On-line Price Discrimination with and without Arbitrage conditions

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Abstract

This paper presents a new form of on-line pricing tactic where airlines post, at the same time and for the same flight, fares in different currencies that violate the law of One Price. Unexpectedly for an on-line market, price discrimination may be accompanied by arbitrage opportunities that tend to persist in the period preceding a flight's departure. The evidence suggests that discrimination may be used to manage stochastic demand.

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1. Introduction

Does it make sense for an online company to post two different prices for the same product on the same web-site, hoping that some buyers will buy at the higher price? According to the traditional view, it should not because the price transparency of the Internet is implicitly assumed not to be conducive to effective on-line price discrimination; the shoppers of a company setting a low and a high price for the same product (e.g., in two different parts of its website) would very quickly learn to buy only at the low price. The main aim of this paper is to present robust evidence of discriminatory prices being posted by the same e-seller on the same website at the same time for exactly the same product. The fares posted on-line by a number of airlines constitute the object of the study. We can then address the question of whether two individuals, who are located in two different countries and are trying to book a seat with identical characteristics on the same flight at exactly the same time, are offered exactly the same fare on the same web-site.

Our data are taken from the websites of six European Low Cost Carriers (hereafter, LCCs) and pertain to both UK domestic and European international flights. A simple example illustrates the nature of the on-line price discrimination tactic under analysis. Consider a flight that a LCC operates from, say, London to Madrid. In the LCCs' web site, the origin of the first leg determines in which currency the fares are denominated. So, the Spanish traveller booking a round trip will be offered a fare in Euro while the Briton one in Sterling. Further, assume the two travellers are booking the shared flight at exactly the same time. In the absence of on-line price discrimination, the ratio of the two fares in different currencies should be very close to the prevailing exchange rate and the Law of One Price should hold (Goldberg and Knetter, 1997). Nonetheless, about 34% of the almost two million observations for international flights in our dataset report a difference between the two fares of at least 5 British Sterling or more. Therefore, this previously unreported type of price discrimination constitutes a source of on-line price dispersion within a single retailer. A main contribution of this study is thus to fill a gap in the literature, whose main focus so far has been on the on-line price dispersion occurring across sellers of the same product and not on the case where the same e-company engages in price discrimination on-line (Baye *et al*, 2005 and 2004; Ellison and Ellison; 2005; Stole, 2006).[1]

In about 18% of observed cases, by applying the above strategy the airlines manage to segment the markets perfectly, that is, due to the way the on-line booking system works, it is not

[1] A partial exception is Haskel and Wolf (2001), which reports evidence of how the multinational Swedish furniture retailer IKEA prices some of its products differently across national markets. However, IKEA uses different Internet domains for each country it serves (e.g. www.ikea.de or www.ikea.fr) where each site uses exclusively the national language. Furthermore, unlike the low cost carriers in our study, IKEA raises only a small proportion of revenues from Internet sales.

possible for the traveller that is offered a higher fare in her own currency to buy using the lower fare in the other currency. A striking feature of this form of on-line price discrimination is that it may be associated with arbitrage opportunities. Indeed, for 9.4% of observations the gains from arbitrage outweigh its costs. This is surprising because, firstly, arbitrage is assumed to be incompatible with discrimination (Armstrong, 2006; Stole, 2007; Tirole, 1988). Secondly, one would hardly expect occasions for profitable arbitrage to be posted systematically on-line, where search costs are assumed to be negligible. Such an assumption holds also in our particular framework, since on-line travellers could easily retrieve and compare the fares in the two different currencies in just a few seconds. [2] Theoretical search models predict that for sufficiently low search (or information) costs, no price dispersion should occur (Varian, 1980; Stahl, 1989); we try to reconcile this apparent contradiction between theory and empirical evidence by arguing that although the physical cost of search is negligible, cognitive search costs may still play an important role in Internet markets (Johnson et al, 2004). Nonetheless, our analysis highlights cases where arbitrage opportunities could be profitably exercised on-line.

To sum up, regardless of whether price discrimination is associated with arbitrage or not, this study depicts a situation where an airline's pricing strategy operates synergistically with the design of its on-line booking system and, more generally, with its adoption of the Internet as an exclusive distribution channel. The upshot is a failure of the Law of One Price within an airline's website. While this study provides further evidence suggesting that the Internet is an information technology that does not eliminate price dispersion (see the seminal work by Brynjolfsson and Smith, 2000 and the survey by Baye *et al.*, 2005),[3] by casting empirical doubts on the theoretical incompatibility between price discrimination and arbitrage it also contributes to enhance our understanding of how on-line markets work.

The third pricing option available to airlines is uniform, i.e. non-discriminatory, pricing, which accounts for the majority of observations for all the airlines except one. The comprehensive nature of our data allows us to evaluate the extent to which each pricing mode is applied by an airline during the 70-days period preceding a flight's departure. The empirical evidence suggests that persistence over this period is a characteristic of both discriminatory cases and arbitrage opportunities. Arguably, the airlines use such pricing mechanisms when they anticipate a low aggregate demand for a specific flight as well as a different willingness to pay in each market.

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[2] Such search engines as, e.g., www.traveljungle.co.uk or www.skyscanner.net are not capable of detecting the type of on-line price discrimination strategy we consider.

[3] Not all Information Technology enhances price dispersion. Jensen (2007) clearly documents how the adoption of mobile phone technology enabled the gathering of information on the local markets' prices by Indian fishermen, thus leading to a dramatic reduction in price dispersion and fishing waste and to a near-perfect adherence to the Law of One Price across markets.

Dispersion in airline prices may arise from variations in costs of serving different passengers or from discriminatory pricing (Borenstein and Rose, 1994). This study analyses the extent to which the application of on-line price discrimination adds to the dispersion of posted fares. Lack of sales data makes it impossible to investigate the extent to which the same pricing strategies affect the realised price dispersion on a flight. However, all our LCCs sell almost exclusively on the Internet; in 2004, Ryanair's on-line sales made up 97% of total sales, while easyJet reported that by 2003 around 97% of purchases were made on-line, moving to 98% by 2005.[4] Based on these figures, our data are therefore likely to correspond to prices used in actual transactions. Hence, this study identifies an important link between the on-line pricing strategies and the realised price dispersion on a flight.

The next Section provides some motivating examples drawn directly from an airlines' web site, which help clarify the nature of the pricing strategies shown in the study. They are analysed using the theoretical framework set out in Section 3; Section 4 presents the data collection strategy adopted to verify the systematic presence of the pricing strategies introduced in Section 2. The data are analysed in Section 5 to test whether the Law of One Price holds for the flights we consider, while Section 6 investigates the simultaneous presence of price discrimination with arbitrage opportunities. Section 7, which investigates the circumstances under which discriminatory pricing is more likely to be observed by using a dynamic Probit approach, is followed by the concluding remarks of Section 8, where we assess the pricing strategies of the airlines in the light of the existing European legislation on competition policy.

2. Motivating examples

Examples of the type of on-line price discrimination on which we focus, are shown in Figures 1 to 3, which are the outcome of queries made using the web site of one of our LCC. An explanation of how the queries work is warranted in order to better appreciate the Figures' content. First, the European LCCs we surveyed set fares for each leg independently; i.e., these fares do not change depending on whether a customer books a round-trip or a one-way ticket. E.g., in Figure 1 the price of GBP 119.99 for the Ancona (AOI) - London Stansted flight on July 17th 2005 would have appeared identically even if the query had been for this single flight only. Second, the queries reported in the two parts of Figures 1-3 were made only a few minutes after the other, therefore ruling out any bias arising from changes in prices due to changes in seats' availability.[5] Third, the programme issuing the queries yields fares expressed in the currency of the country where the first

[4] See http://findarticles.com/p/articles/mi_m0CWU/is_2005_Jan_6/ai_n8643770 obtained from a Google search on "ryanair online sales"; and http://www.easyjet.com/common/img/UBSTransportConference19thSept05.pdf

[5] See the Windows bar at the bottom of each part.

leg originates. Finally, to make their sites look familiar by appearing in the visitor's language the airlines' web sites automatically detect the nation in which the visitor is located.[6] However, we believe that doing so does not affect the level of fares displayed because when we accessed the sites using different languages, the same fares were returned. Moreover, the hypothesis that each airline extracts the fares from the same dataset (or algorithm) is reinforced by the fact that for most airlines the query results are displayed on the same web page, regardless of the language used.[7]

Figures 1 to 3 are made up of two parts: the top one shows the fares in British Sterling (hereafter, GBP, i.e. Great Britain Pound) for each leg of a round-trip departing from the UK and arriving in another European destination. The bottom part reports the fares (in the currency of the country from which the flight originates) for the inverted trip, where the outgoing flight is scheduled on the same day of the return flight in the top part.[8] For ease of comparison, an oval frames the same flight appearing in both parts. That is, the "Coming Back" flight enclosed in the oval in the top part is the same as the "Going Out" flight in the oval of the bottom part. The fare in the European currency is translated using the current exchange rate on the date of the query.

FIGURE 1 ABOUT HERE

Figure 1 reports a non-discriminatory case where the ratio of the fare in Sterling (119.99 GBP) and in Euro (169.99 EUR) for the flight coded "FR 125" from Ancona to Stansted on July 17th 2005 is very close to the exchange rate on July 9th 2005, the date the query was made. No attempt at price discriminating is highlighted in this example, which we refer to as the "uniform price case".

Figure 2 is essential to explain how the airlines' on-line price discrimination strategy may be linked to arbitrage opportunities. It clearly shows how the price in GBP for the flight coded "FR2359" is higher than that in Euro. To understand how arbitrage could be exercised, consider a British traveller wishing to fly from Stansted to Dinard on Aug 25th 2005 and return on Sept 1st. In theory, instead of booking a round-trip ticket and pay 69.99 GBP for the first leg plus 9.99 GBP for the second (which is what a query for a round-trip would automatically allow her to do), this person

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[6] This is however a marketing innovation that was implemented only in the final part of our sample period.

[7] At the time of this draft (June 2006), Ryan Air and EasyJet allow the language to be selected by the visitor. Ryan Air and Bmibaby display the results in the same page regardless of the language selected - http://www.bookryanair.com/skylights/cgi-bin/skylights.cgi and http://www.bmibaby.com/bmibaby/skylights/cgi-bin/skylights.cgi respectively - while Easyjet's fares are shown on a URL that is language-sensitive.

[8] The two parts are taken from two different screenshots, each corresponding to a different query for the same flight. They were edited to facilitate and enhance the comparison of fares expressed in different currencies.

could buy two separate one-way tickets and pay only 0.45 EUR for the return, saving about 9.5 GBP. It is note-worthy that it is impossible to obtain a fare in two different currencies for the outward journey because it has to be paid in each passenger's national currency. Therefore arbitrage opportunities, which require the purchase of two one-way tickets, can arise only for the return trip. This implies that arbitrage opportunities may potentially arise for passengers originating in both countries: in any case, it is worth bearing in mind that the arbitrage opportunities are for the group which is being asked a higher fare and is therefore adversely discriminated (the Britons, in Figure 2). Other examples of profitable arbitrage cases are available upon request.

