is estimated by the coefficient multiplying the 2006 explanatory variables. For example, if the coefficient of frequency were significantly negative, it would mean that Ryanair decreased its price sensibility related to frequency.

I stage regression	**Price**		**Beta**		**II stage regression**	**Price**		**Beta**	
FirstDay	-0.26	***	-3.82E-03	***	Distance	-0.01	***	1.41E-05	***
ΔFirstDay	0.15	***	1.72E-03	***	DirectCompetition	-0.92		6.56E-03	
Frequency	-1.12	***	-1.19E-03		ΔDirectCompetition	-1.44		7.42E-03	
ΔFrequency	-1.29	***	-4.57E-03	***	IndirectCompetition	0.64	***	-1.69E-03	**
OilPrice	-3.92	***	-4.05E-04		ΔIndirectCompetition	-0.46		-2.39E-03	
ΔOilPrice	-2.12	***	1.86E-03	***	DepartureDominance	-3.63	**	1.83E-02	***
GDPEurope	2.51	***	2.38E-02	***	ArrivalDominance	-3.46	**	9.94E-03	
ΔGDP	4.23	***	1.79E-02	***	LOGDepartureGDP	-0.82	*	2.85E-03	*
Month2	-4.68	***	-4.36E-03	*	LOGArrivalGDP	-1.93	***	7.80E-03	***
Month3	-3.23	***	-1.32E-03		Hour6	-3.31	3	2.77E-03	
Month4	5.26	***	-4.00E-03		Hour7	-3.89		1.03E-03	
Month5	19.52	***	5.43E-03		Hour8	-5.35		1.52E-03	
Month6	15.09	***	-1.25E-02	**	Hour9	-5.25		2.97E-03	
Month7	16.19	***	-1.16E-02	*	Hour10	-3.23		2.07E-03	
Month8	21.97	***	-6.08E-04		Hour11	-5.11		1.00E-02	
Month9	21.17	***	-1.96E-02	**	Hour12	-6.59		-1.80E-03	
Month10	14.02	***	-4.02E-02	***	Hour13	-5.25		7.02E-03	
Month11	22.55	***	-3.97E-02	***	Hour14	-5.64		7.08E-04	
Month12	24.04	***	-5.15E-02	***	Hour15	-5.06		9.18E-03	
WeekDay2	1.00	***	-1.20E-02	***	Hour16	-5.63		1.18E-03	
WeekDay3	2.10	***	-1.48E-02	***	Hour17	-3.70		7.80E-03	
WeekDay4	2.23	***	-1.66E-02	***	Hour18	-3.26		6.37E-03	
WeekDay5	1.27	***	-1.82E-02	***	Hour19	-6.99		-1.01E-03	
WeekDay6	0.12		-3.83E-03	**	Hour20	-5.23		9.69E-03	
WeekDay7	-0.28		-8.80E-03	***	Hour21	-8.61		3.15E-03	
BankHoliday	-2.28	***	-4.91E-03	*	Hour22	-8.05		9.19E-03	
					Hour23	9.18		1.55E-02	
					Constant	27.59	***	-8.87E-02	***

*Table 6. Changes on the price and beta determinants from 2006 to 2007. *** indicates a statistical significance lower than 0.001; ** lower than 0.01 and * lower than 0.05.*

In our analysis, some of the explanatory variables listed above do not change from 2006 to 2007. That is the case of the seasonal dummies and some characteristics of departure and arrival airports, as GDP and Ryanair's dominance. For these variables we can only estimate the latter effect due to changes in Ryanair's pricing policy.

Some explanatory variables changed significantly from 2006 to 2007. It is the case of ΔFirstDay meaning that on average during 2007, flights become fully-booked earlier, as a consequence of lower fares, as shown in table 6. Δfrequency is significantly negative meaning that a part of price decreases was due to increase in daily flight frequency from 2.44 to 2.51. This figure does not contradict statistics in table 1, showing a daily frequency decreasing from 1.37 in January 2006, to 0.97 in December 2007, since the empirical analysis does not take into account the low-frequency new routes introduced by Ryanair in the period.

The variable ΔOilPrice is also significantly negative: on average from 2006 to 2007 oil prices in euro terms decreased from 52.7 to 51.6 € per barrel thus accounting for a related reduction in prices. The European GDP, indicated as ΔGDP, steadily increased accounting for an increase in both prices and betas.

The coefficients indicating changes in the Ryanair's pricing policy are also interesting. In order to understand how sensibility changes affect prices and betas, see table 7. It collects information from table 4 and 6 and shows whether prices and betas sensibilities and their changes are statistically significant. The columns "relation" indicate whether the relative variable significantly affects prices (or betas) and the direction of this relationship (for example "+" indicates that an increase of the variable brings an increase of the average price). The columns ΔSensibility indicate whether the impact of the variables (in absolute terms) became stronger or weaker, passing from 2006 to 2006. With an increase "+" in sensibility, variables positively related to prices (betas) generate even higher prices (betas) in 2007, variables negatively related to prices (betas) generate even lower prices (betas) in 2007.

