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The impact of hub hierarchy, alliances and concentration on airfare pricing in European hub-to-hub markets

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Over the past years, full-service carriers in Europe have deployed multi-hub-and-spoke systems by joining alliances to exploit network economies. The concentration of flights on a small group of airports leads to the emergence of 'fortress hubs' and subsequently creates hub-to-hub markets in Europe reminiscent of the US aviation market. This paper explores the factors influencing the pricing behaviour of full-service carriers in European hub-to-hub markets. Drawing on a 2009 dataset containing route and airfare information, we establish an econometric model to estimate the impact of route structure, alliances, and market concentration on the pricing of European full-service carriers in these markets. Three types of hubs (i.e., primary, secondary and tertiary hubs) are hereby identified to investigate the route structure within the hub-to-hub network. The stepwise regression results suggest that alliances on routes connecting two primary hubs, market share inequality and competition from low-cost carriers influence average airfares of full-service carriers in the European hub-to-hub markets.

Keywords: Airfare pricing, Alliances, European hub-to-hub network, Full-service carriers, Hub hierarchy

1 Introduction

Air transport deregulation in Europe has led to dramatic changes in the network configuration and business models of erstwhile national carriers. First, they have implemented or intensified the adoption of a hub-and-spoke network by concentrating traffic and flights around their hubs to accomplish network economies (Burghouwt and de Wit, 2005; Button, 2002; Caves et al., 1984; Janic and Reggiani, 2002). Second, sophisticated revenue management techniques have replaced the traditional regulated pricing mechanisms. Offering more differentiated products - such as in-flight entertainment, VIP waiting lounges, and other 'frills' - has gradually transformed national carriers into so-called 'full-service carriers' (FSCs) (Tretheway, 2011). Third, the industry has been consolidated via cross-border mergers to remedy inefficient excess capacity (Brueckner and Pels, 2005), and through joining global alliances to strengthen their global presence (Benacchio, 2008; Doganis, 1994). In addition, the emergence of low-cost carriers (LCCs) has been a competitive challenge for FSCs due to the former carriers' well-known cost advantages (Alderighi et al., 2012). These changes force FSCs in Europe to constantly (re)examine their pricing strategies in order to achieve profitability in what have become (relatively more) liberalized markets.

The literature examining the pricing strategies of FSCs in Europe is not as extensive as the one focused on the aviation market in the United States. Some of the exceptions include research on 1) flights from Nice Airport (France) to 9 European countries (Giaume and Guillou, 2004), 2) domestic routes and airport-pairs between the United Kingdom and 14 European countries (Piga and Bachis, 2007), and 3) city-pairs between Italy and the main destinations in the UK, Germany and the Netherlands (Alderighi et al., 2012). As a consequence, there has been to the best of our knowledge no research exclusively focused on how carriers determine airfares in the emerging European hub-to-hub (HH) markets, where both origin and destination are to some degree dominated by an FSC.

An analysis of pricing in European HH markets is relevant for three reasons. First, hubs are typically located in Metropolitan Regions characterized by large populations, major levels of economic development, and an economic structure that is conducive to business travel (Dijkstra, 2009). Carriers operating HH routes can therefore not only expect to realize economies of density, but also capture more high-yield business travellers (Neal, 2011). Second, hubs assume different service levels in individual FSCs' networks; i.e. the so-called 'hub hierarchy' that is also emerging in the US (Burghouwt and de Wit, 2005; Burghouwt and Hakfoort, 2001; Dennis, 2005; Frenken et al., 2004; Malighetti et al., 2009; Thompson, 2002). Burghouwt (2005), for instance, clusters airports into 1st tier, 2nd tier and 3rd tier hubs based on the number of weighted indirect connections in a carrier's network, while Malighetti et al. (2009) distinguishes between 'worldwide hubs', 'hubs' and 'secondary gates' based on traffic volume, destination of connections, connectivity and topology of service. The ensuing 'hub hierarchy' implies that the routes connecting different levels of hubs may vary in