FIGURE 2 ABOUT HERE

Figure 3 illustrates a case of on-line price discrimination, which is not associated with the possibility to engage in arbitrage. Note how the price in GBP for the flight coded "FR 195" from Bologna Forli to Stansted is about 33 GBP cheaper than the fare quoted in Euro. However, no arbitrage conditions arise in this case because a Briton would prefer to buy a return ticket and not two separate ones. This example of on-line pricing highlights the perfect segmentation of the two markets, where the Italian travellers are adversely discriminated as, at exactly the same time, they are offered a higher fare for the same flight. Indeed, as discussed above, the Italian travellers cannot obtain a fare for the same flight denoted in GBP, because every query for a ticket from Forli to Stansted would return a fare in Euros, the currency of the country where the flight originates. Note that this case of perfect segmentation with no arbitrage conditions can be applied only on the first leg journey; as before, both national groups can potentially be the victims. Indeed, in Section 6.1. below we provide evidence that arbitrage conditions and perfect segmentation are found in flights that depart from both the UK and a continental European country alike.

FIGURE 3 ABOUT HERE

3. Theoretical framework

Two aspects appear to be central to shed light on the various outcomes in Figures 1 to 3, although their importance varies case by case: search costs (Salop, 1977) and the uncertainty characterizing the demand of the two groups of travellers in each country (Gale and Thomas, 1993).

The latter is important because of the perishability of the airlines' product, and the ensuing need to maximize a flight's load factor.[9]

The "uniform pricing case" (Figure 1) is consistent with a situation where the airlines are confident that aggregate demand is sufficiently high to fill the flight to capacity. Thus, the single price corresponds to the maximum fare a passenger in either country is willing to pay, which the airlines may have predicted from either past experience or on-line price probes (Boyd and Bilegan, 2003).

We argue that a possible motivation leading an airline to engage in the discriminatory pricing of Figures 2 and 3 may lie in its forecast of low aggregate demand and of sensible differences in the price elasticities of the two national groups. Practicing the uniform pricing of Figure 1 could therefore lower profits, because a single high price would alienate the elastic demand group and a single low price would be tantamount to a discount for the other group. Thus, airlines may resort to standard third-degree price discrimination to maximize a flight's revenues. In Figure 3 the group with the more inelastic demand (i.e., the Italians) happens to be located in the country where the flight originates, and the web site booking mechanism prevents arbitrage opportunities from arising.

Similar demand conditions and differences in willingness to pay in the two groups drive the decision to post a case of price discrimination with arbitrage opportunities (Figure 2). This time, however, the high demand group is made up of passengers that are returning to their country of residence (the Britons), who, in theory, could exercise arbitrage by accessing the fare for their return leg offered in a currency different from theirs. Absent search costs, theory predicts that any price divergence would be arbitraged away (Varian, 1908; Stahl, 1989). It is therefore reasonable to assume that the presence of consumers with positive search costs makes on-line price discrimination and arbitrage a feasible strategy for the LCCs. This runs contrary to the belief that search costs are low in on-line markets. Later on, we argue that while the physical cost of searching for arbitrage opportunities is negligible, cognitive search costs may be substantial and may actually help explain why the airlines offer arbitrage opportunities. This issue is further investigated in Section 6.2.

More importantly, in the search-theoretic models surveyed by Baye *et al*. (2005) to explain price dispersion on-line, each firm sets only one price, and price dispersion occurs across firms. In our case, the same firm is posting two fares on-line at the same time for an identical product. Salop (1977) provides a theoretical explanation of such a pricing behaviour. In his model, consumers are heterogeneous in their level of search costs. Assume that within the discriminated group travellers

[9] Very often, some European LCCs offer seats at 0.01 GBP. Leaving any strategic motive aside, this is profit enhancing in the presence of perishability, because a filled seat is likely to generate some extra revenues from sales of on-board services (food, drinks, scratch cards etc.)

differ in their search efficiencies: the inefficient ones then do not search and pay the high price while the efficient ones recognize the arbitrage opportunity and pay a lower fare. Interestingly, Salop (1977) shows that for high enough search costs, no search activity will be conducted: this is consistent with our discussion of how a (possibly large) proportion of on-line consumers does not envisage the possibility of checking the price of two one-way tickets. Similar to our situation, Salop (1977) also shows that the retailer's optimal number of prices is, at most, two.

4. Data Collection

Starting in May 2002, an "electronic spider" collected the fares by connecting directly to the websites of the main LCCs (i.e., Ryanair, Buzz, Easyjet, GoFly) operating in Great Britain at the time.

The dataset includes daily flights information spanning the period June 2002 - June 2004. Over such a period, a number of important events took place. First, GoFly and Buzz were taken over by Easyjet and Ryan Air, respectively. Second, the "spider" was upgraded to retrieve fares from such new LCCs as Bmibaby and MyTravelLite (MTL).

In order to account for the variety of fares offered by the airlines at different times prior to departure, the spider collected the fares for flights' departures due, respectively, 1, 4, 7, 10, 14, 21, 28, 35, 42, 49, 56, 63 and 70 days from the date of the query. Henceforth, these will be referred to as "booking days".[10] Thus, for every daily flight we employ up to 13 prices that differ by the booking day. The main reason to do so was to address the shortcoming that "departure times and how far in advance the ticket is purchased are not included in the available data on prices" (Peters, 2006:629).[11]

The queries were bi-directional, with each leg priced independently. The return flight was scheduled one week after the departure. The collection of the airfares has been carried out everyday at the same time. The spider saved further flight information: the name of the company, the time and date of the query, the departure date, the scheduled departure and arrival time, the origin and destination airports and the flight identification code. These are essential for the matching of the datasets with fares denominated in two different currencies.

The foregoing data collection strategy takes advantage of some of the innovations in pricing introduced by the airlines in our sample. Unlike Full Service Airlines, the European LCCs have eliminated completely such restrictions as the Saturday night stay-over requirement or the surcharge

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[10] Assume the day of the query is April 1st 2003; the spider would retrieve the prices for flights in each direction departing on 2/4/2003, 5/4/2003, 8/4/2003, 11/4/2003 and so on. A more detailed analysis of the dataset thus obtained can be found in Piga and Bachis (2007).

[11] The spider could have retrieved any number of prices: in practice the need to reduce both the number of queries made to an airline server to a manageable level, led to the design above.

for one-way tickets, as well as any form of discrimination based on quality, e.g., on-flight service distinctions (Stavins, 2001; Giaume and Guillou, 2004; Mussa and Rosen, 1978). Furthermore, we need not worry about the pricing of connecting flights, since they are ruled out by the fact that LCCs issue only "point to point" tickets (Clemons *et al*., 2002).

The prices retrieved from the Internet represent an accurate sample of the activity of each of the Low Cost Carriers we consider (more details are available from the authors on request). Suffice to say that the dataset includes daily fares for a wide majority, and sometimes the universe, of the routes operated by each LCC.

4.1. Identifying Price Discrimination on-line

The spider ran two sets of queries. In one, the outgoing flights originated in the UK, thereby creating a dataset with fares denominated in GBP. In the other, trips originated in continental Europe, and fares were denominated in the currency of the origin country.[12] These two datasets were then matched using a code combining the values of airline, route, flight code, day of departure and booking day. Such a matching strategy enables the comparison of the on-line fares for the same flight available at approximately the same moment to two travellers in different countries. More details on how the matching was structured are available from the authors on request.

Importantly, to perform a meaningful match of the two fares, no ticket should be sold on-line during the time that separates their retrieval, as new purchases may change the shadow cost of capacity, a source of price dispersion (Borenstein and Rose, 1994). Although it was impossible to guarantee that the two fares were collected at exactly the same time, this potential problem was tackled in two ways. First, the "spider" operated overnight, thereby minimizing the possibility of intervening purchases.[13] Second, the "spider" saved the exact time in which each fare was retrieved: the sample in this study includes only pairs of fares collected within a one-hour interval, which is short enough to guarantee no dispersion due to changes in the shadow cost of capacity.[14] Thus, any detection of price dispersion can only be ascribed to on-line price discrimination, as cost conditions refer to the same flight, capacity level and booking day.

[12] For the UK domestic routes, in the second case we simply inverted the direction of the trip.

[13] As Ellison and Ellison (2005) discuss, inertia in Internet prices is often observed, suggesting that companies do not continually monitor the market situation and reoptimize. In the case at hand, we casually noted that after buying tickets on-line from the LCCs in our study, fares remained unchanged despite the obvious reduction in the seat availability.

[14] Intervening purchases between the collections of the two prices should be more likely as the interval increases. Thus, we should expect a greater discrepancy between the two prices when the interval is large. We find no support to this hypothesis in the data (contact the authors for more details).

5. Deviations from the Law of One Price

Figures 2 and 3 show cases of deviations from the Law of One Price (henceforth, LOP). However, menu costs are negligible in electronic commerce, and both Figures may correspond to very rare, temporary events. In this Section we address the question of *whether* the airlines systematically engage in on-line price discrimination. We try to answer this by detecting the extent to which deviations from the LOP are consistently observed in the database of posted fares. Thus, our focus is on determining whether the airlines have embedded the discriminatory pricing strategies previously discussed within their revenue management systems, which have become important strategic tools in the industry (Borenstein and Rose, 2007). The use of posted data, as opposed to actual transaction prices, provides an effective means to gain a better understanding of how the airlines use the Internet as a tool to maximize a flight's yield. Using actual transaction prices would make it practically impossible to control whether tickets were purchased at exactly the same time, which is an essential part of our analysis.[15]

Let f_{irtc} be a directional flight (i.e., from A to B or B to A) offered by carrier i, on route r, with departure scheduled to fly on date t, code flight c. Route r denotes an airport pair, with at least one of its endpoints in the UK. The airlines post two prices, which are expressed in the same currency for domestic flights (i.e., A and B are both in the UK), or in two different currencies when one of route r's endpoints is in continental Europe. The following analysis holds for both domestic and international flights. Let P_{irtcb}^{EU} and P_{irtcb}^{UK} identify the prices for flight f_{irtc} in the continental European currency (EU) and in the UK currency (i.e., GBP). They are posted b days before t (that is, b is the booking day). Define $\Phi = P_{irtcb}^{EU} / P_{irtcb}^{UK}$. Denote $e_{EU/UK}^{b}$ as the nominal exchange rate, the *EU* price of currency *UK*, available on the date (*t-b*).[16] If LOP holds for flight f_{irtc}, then:

$$\Phi = P_{irtcb}^{EU} / P_{irtcb}^{EU} = e_{EU/UK}^{b}\,, \tag{1}$$

or, rearranging:

$$\Delta = \left| \left(P_{irtcb}^{EU} / e_{EU/UK}^{b} \right) - P_{irtcb}^{UK} \right| = 0\,. \tag{2}$$

Throughout the paper, Δ is expressed in GBP. The LOP fails to hold if $\Phi / e_{EU/UK}^{b} \neq 1$ or $|\Delta| > 0$. For the latter case, Table 1 reports the percentile distribution of the absolute value of Δ by airline and type of flights (domestic and international). Even noting that small values of $|\Delta|$ may be

[15] In any case, our study mainly focuses on dispersion of posted prices (e.g., Baye et al, 2004), not on dispersion of fares paid by passengers on a plane (Borenstein and Rose, 1994).