Regarding prices, the sensibility of the variable FirstDay decreased even if it remains largely positive. It means that on average Ryanair's prices increased less intensely as the number of the fully-booked days increase. The price sensibility to frequency decreased even if the frequency coefficient was not statistically different from zero in 2007. Price sensibility related to oil prices decreased meaning that during 2007, fares increases were less driven by oil prices. In other words, the correlation between those two variables decreased. The traditional correlation between fares and flight length, still strongly positive, became less intense: the price sensibility related to distance decreased significantly and thus fares increased less with

distance. Pricing sensibility related to the Ryanair's dominance in departure and arrival airports increased, given that the correlation between those variables and prices were strongly negative, it means that average fares departing or arriving in Ryanair's dominated airports decreased even more in 2007.

I stage regression	Price		Beta		II stage regression	Price		Beta	
	Relation	ΔSens.	Relation	ΔSens.		Relation	ΔSens.	Relation	ΔSens.
FirstDay	+	-	+	-	Distance	+	-	-	-
Frequency	0	-	-	0	DirectCompetition	+	0	0	0
OilPrice	+	-	+	0	IndirectCompetition	+	+	0	-
GDPEurope	0	+	+	+	DepartureDominance	-	+	+	+
Month2	+	-	0	-	ArrivalDominance	-	+	0	0
Month3	+	-	-	0	LOGDepartureGDP	0	-	0	+
Month4	+	+	-	0	LOGArrivalGDP	0	-	0	+
Month5	+	+	-	0	Hour6	0	0	0	0
Month6	0	+	-	+	Hour7	0	0	0	0
Month7	+	+	-	+	Hour8	0	0	0	0
Month8	+	+	-	0	Hour9	0	0	0	0
Month9	-	-	-	+	Hour10	0	0	0	0
Month10	-	-	-	+	Hour11	0	0	0	0
Month11	-	-	-	+	Hour12	0	0	0	0
Month12	-	-	-	+	Hour13	0	0	0	0
WeekDay2	-	-	+	-	Hour14	0	0	0	0
WeekDay3	-	-	0	-	Hour15	0	0	0	0
WeekDay4	-	-	-	+	Hour16	0	0	0	0
WeekDay5	-	-	+	-	Hour17	0	0	0	0
WeekDay6	-	0	+	-	Hour18	0	0	+	0
WeekDay7	-	0	-	+	Hour19	0	0	0	0
BankHoliday	+	-	-	+	Hour20	-	0	0	0
					Hour21	0	0	0	0
					Hour22	+	0	-	0
					Hour23	-	0	+	0
					Constant	0	+	0	-

Table 7. Price and beta sensibility in 2007 and their changes from 2006 to 2007. + indicates a positive coefficient with a significance lower than 0.05; - indicates a negative coefficient with a significance lower than 0.05; 0 indicates non-significant coefficients.

Regarding betas, the sensibility related to FirstDay decreased. Given that their correlation remains positive, as shown in table 6, it means that during 2007 not only prices for fully-

booked flights increased less but also the dynamic pricing activities became less intense. Interestingly, beta sensibility to European GDP, positive in 2006, increased in 2007. It means that Ryanair's strategy regarding the economic growth of the euro area is to increase dynamic pricing activities to stimulate further demand. Betas sensibility related to distance decreased, even if it remained significantly negative in 2007. It means that not only Ryanair tended to increase less average fares on long-haul flights but also the dynamic pricing trend tended to be less steady, ceteris paribus. Beta sensibility related to Ryanair's dominance in departure airports became more negative, meaning that Ryanair offered higher discounts for advance booking when travelling from a dominated airport.

5. Conclusion

This paper tries to understand whether the Ryanair's dynamic pricing strategy changes over time. We consider fares relating to all Ryanair's European flights over a two-year period, from 1st January 2006 to 31th December 2007. Our results show that on average both fares and the intensity of dynamic pricing significantly decreased. We analyze variations on both average and dynamic pricing intensity linking each flight in 2006 with its correspondent in 2007 in order to obtain couples of flights temporally comparable in terms of departure time, day of the week, period of the year and the presence of bank holidays. By employing a panel data approach, we correlate price variations and the variations in the intensity of dynamic pricing to a set of variables related to single routes and their competitive conditions, connected airports and single flights. Our empirical model allows us to distinguish price and dynamic pricing variations due to changes in the underling explanatory variables, such as an increase in oil prices, from changes in their correlation structure.

On average Ryanair's prices increased less strongly and its dynamic pricing activities became less intense as the number of the fully-booked days increases. The correlation between fares and oil prices decreased in 2007. The price correlation with distance decreased significantly and thus fares increased less with distance. In this case, the dynamic pricing trend tended to be less steady too. Average fares departing or arriving in Ryanair's dominated airports decreased even more in 2007. Ryanair also offered higher discounts for advance booking when travelling from a dominated airport. Interestingly, the Ryanair's strategy to exploit the higher economic growth of the euro area in 2007 was to increase its dynamic pricing activities.

This paper sheds some light on the "consolidation and growth" strategy of Ryanair. On the one hand, the most significant result of the analysis on fare variations is that, on average, Ryanair significantly lessened its dynamic pricing activities on existing routes. By doing so, after having stimulated new demand and increased frequency of existing flights, Ryanair consolidates its dominant position and thus employs a less aggressive pricing strategy. On the other hand, it expands dramatically its network, as shown by the more than doubled number of routes in two years.

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