their pricing: routes involving more dominant hubs can in principle be related with higher airfares because of ‘hub premiums’ (Vowles, 2006). Third, strategic alliances have complicated the route structure of HH networks. European FSCs have over time joined one of the three global alliances, thus leading to the development of explicit and implicit multi-hub-and-spoke networks: carriers extend their reach by interlinking each other’s networks (often via their hubs), so that the scope of their network grows without having to internally extend their own networks. Alliance carriers can, as a consequence, increase frequencies on their nonstop HH routes to facilitate customers, especially time-sensitive business travellers. Doganis (2006), for instance, found that the Lufthansa-SAS alliance increased daily departures between Frankfurt and Copenhagen for both carriers. As a consequence, carriers that do not ally on HH routes may lose competitive advantages comparing to allied carriers, so that the resulting market concentration can be expected to play an important role in explaining price discrimination (Borenstein, 1989; Piga and Bachis, 2007).
The emerging ‘hub hierarchy’, the growing importance of alliances and their combined impact (i.e., a route connected by two hubs with different levels of hubness may also be an allied route) gives rise to an inherently complex European HH network. This raises questions on the major factors influencing the pricing strategies of FSCs serving the hub markets. The objective of this paper, therefore, is to investigate to what extent the emerging hub hierarchy, strategic alliances and the ensuing landscapes of market concentration influence the price-setting of FSCs in the European HH markets. The remainder of this paper is organized as follows. Section 2 reviews previous studies on how alliances and market structure determine airfares and yield in the US and European airline industry. Section 3 defines the European HH network, and introduces our data and method. Section 4 presents an analysis of the complex market structure of the European HH markets, and examines how route structure, alliances and market concentration influence the pricing strategies of FSCs. In section 5, we summarize the main implications of our analysis and outline some avenues for further research.

2 Literature Review

2.1 Hub dominance and airfares in HH markets

Hub-and-spoke networks are associated with dominance of a hub airport by one or, occasionally, two carriers (Borenstein, 1992). If a carrier provides a large number of competitive indirect connections (Burghouwt and de Wit, 2005) or connects large volumes of transfer passengers (Lee and Luengo-Prado, 2005), then this carrier is said to ‘dominate’ its hub airport. The debate about the relationship between hub dominance and airfares rests on the question whether carriers can wield of market power by charging higher airfares on routes from/to their hubs than on other routes. There is no consensus as to whether a carrier’s pricing power at its hub airport can be conveyed to all routes involving the dominant airport, so that this relationship is discussed at both the airport and the route level to obtain unbiased estimations.

In US airline markets, researchers had found that the market power exercised by carriers has not been undermined since deregulation. Borenstein (1989) found that a carrier dominating at both the airport and the route level has the ability to charge higher fares, whereby the sources of this market power originate from 1) the dominant carriers' ability to deter the entry of potential competitors by controlling airport facilities, as well as 2) the marketing devices such as frequent flyer programs (FFP). However, Evans and Kessides (1993) found that dominance at the airport level, but not the route level, can confer substantial market power upon the carrier when unexplained inter-route heterogeneity is considered. Aircraft can be switched relatively easily and costlessly between different routes making these routes naturally contestable, whereas airport facilities, product differentiation barriers arising from FFPs and other impediments make these harder to contest. More recently, researchers have offered new evidence for US markets and found that a carrier dominating at the route level can also charge higher fares (Fischer and Kamerschen, 2003; Stavins, 2001).

Marín (1995) was the first to address the issue in the European context and found that, in contrast to the US situation, European carriers tended to compete in terms of prices by exploiting cost advantages after liberalization. Captain and Sickles (1997) further found that the reasons why some 'flag carriers' cannot exploit such cost advantages is due to technically inefficient use of inputs and high labour wages rather than wielding market power between 1976 and 1990. However, it is clear that these studies deal with the earlier stages of European aviation deregulation. As the European aviation sector has gone through dramatic changes in the last decades, the impact of market dominance on airfares has also been altered by factors such as the proliferation of low-cost carriers (LCCs). Piga and Bachis (2007) concluded that the impact of market dominance on fares in European airline market depends on the type of carriers (i.e. FSCs versus LCCs). FSCs' dominance at an airport plays a crucial role only for the fares associated with a particular set of booking days, i.e., the late booking ones, whereas LCCs dominating at an airport can always charge higher fares due to their ability to operate at lower costs. Dominance at the route level enables FSCs to exercise market power, but limits LCCs' ability to charge higher fares only for late booking fares. They also argue that the limited size of many 'natural monopoly' routes contribute to the route dominance enjoyed by European carriers.