[16] For domestic flights, we set $e_{EU/UK}^{b}$ =1.

induced by differences between the exchange rates used by us and by the airlines, half of the almost two millions observations for international flights report a |Δ|>3.41, while the LOP holds unconditionally (i.e., |Δ|=0) for at least 95% of the observed domestic fares, with the minor exception of fares posted by Ryan Air. Such a finding suggests two considerations. One, presumably the airlines try to avoid the bad publicity of being found out practicing price discrimination strategies, which can be more easily noted when the fares are in the same currency.[17] Two, the comparability of two fares in different currencies entails the gathering by a passenger of detailed information on $e^{b}_{EU/UK}$, which is a costly activity that not everyone may be willing to undertake. Thus for international flights, search costs seem to shield the airlines from the risk of negative publicity. In turn, the airlines have thus more leeway in engaging in on-line price discrimination as a revenue management strategy. Indeed, Table 1 shows that most airlines, with the exception of EasyJet and Buzz, have at least 25% (or more) of their fares with a |Δ|>5.

----TABLE 1 ABOUT HERE ----

----TABLE 2 ABOUT HERE ----

Table 2 presents values of $\Phi = P^{EU}_{irtcb} / P^{UK}_{irtcb}$ and $e^{b}_{EU/UK}$ broken down by airline and country. It confirms that the LOP holds for UK domestic flights, while it generally does not for international flights, with the exception of those operated by EasyJet, for which the two statistics are very similar across countries. BmiBaby and MyTravel systematically violate the LOP as, in all the countries they serve, their fares expressed in the continental European currency are, on average, higher than the one expressed in GBP. On the other hand, Ryan Air, which Tables 1 and 2 reveal to be the airline which is more heavily reliant on international on-line price discrimination, tends to post a higher fare in GBP for flights to and from Holland, Ireland and Austria, with the opposite holding for most of the other countries. For Buzz and GoFly, deviations from the LOP are particularly large in specific countries, namely Switzerland and France. The findings from Table 3 indicates that most airlines (the exceptions being BmiBaby and MTL) do not tend to favour a national group. This is further investigated in the next Section.

To further highlight the deviations from LOP in our dataset, Figure 4 shows, for each airline, the kernel density for $\Phi = P^{EU}_{irtcb} / P^{UK}_{irtcb}$ and $e^{b}_{EU/UK}$ for flights to countries adopting the European common currency, the Euro. The overlapping of the two distribution is indicative of adherence to the LOP: this only seems to be the case for EasyJet, while for all the other LCCs the two distributions are either disjoint (BmiBaby and MyTravelLite) or the distribution of Φ presents

[17] Using an extended version of the price dataset, that includes fares for flights arriving and departing within the countries adopting the Euro, the same result of no difference between the two fares is found. See Bachis (2007)

thicker and longer tails (Ryan Air, Buzz and GoFly). Generally in Figure 4, Φ appears to be more dispersed than the distribution of the exchange rate between the Euro and the GBP.

FIGURE 4 ABOUT HERE

Because we observe many cases where the LOP fails to hold, and given the way our data was collected, we conclude that the evidence in this Section supports the notion that most LCCs have actively pursued on-line price discrimination strategies. However, we have not determined the extent to which these are associated with arbitrage opportunities. That is, if the Internet has created a "frictionless market" where arbitrage opportunities are instantly wiped away by costless search and negligible menu costs (Brynjolfsson and Smith, 2000), we should expect very few cases of on-line price discrimination with arbitrage, as in Figure 2. This is further investigated in the next Section.

6. Price Discrimination and Arbitrage

Before analysing the extent to which LCCs pursue discriminatory tactics and allow the possibility of arbitrage opportunities to arise, note that a customer will exercise arbitrage only if the discount she can obtain from buying the low-price single ticket, Δ, exceeds the "cost of arbitrage", *AC:*

$$AC = 6.0 + 0.05 \min(P_{irtcb}^{UK}, P_{irtcb}^{EU} / e^{b}), \tag{3}$$

which is derived by adding the following costs: 1) an extra credit card commission of 4.5 GBP for the second ticket transaction; 2) other non-pecuniary costs associated with arbitrage (printing an extra ticket, opportunity cost of time it takes to fill in an extra booking form and to do an extra search, etc), whose value we approximate as 1.50 GBP 2) a commission on the transaction imposed by the credit card company, normally in the form of exchange rate which is less favourable than the official one we used: we assume such a commission to be 5% of the paid price. Hence, the cost of arbitrage is made up of a fixed and a variable part that increases with the value of the transaction.

The discrete variable "Discrimination Type" provides a taxonomy of cases included in our dataset. It assumes four values, each representing one of the three different situations depicted in Figures 1 to 3, plus a fourth case where arbitrage opportunities are not profitable. The formal conditions used to construct "Discrimination Type" are reported in Table 3. To explain them while saving on space, we refer only to the conditions in its first column for flights departing from the UK; the same logic applies to the conditions used in the last column for flights departing from continental Europe. No discrimination, i.e., uniform pricing, (value *0*) is observed if the absolute difference between the two fares is less than 5 GBP (i.e., if $|\Delta|<5$). We deem a price difference of less than 5 GBP to be sufficiently small to consider the two groups of passengers as being offered the same fare. A value "1" for "Discrimination Type" identifies discriminatory observations with no arbitrage conditions. That is, when P_{irtcb}^{UK} is at least 5 GBP higher than $P_{irtcb}^{EU} / e_{EU/UK}^{b}$, then a continental European will prefer to pay the fare of the return leg in her national currency: in any case, the Britons are adversely discriminated. To obtain value *2* of "Discrimination Type", consider that even if $P_{irtcb}^{EU} / e_{EU/UK}^{b}$ is at least 5 GBP more expensive than P_{irtcb}^{UK}, a continental European may not find it profitable to exercise arbitrage when its benefit (i.e., Δ) is smaller than its costs, *AC*. In this case, the continental Europeans are adversely discriminated. Finally, the arbitrage is profitable in the case of value 3.

When "Discrimination Type" is greater than zero, Stigler's (1987) definition of price discrimination holds, because the marginal cost for a seat booked at the same time for the same flight has to be the same regardless of whether the booking takes place in UK or in continental Europe.

TABLE 3 ABOUT HERE

6.1. Assessing the presence of arbitrage opportunities on-line

In Table 4, the incidence of the values of "Discrimination Type" in the sample of international flights is broken down by airline and a flight's departure location, UK or Continental Europe.[18] Overall, the last two rows show that 9.4% of the observations are associated with profitable opportunities of arbitrage, 6.4% present non-profitable arbitrage conditions, while 18.2% exhibit characteristics of on-line price discrimination without arbitrage. In total, 34% of observations are discriminatory, supporting the conclusion of an extensive use of our form of on-line price discrimination. However, there are clear differences across the airlines. The Total rows show how Ryan Air is the company with the lowest percentage of non-discriminatory cases (47.9%), immediately followed by Bmibaby (59.7%), GoFly (61.1%) and MyTravelLite (61.9%). Ryan Air and GoFly are the companies reporting by far the highest percentage of cases with arbitrage, 19.3% and 13.3% respectively, while only 5% or less of the fares posted by the other companies satisfy the arbitrage conditions. Indeed, these are extremely rare for EasyJet (only 1.1%), which reports 83.7% of non-discriminatory fares. Interestingly, the Total row indicates that the discriminatory observations are more or less equally split between including and not including

[18] From now on, only international flights are considered, given that domestic flights are generally not used for on-line price discrimination purposes.

arbitrage opportunities, implying that the airlines do not necessarily target the same specific group of travellers to be adversely discriminated or to be offered arbitrage opportunities.

TABLE 4 ABOUT HERE

To further this point, consider for instance Ryan Air and GoFly in Table 4. For both airlines we retrieved a large proportion of arbitrage opportunities for flights departing from continental Europe (27.3% and 14.6% of Ryan Air and GoFly cases, respectively): these are beneficial to British travellers only to the extent that arbitrage is exercised. Otherwise, this implies higher prices for the Britons. By the same token, for the same airlines a large share of cases with “Discrimination Type” equal to 1 is found to depart from the UK (respectively, 35.8% and 23.2%), thus adversely discriminating British travellers relative to their continental European counterparts returning from a visit to UK. However, we also found a significant proportion of cases where non-UK resident travellers are offered higher fares that either come with arbitrage opportunities (11.3% for Ryan Air and 12.0% for GoFly) or without (15.7% and 14.1%, respectively). The fact that no group of travellers is singled out by these companies to be the exclusive victim of discriminatory pricing suggest that discriminatory pricing may be driven by such contingent factors as specific demand conditions that are independently distributed across national groups.

Recall from Table 3 how BmiBaby and MyTravelLite systematically recorded values of $P_{irtcb}^{EU} / P_{irtcb}^{UK}$ above the relevant exchange rate. Table 4 shows that for BmiBaby, we retrieved 8325 cases (9.8%) of profitable arbitrage opportunities for flights departing from the UK, while only 211 (0.3%) were from continental Europe. That is, BmiBaby offers arbitrage opportunities almost exclusively to travellers residing in a continental European country, which, if not exercised, imply higher fares for them. However, they are also almost exclusively the victims of on-line price discrimination (i.e., when “Discrimination Type” is equal to 1). Indeed, in 40.8% of cases departing from continental Europe, BmiBaby offered a fare $P_{irtcb}^{EU} / e_{EU/UK}^{b}$ for a first leg flight, which is at least 5GBP higher than that offered to Britons returning to their country. A similar analysis holds also for MyTravelLite. Furthermore, both airlines exhibit about 14% of cases for which it is not worth exploiting arbitrage opportunities. The figures in Table 4 seem to suggest that, with the exception of Ryan Air and GoFly, all the other airlines were reluctant to offer viable arbitrage opportunities. The higher fares that Bmibaby and MyTravelLite offered to continental European travellers may be explained by the composition of their customers, which is predominantly British. This is not surprising given that their holding companies are, respectively, BMI British Midlands and MyTravel Group PLC; the former being the second largest British Full Service Carrier; the latter (formerly Airtours) one of the leading integrated travel companies that dominate the tour operators market in the UK.

To conclude, the recourse to on-line price discrimination is widespread across the LCCs in our sample (easyJet being one notable exception), although the analysis reveals important differences in the way each airline combines its mix of pricing modes, especially as far as offering profitable arbitrage opportunities is concerned. Nevertheless, the high proportion of observed profitable arbitrage cases poses a fundamental question: if, from a theoretical viewpoint, price discrimination and arbitrage cannot co-exist (Armstrong, 2006; Stole, 2007; Tirole, 1988), *a fortiori* should this not be the case in on-line markets, where search costs are assumed to be low?

6.2. Reconciling the co-existence of Price Discrimination and Arbitrage

Providing a conclusive answer to such a question is beyond the scope of this paper. We argue, however, that the airlines' pricing behaviour may be consistent with two distinct, but not incompatible explanations.

First, the enduring and systematic practice of on-line price discrimination hints that LCCs' customers may have remained largely unaware of the presence of arbitrage opportunities, despite LCCs sell their tickets almost exclusively on-line. This is further evidence that the Internet is providing firms with new and imaginative price setting schemes. But unlike the firms selling computer RAM described by Ellison and Ellison (2004), LCCs do not need to implement "search obfuscation" techniques. Indeed, different prices for the same flight may be available on the same web site at the same time.[19] However, they can be found out only if the on-line customers run two queries, instead of one, the latter being the default option offered on the web-site. It is unlikely that even a very expert web-surfer could contemplate the possibility to do so in order to look for arbitrage opportunities. Indeed, most individuals would naturally issue a query using the default option for a return ticket and would not think about the possibility to search for the price of the return leg independently of the first leg. This could be interpreted as a form of cognitive search cost due to psychological inertia (Johnson *et al.*, 2004), which drastically limits search activity, and may help protect LCCs when they post prices entailing arbitrage opportunities. That is, the natural propensity of the great majority of travellers to issue a query for a round-trip ticket may help explain the co-existence of discrimination and arbitrage on the same site. This is tantamount to thinking of consumers who are less adept in understanding the subtleties of airlines' on-line pricing as having high search costs (Salop, 1977).The upshot may be that the airlines, protected by the presence of cognitive search costs, have little to fear that arbitrage opportunities will be extensively

[19] Some airlines, however, have recently begun to engage in obfuscation practices similar to the ones described in Ellison and Ellison (2004). For instance, travel insurance is now automatically included in the order, and the customers have to unclick to avoid being charged for it. Moreover, uncertainty about the final price arises also because the charge for landing fees and airport taxes is not specified together with the fares.

exploited.[20] Indeed, in Table 4, about 19% of cases from Ryan Air present arbitrage conditions. This is quite a high proportion, hinting that these opportunities are seldom taken.

Second, arbitrage chances may be intentionally "up for grabs". That is, LCCs post them specifically for the purpose of being exercised or are not too worried if some savvy Internet-surfer recognizes them. In any case, Table 5, by showing the mean values of $|\Delta|$ and of the arbitrage cost *AC*, reveals that arbitrage opportunities are generally worth pursuing. Indeed, in the last column, the average net gain from arbitrage, given by the difference between $|\Delta|$ and AC, varies by airline: it is rather small for BmiBaby, and between 8-13 GBP for the other airlines.

TABLE 5 ABOUT HERE

7. A closer look into discriminatory pricing.

The foregoing analysis introduced a novel form of on-line pricing and showed its extensive use by the airlines. The remainder of the paper investigates under what circumstances the LCCs engage in on-line price discrimination with and without arbitrage. First of all, we investigate whether the same strategy persist over a period of 70 days prior to a flight's departure. The presence of persistence would be indicative of an airline's decision to apply a specific pricing mode to a specific flight, presumably based on its expectation of the final demand realisation. It would also reinforce the view of discriminatory practices as largely motivated by the presence of broadly defined search costs.

Imagine an airline has a prior belief that a certain flight is likely to realize a low load-factor. We have argued that to counteract this, the airline may want to engage in discriminatory pricing, in order to attract demand from the price elastic group of consumers. To check if the values of "Discrimination Type" persist over time, recall how for each flight we have up to 11 observations of fares' pairs, each one for a different booking day. Table 6 cross-tabulates the values of "Discrimination Type" with the same values lagged by one booking day (63 relative to 70, 56 relative to 63, etc.). By doing so, we try to shed light on whether the same pricing strategy is applied consistently over the booking period we observe (i.e., 70 to 7 days from departure). In line with our expectation, a high degree of persistence characterizes the airlines' approach to pricing. Indeed, an identical pricing scheme tends to precede the large majority of cases in each column (about 89%, 73%, 58% and 67%, respectively). Between 20%-28% of the discriminatory observations (i.e., with "Discrimination Type" ≥1) are preceded by uniform pricing cases, suggesting that the latter

[20] It is possible that the airlines may tolerate arbitrage only to a certain extent, and programme their sites accordingly.

constitute a focal point from which the airlines move away only if necessary. In general, leaving the uniform pricing cases aside, the same type of discriminatory mode is applied consistently for each flight. In only 3.3% of cases, discrimination with no arbitrage is preceded by an arbitrage condition. Similarly, only 2.2% and 4.9% of non-arbitrage discriminatory cases feature in the last two columns of arbitrage situations. For the latter, we observe a slightly larger proportion (11.7% and 8.2%) of mutual interdependence, which is consistent with the posting of arbitrage opportunities (whether profitable or not) being driven by similar factors. Overall, Table 6 reveals a high degree of persistence in the approach the airlines follow in setting the on-line fares for a specific flight.

TABLES 6 ABOUT HERE
TABLES 7 ABOUT HERE

Second, we consider a number of flight's characteristics and study their relationship with the incidence of each pricing mode. Higher fares seem to be associated with discriminatory observations for all the airlines (Table 7). This is further confirmed by a cross-tabulation analysis of the pricing modes with such flight's characteristics as the day and time of departure, the season, the level of fare, and the booking day.[21] It turns out that discriminatory observations are more likely for flights departing in the week-end, scheduled at a very convenient time (i.e., middle of the day) or in the summer. Late booking fares, i.e., those available from 14 up to 7 days from take-off, are also more likely to be discriminatory. Generally, these characteristics are positively related to a fare premium (see Piga and Bachis, 2007) and thus provide more scope for large differences between P^{UK}_{irtcb} and P^{EU}_{irtcb}. Indeed, when $P^{UK}_{irtcb} \geq 70$, more than 65% of the observations are discriminatory in nature, with 10.6% offering profitable arbitrage opportunities. We control for these characteristics in the following econometric analysis.

7.1. Econometric methodology and dependent variables

We consider the estimation of a dynamic (habit persistence) panel Probit model (see Greene, 2007, pp.E20-56 and E20-57 for a more technical analysis):

$$y^{*}_{ib} = \alpha + \beta' X_i + \gamma y_{i,b-1} + \sigma u_i + \varepsilon_{ib}; \quad y_{ib} = 1(y^{*}_{ib} > 0);$$

(4)

where *i* denotes a daily, company specific, flight and *b* a booking day. The estimation procedure is a random parameter probit model that takes into account the correlation of the random effects with the X_i and $y_{i,t-1.}$ (Greene, 2007) To do so, it treats the initial condition as an equilibrium:

[21] The analysis is not reported to save on space; it is available on request.

$$y^*_{i0} = \alpha + \delta' X_i + \tau u_i + \varepsilon_{i0}; \quad y_{i0} = 1(y^*_{i0} > 0);$$

(5)

and retains the preceding model for booking days *b=1,..,T*. In (5), the lagged dependent variable does not appear and the coefficients multiplying X_i and u_i are assumed to be different from those in (4).

The dependent variable, y_{ib}, which will be referred to as "Discriminatory", assumes the value of 1 when "Discrimination Type" is greater or equal to 1 and zero elsewhere.[22] Note that, in the light of the findings of Table 6, in the econometric analysis the dependent variable does not distinguish between discriminatory observations with or without arbitrage opportunities. The matrix X_i includes the monthly mean of the variables reported in Table 8, as well as dummy variables for the following flight characteristics: Summer Season; Week-end; Time of departure between 12.40 and 14.0 and before 8.20am.

TABLE 8 ABOUT HERE

7.2 Results

Table 9 reports the coefficients in (4) and (5), obtained using different samples. Model 1 includes all the airlines; Model 2 excludes EasyJet and Buzz because of their limited involvement in pursuing on-line price discrimination strategies; Model 3 considers Ryan Air exclusively. All models present similar results. Only flights for which we have at least five consecutive booking days were included in the estimation samples. However, the results from alternative specifications where we include all the observations but leave the characteristics' dummies out yield results similar to those in Table 9.

TABLE 9 ABOUT HERE

As far as the impact of "Persistence" is concerned, observing a discriminatory case in the previous booking day increases the probability of observing a similar case in the current booking day. The extremely high z-statistics indicates that the same pricing mode tends to be applied consistently in the period preceding a flight's departure (see Table 6). We infer that price discrimination is a tactic used by the airline after it has targeted a specific flight. Indeed, if this was not the case and discriminatory was applied randomly, we should more often observe a reversion towards uniform pricing, hence a negative (not a positive) coefficient for the lagged dependent.

The estimates in Table 9 support the previous finding that discriminatory pricing is more likely observed in Summer and week-end flights but not for the departure times for which dummies

[22] As usual, y^*_{ib} is a latent, unobserved variable.

were included. Price discrimination seems to be negatively related with the level of route concentration (the effect is stronger in Model 3) and therefore appears to be motivated by the airlines' need to meet the competitive pressure of other airlines (see Borenstein and Rose, 1994 for a discussion). This is further supported by the findings for "Market Size" and the presence of charter operators, which both indicate an increase in the degree of competition; the former because in larger markets consumers have more possibility to substitute one scheduled flight with another; the latter because charter operators are direct competitors of LCCs.

8. Conclusions

The low search costs of the Internet facilitate price comparisons on-line that may even lead to lower off-line prices (Brown and Goolsbee, 2002). To protect themselves from Bertrand-type competition, e-retailers may either try to build brand allegiance or engage in obfuscation strategies (Brynjolfsson and Smith., 2000; Ellison and Ellison, 2004 and 2005). Given the high price transparency of the Internet, it would therefore seem unlikely to observe the same company offering two different prices for the same product on-line.

The thrust of this paper is to show, through a particular data collection design, how some important European Low Cost Carriers systematically posted fares on-line that violate the Law of One Price (Asplund and Friberg, 2001). Our analysis still supports the notion of low search costs on-line. Indeed we find airlines do not practice on-line price discrimination for U.K. domestic flights, because their fares, being expressed in the same currency, can be more easily compared. As discrimination is applied only to international flights, we argue that other forms of search costs remain important, even if the transaction takes place on-line: an obvious example is learning about the prevailing exchange rate. However, the strongest factor facilitating on-line price discrimination is probably the presence of cognitive search costs, i.e., the inability of an on-line customer to conceive the possibility to control for the presence of arbitrage opportunities, which make up 9.4% observations in our dataset, but account for about one-fifth of Ryan Air's observations.

We discuss how the airlines may actually benefit from having customers acting as arbitrageurs, as this may help improve their yield. The evidence indicates discriminatory cases are more likely within the two weeks prior to take-off, when the airlines have better information about demand realization. When associated with the offering of discounts via arbitrage, the form of on-line price discrimination we present is therefore likely to be welfare-enhancing, as it does not penalize the airlines and allows consumption by customers that otherwise would not have purchased the ticket. The usual ambiguous effects on welfare remain when the airlines charge differing fares that cannot be arbitraged away. However, the pricing strategies we analyse do not seem to meet the conditions to be deemed discriminatory pursuant to Article 82(c) of the Treaty of the European

Community because, although such strategies "apply dissimilar conditions to equivalent transactions", Article 82 (c) does not apply to transactions with final consumers (Geradin and Petit, 2005). Further support to this view is provided by the EU Services Directive (European Commission, 2006, comma 95), stating that "…It does not follow that it will be unlawful discrimination if provision were made in such general conditions for different tariffs and conditions to apply to the provision of a service, where those tariffs, prices and conditions are justified for objective reasons that can vary from country to country, such as … different market conditions, such as higher or lower demand influenced by seasonality, …and pricing by different competitors". This is in line with the view in Armstrong (2006) that, because ascertaining whether price discrimination is welfare enhancing or decreasing requires a formidable amount of detailed information, competition bodies should follow a rule of thumb based on the presumption that price discrimination by dominant firms aimed final consumers should be permitted.

A striking result is that over a period of 70 days, discriminatory cases for a flight are observed repeatedly before a flight's departure. Even more strikingly for an on-line market, arbitrage opportunities also tend to persist over time. This is in shark contrast with the conventional wisdom of arbitrage being incompatible with discriminatory pricing, especially in markets with low search, menu or transportation costs. On the whole, the evidence seems to suggest how airlines do not seem particularly worried by the price transparency of the Internet, but, rather, they can exploit some of the Internet's features to maximize their yield in a route.

Finally, the paper shows how price discrimination constitutes a source of price dispersion on-line. Because the airlines in our sample sell their seats using the Internet as the almost exclusive distribution channel, our evidence suggest an important link between the price dispersion on-line and that realised on a single flight. Lack of sales data prevents a thorough analysis of such a link, which is left for future research.

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Figure 1: The “uniform pricing” case with no price discrimination.

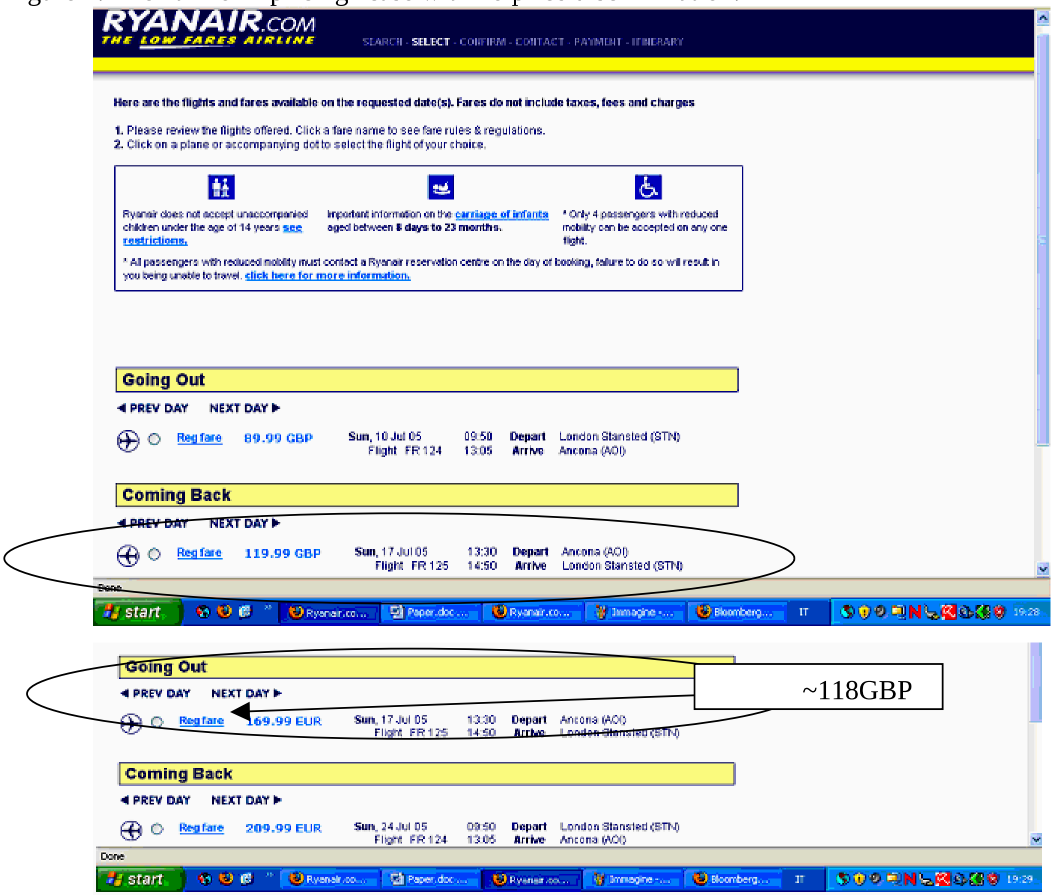


Figure 2: An example of price discrimination with arbitrage

Figure 3: An example of price discrimination without the possibility of arbitrage – perfect segmentation.

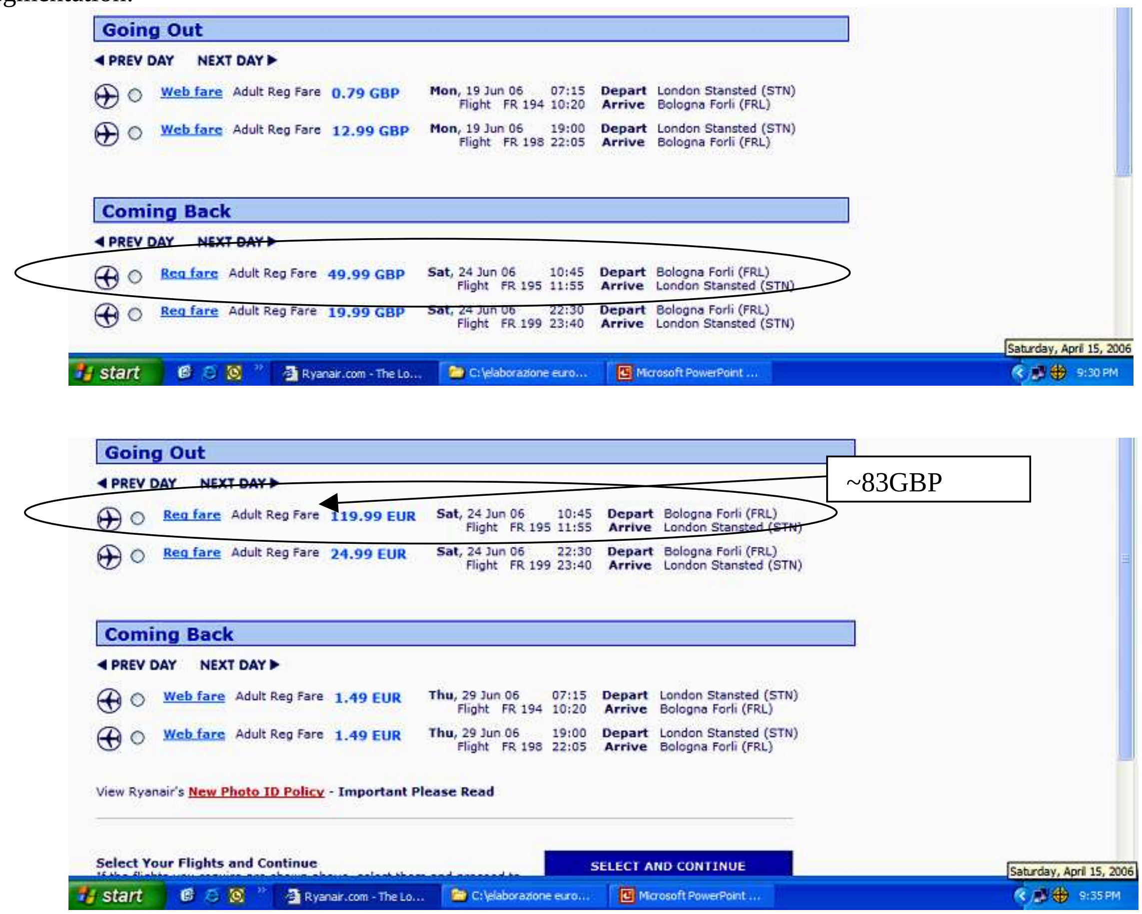


Figure 4 – Kernel Densities of $\Phi = P^{EU}_{irtb} / P^{UK}_{irtb}$ and $e^{b}_{EU/UK}$.

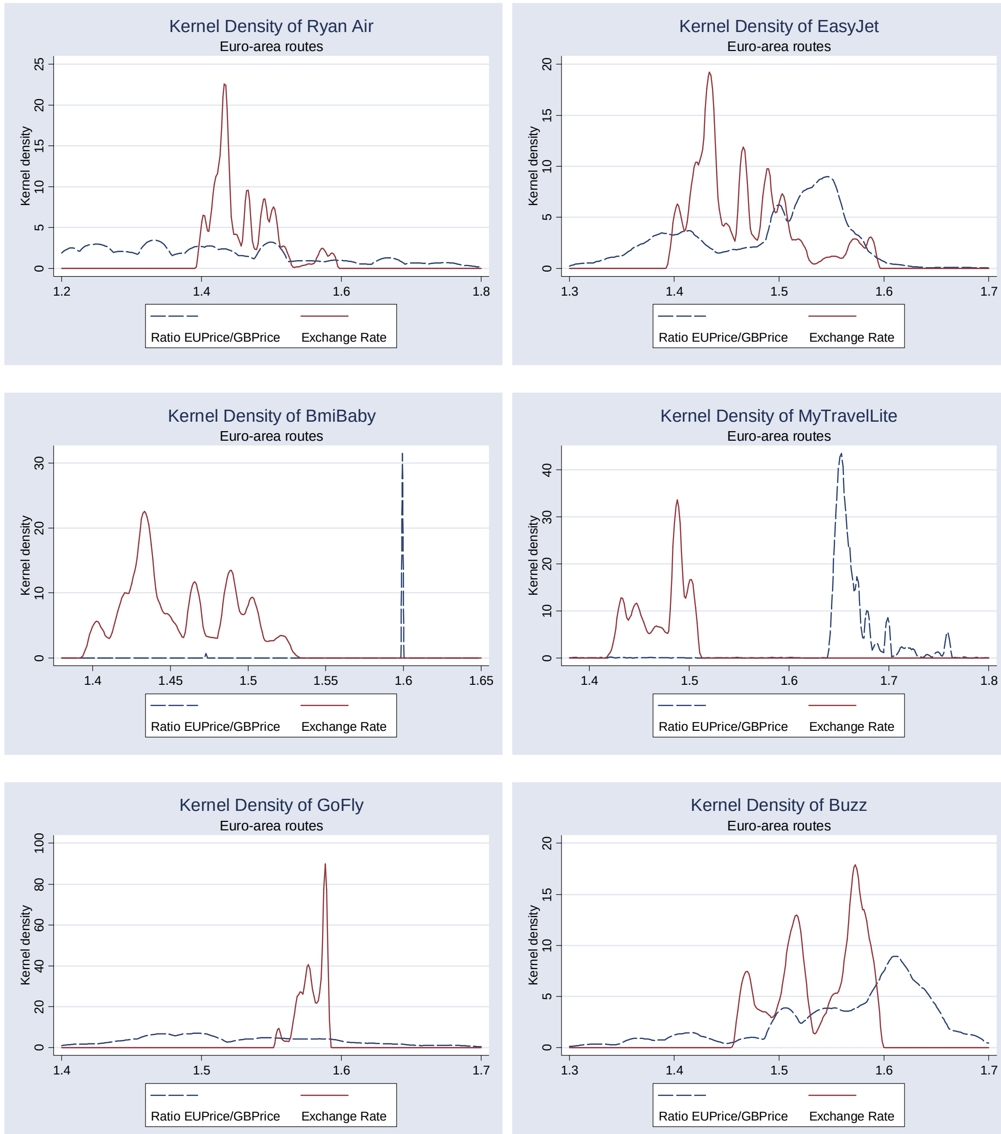


Table 1: Descriptive statistics of $\left|\Delta\right| = \left|\left(P_{irtcb}^{EU} / e_{EU/UK}^{b}\right) - P_{irtcb}^{UK}\right|$ by company and destination.

	Company						
Statistic	Bmibaby	RyanAir	EasyJet	Buzz	GoFly	MyTravel	Total
			International Flights				
p1	0.60	0.06	0.05	0.03	0.05	0.50	0.06
p5	1.23	0.39	0.24	0.23	0.29	0.91	0.32
p10	1.67	0.88	0.46	0.45	0.62	1.37	0.63
p25	2.56	2.32	1.07	1.03	1.91	2.53	1.50
p50	4.25	5.32	2.35	2.05	3.62	4.20	3.41
p75	7.15	9.93	4.15	3.45	9.56	6.32	6.53
p90	10.67	17.20	5.92	8.17	16.95	10.13	12.13
p95	14.58	23.51	8.53	14.01	23.23	14.35	17.50
p99	22.79	36.81	17.58	29.50	42.21	32.96	34.08
mean	5.56	7.68	3.17	3.65	7.05	5.53	5.38
min	0.00	0.00	0.00	0.00	0.00	0.01	0.00
max	79.99	79.84	79.97	79.91	79.98	79.36	79.99
sd	4.85	8.08	3.81	5.62	8.65	5.94	6.53
N	168750	803782	849313	42333	30957	23289	1918424
			Domestic Flights				
p1	0	0	0	-	0	0	0.00
p5	0	0	0	-	0	0	0.00
p10	0	0	0	-	0	0	0.00
p25	0	0	0	-	0	0	0.00
p50	0	0	0	-	0	0	0.00
p75	0	0	0	-	0	0	0.00
p90	0	0	0	-	0	0	0.00
p95	0	2.52	0	-	0	0	0.00
p99	0	10	5.00	-	10	0	5.00
mean	0.05	0.40	0.12	-	0.26	0.00	0.18
min	0	0	0	-	0	0	0.00
max	55.50	63.00	75.00	-	39.15	3.99	75.00
sd	0.88	2.05	1.39	-	2.20	0.13	1.54
N	54601	71408	137083	-	7534	1772	272398
Total N	223351	875190	986396	42333	38491	25061	2190822

Source: Fares are from the airlines' web sites. Δ is expressed in GBP

Table 2 – Ratio of prices in different currencies and exchange rates, by company and country.

	countries		Bmi baby	Ryan Air	Easy Jet	Buzz	Go Fly	My Travel	Total	N
No Euro-Zone	UK	$e^{b}_{EU/UK}$	1.00	1.00	1.00	-	1.00	1.00	1.00	272398
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.00	1.01	1.00	-	1.00	1.00	1.01	
	Switzerland	$e^{b}_{EU/UK}$	2.22	-	2.23	2.22	-	-	2.23	108534
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	2.49	-	2.26	3.29	-	-	2.26	
	Sweden	$e^{b}_{EU/UK}$	-	13.45	-	-	-	-	13.45	57275
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	-	13.41	-	-	-	-	13.41	
	Norway	$e^{b}_{EU/UK}$	-	11.80	-	-	-	-	11.80	19849
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	-	16.99	-	-	-	-	16.99	
	Czech Rep.	$e^{b}_{EU/UK}$	48.24	-	48.42	-	-	-	48.37	10933
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	56.69	-	44.88	-	-	-	48.12	
Eurozone	Italy	$e^{b}_{EU/UK}$	1.44	1.46	1.46	-	1.58	-	1.46	266918
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.61	1.75	1.48	-	1.64	-	1.68	
	France	$e^{b}_{EU/UK}$	1.46	1.46	1.47	1.54	1.58	-	1.47	287646
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.61	1.57	1.46	1.61	1.73	-	1.53	
	Spain	$e^{b}_{EU/UK}$	1.45	1.46	1.46	1.54	1.58	1.47	1.47	501131
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.61	1.47	1.50	1.68	1.60	1.67	1.52	
	Holland	$e^{b}_{EU/UK}$	1.46	1.45	1.47	1.52	-	-	1.47	151541
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.60	1.25	1.46	1.65	-	-	1.46	
	Germany	$e^{b}_{EU/UK}$	1.45	1.46	1.45	1.54	1.58	-	1.47	109645
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.60	1.50	1.46	1.57	1.53	-	1.51	
	Belgium	$e^{b}_{EU/UK}$	1.45	1.47	-	-	-	-	1.46	25006
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.61	1.41	-	-	-	-	1.46	
	Greece	$e^{b}_{EU/UK}$	-	-	1.47	-	-	-	1.47	18941
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	-	-	1.51	-	-	-	1.51	
	Ireland	$e^{b}_{EU/UK}$	1.46	1.46	-	-	-	1.47	1.46	300059
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.61	1.17	-	-	-	1.74	1.22	
	Portugal	$e^{b}_{EU/UK}$	1.48	-	1.46	.	1.58	1.47	1.47	35268
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.60	-	1.49	.	1.57	1.67	1.51	
	Austria	$e^{b}_{EU/UK}$	1.50	1.47	-	-	-	-	1.47	25678
		$P^{EU}_{irtcb} / P^{UK}_{irtcb}$	1.60	1.32	-	-	-	-	1.33	

Source: Datastream for the exchange rates, price data from the airlines' web sites.

Table 3 – Conditions used to derive the values for Discrimination Type .

Discrimination Type values	Condition	Logic Oper.	Condition
0 – Uniform.	$\lvert\Delta\rvert<5$		
1- Discriminatory no arbitrage	(UK AND $\Delta\leq-5$)	OR	(Cont.EU AND $\Delta\geq 5$)
2 – Discriminatory. No profitable arbitrage	(UK AND $\Delta\geq 5$ AND $\Delta\leq AC$)	OR	(Cont.EU AND $\Delta\leq-5$ AND $\Delta\geq-AC$)
3– Discriminatory. with profitable arbitrage	(UK AND $\Delta\geq 5$ AND $\Delta\geq AC$)	OR	(Cont.EU AND ≤-5 AND $\Delta\leq-AC$)

Note: UK and Cont.EU denote the location of a route's departing airport. So a flight departing in the UK corresponds to the outward leg for a Briton and to the return leg for a Continental European passenger. Vice versa for a flight departing in Continental Europe. From (2) and (3), Δ and AC denote, respectively, the absolute difference of the fares for the same flight expressed in different currencies, and the cost of arbitrage.

Table 4 – Type of discrimination by company and departure location.

		Variable "Discrimination Type" – Frequency (row %)				
	Departure From	0- Uniform	1 Discriminatory - no arbitrage	2 Discriminatory -no prof. arbitrage	3 Discriminatory - with arbitrage	N row
Bmi Baby	Cont. Europe	58.9%	40.8%	0.0%	0.3%	84120
	UK	60.6%	0.1%	29.4%	9.8%	84630
	Total	59.7%	20.4%	14.8%	5.1%	168750
Ryan Air	Cont. Europe	48.1%	15.7%	9.0%	27.3%	401757
	UK	47.7%	35.8%	5.2%	11.3%	402025
	Total	47.9%	25.7%	7.1%	19.3%	803782
Easy Jet	Cont. Europe	78.7%	18.5%	1.8%	1.0%	419109
	UK	88.6%	3.9%	6.3%	1.1%	430204
	Total	83.7%	11.1%	4.1%	1.1%	849313
Buzz	Cont. Europe	84.2%	11.7%	0.8%	3.2%	20984
	UK	86.4%	5.7%	3.6%	4.3%	21349
	Total	85.3%	8.7%	2.2%	3.8%	42333
Go Fly	Cont. Europe	60.6%	14.1%	10.6%	14.6%	15363
	UK	61.5%	23.2%	3.2%	12.0%	15594
	Total	61.1%	18.7%	6.9%	13.3%	30957
MTL	Cont. Europe	61.0%	36.9%	0.6%	1.5%	10907
	UK	62.7%	1.5%	26.2%	9.6%	12382
	Total	61.9%	18.1%	14.2%	5.8%	23289
	N (Col)	1266193	349430	123211	179590	1918424
	%N (Col)	66.0%	18.2%	6.4%	9.4%	

Source: Our elaboration of the fares retrieved from the airlines' web sites.

Table 5 – Mean of absolute difference of fares and arbitrage costs by type of discrimination.

	Departure From	Variable "Discrimination Type" 0- Uniform	1 Discriminatory - no arbitrage	2 Discriminatory -no profitable arbitrage	3 Discriminatory - with arbitrage
Bmi Baby	Mean $\lvert\Delta\rvert$	2.9	9.7	7.1	15.9
	Arbitrage Cost	-	-	9.3	11.3
Ryan Air	Mean $\lvert\Delta\rvert$	2.3	12.8	6.4	14.8
	Arbitrage Cost	-	-	7.8	7.5
Easy Jet	Mean $\lvert\Delta\rvert$	2.1	8.4	7.0	19.2
	Arbitrage Cost	-	-	10.6	8.8
Buzz	Mean $\lvert\Delta\rvert$	1.9	13.6	6.4	19.2
	Arbitrage Cost	-	-	10.0	7.2
Go Fly	Mean $\lvert\Delta\rvert$	2.3	14.7	7.3	18.2
	Arbitrage Cost	-	-	10.6	9.0
MTL	Mean $\lvert\Delta\rvert$	2.9	9.7	6.9	17.4
	Arbitrage Cost	-	-	9.0	10.3

Source: Our elaboration of the fares retrieved from the airlines' web sites. Values are expressed in GBP.

Table 6 – Persistence in the pricing strategy of a flight.

	Variable "Discrimination Type" – Col %			
Lagged values – previous booking day	0 – Uniform	1 Discriminatory no arbitrage	2 Discriminatory no prof. arbitrage	3 Discriminatory with arbitrage
0 - Uniform	89.1%	24.1%	28.3%	20.4%
1 Discriminatory no arbitrage	5.7%	72.6%	2.2%	4.9%
2 Discriminatory no prof. arbitrage	2.6%	0.9%	57.8%	8.2%
3 Discriminatory with arbitrage	2.6%	2.4%	11.7%	66.5%

Table 7 – Mean fares, P_{irtcb}^{UK}, by type of discrimination and company

	Variable "Discrimination Type"			
Company	0- Uniform	1 Discriminatory - no arbitrage	2 Discriminatory -no prof. arbitrage	3 Discriminatory - with arbitrage
BmiBaby	33.5	82.1	66.6	107.5
Ryanair	24.6	41.0	40.7	40.5
EasyJet	41.0	83.0	93.7	65.3
Buzz	42.9	58.8	80.6	32.5
Go Fly	61.3	73.6	98.1	70.6
MyTravelLite	22.5	66.5	60.5	89.3

Table 8 – Description of regressor used in the Bivariate Probit with Sample Selection model

Variable	Description	Mean If y_{it}=0	Mean If y_{it}=1
Persistence	Dummy = 1 if, for the same flight, the observation in the previous booking day is discriminatory.	0.09	0.62
Summer Season	Dummy – Summer=1.	0.71	0.79
HHI_route	Herfindhal Index in a route - Shares calculated using the monthly number of flights by an airline in a route	0.72	0.75
Market Size†	Share of total flights in a city-pair over the total flights in a nation's sub-area†.	0.17	0.17
Shr Charter Pass	Monthly share of charter passengers over the total number of passengers in a city-pair.	0.08	0.11
Time≤8.20	Dummy flight departs before: "<=8.20am";	0.23	0.21
12.40≤Time≤14.40	Dummy flight departs between:"12.40-14.40";	0.71	0.73
Week-end	Dummy for week-end days	0.33	0.43

†The UK, as well as the largest destination countries, Italy, France, Germany and Spain, were divided in three sub-areas: North, Centre and South. Recalling that a city-pair includes all the routes connecting two cities (e.g., London to Rome), this variable is calculated as the share of total flights in a city-pair over the total flights to a nation's sub-area (i.e., the Centre of Italy, the sub-area where Rome is located). For smaller countries, the denominator is given by taking the whole country.

Table 9 – Dynamic Probit model – Dependent Variable "Discriminatory".

	Model 1 – Full Sample	Model 2 – No Easyjet and Buzz	Model 3 – Only Ryanair
Persistence $y_{i,b-1}$	1.12 (382.5)	1.10 (312.2)	0.99 (258.3)
$\text{HHI\_route}_{b>0}$	-0.15 (21.0)	-0.19 (19.3)	-0.33 (29.0)
$\text{HHI\_route}_{b=0}$	-0.13 (6.5)	-0.31 (12.1)	-0.46 (15.5)
Market $\text{size}_{b>0}$	0.05 (5.7)	0.78 (73.3)	0.39 (37.1)
Market $\text{size}_{b=0}$	-0.21 (10.3)	0.93 (35.3)	0.23 (8.3)
Shr Charter $\text{Pass}_{b>0}$	0.46 (66.5)	1.11 (91.3)	1.21 (41.7)
Shr Charter $\text{Pass}_{b=0}$	0.37 (19.6)	1.20 (37.0)	1.60 (21.2)
$\text{Week-end}_{b>0}$	0.26 (90.9)	0.23 (65.0)	0.18 (45.9)
$\text{Week-end}_{b=0}$	0.41 (53.7)	0.38 (41.1)	0.30 (30.0)
$12.40\leq\text{Time}\leq14.40_{b>0}$	-0.13 (37.7)	-0.11 (19.8)	-0.15 (33.5)
$12.40\leq\text{Time}\leq14.40_{b=0}$	-0.12 (26.9)	-0.18 (13.0)	-0.10 (15.5)
$\text{Time}\leq8.20_{b>0}$	-0.12 (13.2)	-0.13 (31.8)	-0.13 (11.6)
$\text{Time}\leq8.20_{b=0}$	-0.21 (17.8)	-0.11 (10.6)	-0.17 (10.8)
$\text{Summer}_{b>0}$	0.32 (84.6)	0.10 (21.0)	-0.14 (26.2)
$\text{Summer}_{b=0}$	0.70 (70.5)	0.50 (43.7)	0.25 (19.5)
τ	1.28 (218.9)	0.95 (162.3)	0.82 (137.7)
σ	0.88 (405.2)	0.65 (278.7)	0.54 (231.9)
N Observations	1026778	832116	647266
N Flights	190568	104655	81240

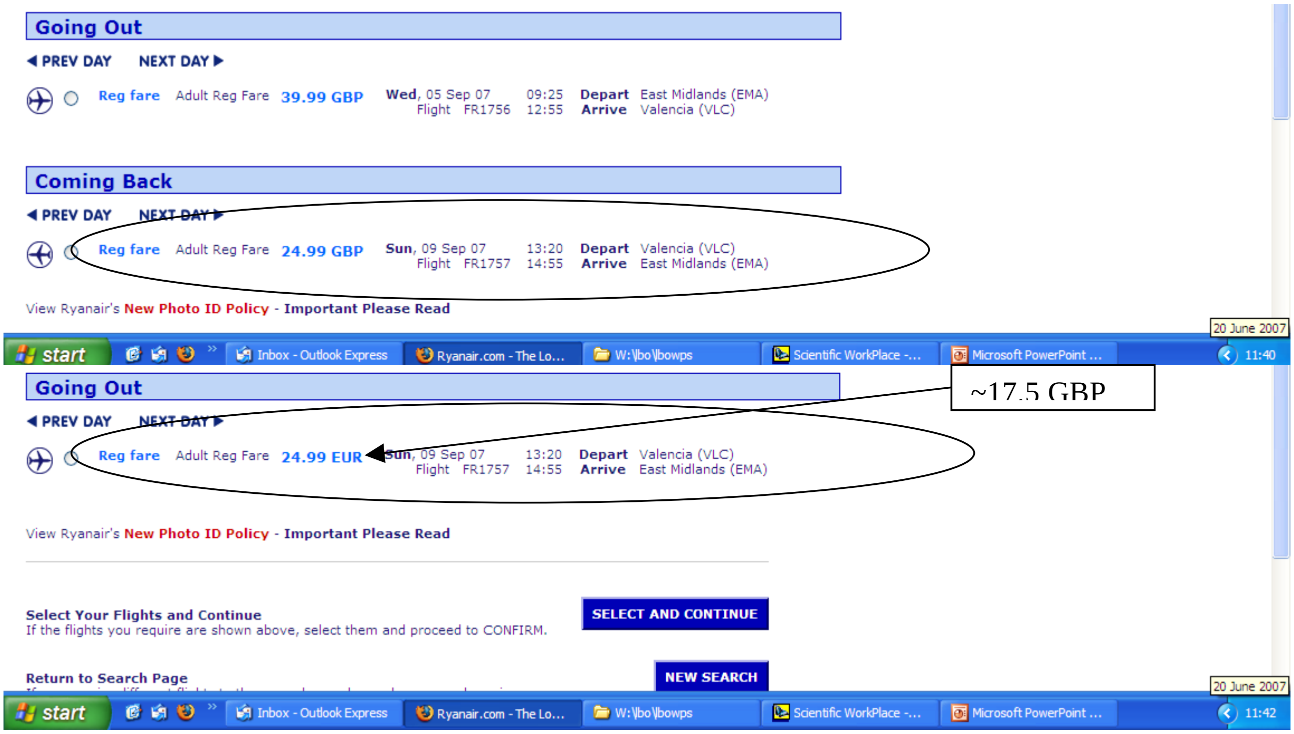
Note: Only flights for which we have at least five consecutive booking days were included in the estimation samples. z-statistics in parentheses. All reported coefficients are significant at any reasonable probability level.

Electronic Appendix - Material Available on request, to be given only to referees

EA.1 Two further examples of price discrimination with arbitrage conditions. – Discussed in Section 2.

Figure EA.1: Another example of price discrimination with arbitrage.

Figure EA2: A more recent example of price discrimination with arbitrage.



EA.2. Representativeness of the data on fares. – Discussed in Section 4

Table EA.1 in the Electronic Appendix illustrates how the prices retrieved from the Internet represent an accurate sample of the activity of each of the Low Cost Carriers (LCCs) we consider. It compares the number of routes for which we have price data with the actual total number of routes operated by each airline. The latter figure is taken from the U.K. Civil Aviation Authority dataset, which also provides the number of routes where our LCCs face competition by either a major Full Service Carrier or another LCC. To test the spider's functionality, initially we limited the number of surveyed routes. Indeed, in August 2002 the percentage of routes with prices was 63% of the total number operated by Ryan Air, 50% for Easyjet, 64% for Buzz and 46% for GoFly. However, thanks to the speed of the programme, within a few months such percentages could be increased significantly for all the airlines, to cover 90% or more of the total routes they operated. Considering that the spider took all the prices for all the daily flights, the price dataset provides an exhaustive illustration of the on-line pricing activity of each airline. Table EC.1 also shows that the airlines differ in the degree of competition they face. For instance, in about 21-26% of EasyJet's routes at least another competitor is also present. At the other extreme, Ryan Air (and Buzz to a lesser extent) faced competition in a very limited subset of routes. The other airlines operate in a smaller number of routes, which is probably why competitive routes account for about one-third of the total. Such differences may be driven by the choice of the arrival destinations. Ryan Air and Buzz chose almost exclusively secondary airports that may be many miles away from the city of arrival, while the other airlines also fly to major airports where Full Service Carriers also land.

Table EA.1 – Number of routes, and their percentage relative to the total number operated by the company, by type of sample, airline and period.

	BMIBABY		RYANAIR		EASYJET		BUZZ		GOFLY		MyTRAVELLITE	
Year_ month	Routes with fares	Compet. Routes	Routes with fares	Compet. Routes	Routes with fares	Compet. Routes	Routes with fares	Compet. Routes	Routes with fares	Compet. Routes	Routes with fares	Compet. Routes
02_07			34 (57.6)	7 (11.9)	19 (50.0)	9 (23.7)	21 (63.6)	3 (9.1)	17 (45.9)	11 (29.7)		
02_08			37 (62.7)	8 (13.6)	19 (50.0)	9 (23.7)	21 (63.6)	5 (15.2)	17 (45.9)	11 (29.7)		
02_09			37 (62.7)	7 (11.9)	28 (70.0)	9 (22.5)	21 (63.6)	5 (15.2)	30 (85.7)	9 (25.7)		
02_10			37 (62.7)	7 (11.9)	28 (68.3)	10 (24.4)	21 (65.6)	5 (15.6)	30 (76.9)	11 (28.2)		
02_11			37 (61.7)	8 (13.3)	29 (70.7)	9 (22.0)	20 (100.0)	0 (0.0)	32 (84.2)	11 (28.9)		
02_12			37 (61.7)	8 (13.3)	61 (77.2)	20 (25.3)	22 (100.0)	0 (0.0)	32 (84.2)	11 (28.9)		
03_01	26 (74.3)	10 (28.6)	49 (80.3)	9 (14.8)	61 (76.3)	20 (25.0)	22 (100.0)	1 (4.5)				
03_02	26 (74.3)	11 (31.4)	50 (78.1)	7 (10.9)	63 (76.8)	21 (25.6)	22 (100.0)	0 (0.0)				
03_03	30 (81.1)	12 (32.4)	50 (78.1)	7 (10.9)	66 (78.6)	22 (26.2)	22 (84.6)	4 (15.4)				
03_04	26 (70.3)	9 (24.3)	56 (86.2)	7 (10.8)	66 (75.0)	19 (21.6)						
03_05	31 (77.5)	10 (25.0)	69 (78.4)	6 (6.8)	67 (75.3)	19 (21.3)						
03_06	32 (74.4)	10 (23.3)	69 (78.4)	6 (6.8)	67 (75.3)	20 (22.5)						
03_07	33 (73.3)	11 (24.4)	69 (78.4)	6 (6.8)	67 (75.3)	21 (23.6)						
03_08	34 (75.6)	11 (24.4)	83 (93.3)	8 (9.0)	88 (95.7)	24 (26.1)						
03_09	35 (79.5)	11 (25.0)	83 (93.3)	6 (6.7)	88 (95.7)	23 (25.0)						
03_10	35 (72.9)	13 (27.1)	84 (91.3)	8 (8.7)	89 (92.7)	26 (27.1)						
03_11	37 (88.1)	12 (28.6)	87 (93.5)	8 (8.6)	88 (92.6)	23 (24.2)						
03_12	38 (80.9)	15 (31.9)	87 (92.6)	8 (8.5)	88 (89.8)	25 (25.5)					13 (92.9)	5 (35.7)
04_01	33 (67.3)	15 (30.6)	42 (42.9)	8 (8.2)	46 (46.9)	25 (25.5)					13 (92.9)	5 (35.7)
04_02	36 (76.6)	14 (29.8)	84 (89.4)	8 (8.5)	88 (89.8)	25 (25.5)					13 (100.0)	5 (38.5)
04_03	38 (88.4)	13 (30.2)	84 (89.4)	8 (8.5)	89 (88.1)	25 (24.8)					13 (100.0)	4 (30.8)
04_04	34 (70.8)	17 (35.4)	87 (87.9)	10 (10.1)	89 (83.2)	27 (25.2)					13 (100.0)	4 (30.8)
04_05	34 (68.0)	16 (32.0)	81 (86.2)	9 (9.6)	89 (80.9)	27 (24.5)					10 (100.0)	3 (30.0)
04_06	34 (61.8)	18 (32.7)	84 (87.5)	9 (9.4)	88 (77.2)	29 (25.4)					9 (100.0)	3 (33.3)

Source: Price sample is retrieved from the airlines' web sites. The airlines' total routes and the competitive routes are from the Civil Aviation Authority dataset. Percentages with respect to the total number of routes are in parentheses.

EA.2 Matching of fares in different currencies for the same flight – Discussed in Section 4.1

To better illustrate how our data can be used to identify the situations in Figures 1 to 3, it is essential to focus on two main features of the data collection strategy, that is, the matching of records and the control for the booking day. We begin by discussing the latter using the hypothetical situation in Table EA2. The first column identifies the date of the query for a round-trip journey: the second leg is normally due seven days after the first leg, with one exception on which we shall focus shortly. The second and the third column describe the dates of departure of each leg for trips originating in UK, when the date of departure is assumed to be respectively, 1, 4, 7, 10, 14, 21, 28, 35, 42, 49, 56, 63, 70 days from the date of the query (booking days are reported in round brackets). In this case, we would obtain the price in GBP. The fourth and fifth column do the same for trips originating in Italy, as we chose the route London Stansted – Rome Ciampino as an example. Fares in this case would be in the Italian currency, the Euro. Finally, note the exception of queries made four days from the take-off of the first leg: there are combined with a second leg due ten (not eleven) days from the time of the query.

As for the matching of records, consider the third row. It reports the dates of departure when the first leg is booked 7 days before. Now consider the first row. The second legs are booked exactly the same number of days from take-off as the first legs in the third row.

The Greek capital and lowercase letters identify all the possible matches for the Stansted-Ciampino and the Ciampino-Stansted leg, respectively. Repeating the same procedure every day yields the possibility to collect up to eleven prices for each daily flight.

Table EA2. Strategy for data collection and matching.

date of booking	***Booking from UK***		***Booking from Italy***	
	First Leg Flight (£)	***Second Leg Flight (£)***	***First Leg Flight (€)***	***Second Leg Flight (€)***
	Stansted-Ciampino	*Ciampino-Stansted*	*Ciampino-Stansted*	*Stansted-Ciampino*
	date of departure (days from take-off)	***date of arrival (days from take-off)***	***date of departure (days from take-off)***	***date of arrival (days from take-off)***
01/04/2003	*02/04/2003 (1)*	*08/04/2003 (7)*$^{\alpha}$	*02/04/2003 (1)*	*08/04/2003 (7)*^{A}
01/04/2003	*05/04/2003 (4)*	*11/04/2003 (10)*$^{\sigma}$	*05/04/2003 (4)*	*11/04/2003 (10)*$^{\Sigma}$
01/04/2003	*08/04/2003 (7)*^{A}	*15/04/2003 (14)*$^{\beta}$	*08/04/2003 (7)* $^{\alpha}$	*15/04/2003 (14)* ^{B}
01/04/2003	*11/04/2003 (10)*$^{\Sigma}$	*18/04/2003 (17)*	*11/04/2003 (10)*$^{\sigma}$	*17/04/2003 (17)*
01/04/2003	*15/04/2003 (14)*^{B}	*22/04/2003 (21)*$^{\chi}$	*15/04/2003 (14)* $^{\beta}$	*22/04/2003 (21)* ^{X}
01/04/2003	*22/04/2003 (21)*^{X}	*29/04/2003 (28)*$^{\delta}$	*22/04/2003 (21)* $^{\chi}$	*29/04/2003 (28)* $^{\Delta}$
01/04/2003	*29/04/2003 (28)*$^{\Delta}$	*06/05/2003 (35)*$^{\varepsilon}$	*29/04/2003 (28)* $^{\delta}$	*06/05/2003 (35)* ^{E}
01/04/2003	*06/05/2003 (35)*^{E}	*13/05/2003 (42)*$^{\phi}$	*06/05/2003 (35)* $^{\varepsilon}$	*13/05/2003 (42)* $^{\Phi}$
01/04/2003	*13/05/2003 (42)*$^{\Phi}$	*20/05/2003 (49)*$^{\gamma}$	*13/05/2003 (42)* $^{\phi}$	*20/05/2003 (49)* $^{\Gamma}$
01/04/2003	*20/05/2003 (49)*$^{\Gamma}$	*27/05/2003 (56)*$^{\eta}$	*20/05/2003 (49)* $^{\gamma}$	*27/05/2003 (56)* ^{H}
01/04/2003	*27/05/2003 (56)*^{H}	*03/06/2003 (63)*$^{\iota}$	*27/05/2003 (56)* $^{\eta}$	*03/06/2003 (63)* ^{I}
01/04/2003	*03/06/2003 (63)*^{I}	*10/06/2003 (70)*$^{\lambda}$	*03/06/2003 (63)* $^{\iota}$	*10/06/2003 (70)* $^{\Lambda}$
01/04/2003	*10/06/2003 (70)*$^{\Lambda}$	*17/06/2003 (77)*	*10/06/2003 (70)* $^{\lambda}$	*17/06/2003 (77)*

EA.3. The effect of the time interval between the retrieval of two matching fares in different currencies. Discussed in Section 4.1

Table EC.3 - Distribution of "Discrimination Type" by the time interval separating the retrieval on-line of P^{EU} and P^{UK}.

Time Interval	0 - Non discriminatory	1 Discriminatory no arbitrage	2 Discriminatory no prof. arbitrage	3 Discriminatory with arbitrage	Total (N)
<=10 min	64.7	18.7	7.4	9.2	556,263
10-20 min	64.6	19.9	5.9	9.6	473,693
20-30 min	67.8	15.8	6.3	10.0	268,894
30-40 min	68.3	17.4	5.8	8.4	190,912
40-50 min	66.1	18.2	6.2	9.6	225,625
50-60 min	68.1	17.0	5.8	9.1	203,037
Total	66.0	18.2	6.4	9.4	1,918,424

Recall from the main text that the fares in British Sterling (P^{UK}) and in the continental European currency (P^{EU}) were retrieved at most 60 minutes from each other. However, The majority of observations were constructed using prices collected within a 20 minutes interval. Regardless, the Table shows that Discriminatory and non-Discriminatory cases are very similarly distributed across time intervals. This suggests that no bias is induced by intervening events separating the retrieval of the two prices.

Table EA.4 – Type of Discrimination by Season and time of booking. Discussed in Section 7

		Variable "Discrimination Type" – Row %				
Type	Variable	0 – Uniform	1 Discriminatory no arbitrage	2 Discriminatory no profitable. arbitrage	3 Discriminatory with arbitrage	N
	Summer	63.5%	19.8%	7.1%	9.6%	1419069
	Winter	73.1%	13.7%	4.6%	8.6%	499355
Booking Days	7	59.9%	22.1%	8.0%	10.0%	173358
	10	62.8%	20.2%	6.4%	10.6%	206143
	14	64.5%	18.8%	6.3%	10.4%	229889
	21	66.5%	18.2%	6.5%	8.7%	165725
	28	64.4%	18.9%	7.2%	9.4%	165957
	35	65.5%	18.6%	7.2%	8.7%	160698
	42	66.8%	17.7%	6.2%	9.4%	161806
	49	67.9%	17.3%	6.2%	8.6%	154176
	56	68.6%	16.4%	5.9%	9.1%	154252
	63	70.3%	15.6%	5.1%	9.0%	196572
	70	70.4%	15.6%	5.8%	8.2%	149848
Class P^{UK}	0-9.99	81.2%	9.1%	2.8%	6.8%	204601
	10-19.99	71.7%	13.7%	5.3%	9.2%	328400
	20-39.99	70.2%	14.9%	3.2%	11.8%	562978
	40-69.99	68.3%	18.1%	6.3%	7.2%	540862
	>=70	35.5%	36.9%	16.9%	10.6%	281583
Time Departure	<=8.20	63.2%	15.9%	5.4%	15.4%	59911
	8.21-10.45	65.0%	15.4%	8.8%	10.9%	275,154
	10.46-12.40	65.9%	20.5%	5.5%	8.1%	235,827
	12.41-14.40	61.7%	21.9%	6.0%	10.4%	224,322
	14.41-16.40	65.0%	19.5%	6.3%	9.3%	219,152
	16.41-18.40	64.6%	17.3%	6.6%	11.5%	270,739
	18.41-20.40	67.6%	18.5%	5.6%	8.3%	165,339
	>20.40	68.0%	20.5%	4.3%	7.2%	220,634
Week Day	Sunday	61.0%	21.7%	6.9%	10.4%	277749
	Monday	65.6%	18.5%	5.9%	10.0%	277888
	Tuesday	72.7%	14.7%	4.7%	7.9%	261994
	Wednesday	73.4%	14.2%	4.8%	7.6%	261237
	Thursday	68.6%	16.5%	6.0%	8.9%	260433
	Friday	61.6%	20.0%	8.0%	10.4%	291494
	Saturday	60.6%	21.0%	8.4%	10.0%	287629

Source: Airlines' web sites. Price class expressed in GBP. Summer: April to October; Winter: November to March.