2.2 Alliances and airfares in HH markets

An alliance can increase the market share and market power of alliance carriers at their hubs, and reduce or eliminate competition on specific routes. However, when alliances or mergers significantly reduce competition in the relevant markets, the European Commission has imposed conditions such as giving up airport slots or route licenses to encourage the entry of new carriers (Doganis, 2006).The vast majority of dense intra-European routes are short-haul routes with less than two-and-a-half hours of flying time, implying that alternatives via transfer routes are not very attractive.

Joining in an alliance can therefore very effectively reduce competition on those routes by turning the previous duopoly into a monopoly (Doganis, 2006). However, the degree to which alliance partners (ab)use their strengthened dominance to charge higher fares on their hub-to-hub routes remains unclear. Oum et al. (2000) study 22 international airlines for the 1986-95 period and find that partner airlines lowered prices by 1.3% after entering an alliance, and ascribe this result to the reduced cost because of efficiency or productivity gains. They particularly find that an airline with a longer average route length charged lower prices than that with a short average route length due to the competitive advantage of longer routes (e.g., reduced fuel consumption). At the same time, researchers have found that fares in markets served by an alliance were higher than those in non-alliance markets because of reduced competition, as in the SAS-Swissair alliance (Youssef and Hansen, 1994) and the Air France-KLM merger (Brueckner and Pels, 2005). Meanwhile, Wan et al. (2009) investigate the impact of airline alliances on airfares on transatlantic HH routes, and come to the conclusion that the net effect on airfares is uncertain as it depends on the ability of an alliance to coordinate fares.

2.3 Market concentration and airfares in HH markets

A carrier's pricing strategy is driven not only by the internal carrier-specific considerations but also by the structure of external markets. As a market (i.e., individual airport-pair market) is comprised of carriers, passengers, and air travel products, the external market structure in which the carriers are operating depends upon four aspects: 1) the number of carriers and passengers, 2) ease of market entry, adaptation, and exit, 3) the extent of product differentiation or distinctiveness, and 4) the availability and cost of information (Holloway, 2008).

The structure of the European airline markets can in practice be mainly categorized through three types, based on the number of carriers: monopoly (i.e., one carrier), duopoly (i.e., two carriers) and oligopoly (i.e., more than two carriers) (Alderighi et al., 2012). However, the number of carriers per se on a route is not the best measure of market structure and the competitive behaviour of carriers as it does not evaluate concentration (i.e., the market share distribution of carriers) (Giaume and Guillou, 2004; Shepherd, 1999). The concept of concentration has been extensively applied to represent market structure in research focused on the relationship between market structure and pricing. Aiming to reflect the entire market share distribution of carriers in a single indicator, researchers frequently use the Herfindahl-Hirschman Index (HHI) to quantify market concentration (Hannan, 1997).

The impact of route HHI on prices can be mixed and depends on the geographical areas. In the US airline markets, researchers have found that increases in route HHI raise prices to some degree as a few carriers in a concentrated market may collude more easily to charge higher prices (Borenstein, 1989; Chi and Koo, 2009; Evans and Kessides, 1993). However, a negative relationship between route HHI and prices also occurs when the dominant carrier enjoys technological advantages over its rivals and forces the other carriers to reduce prices to compete (Fischer and Kamerschen, 2003).

In the European airline markets, Piga and Bachis (2007) found that prices were raised by FSCs and LCCs as route HHI increased, but only for the prices associated with late booking days. Giaume and Guillou (2004) observed a negative relationship between route HHI and prices in the European markets and attributed it to the high inequality of market share leading to strong price competition between carriers.
These findings suggest that the impact of changing market structure on fares for European markets will probably not be a copy of the US case, which calls for a systematic appraisal of its role in European aviation markets.

3 Framework

3.1 The European HH network

A first step is to identify different types of carriers (i.e., FSCs, LCCs and regional carriers) in Europe. Researchers have long defined all the former 'flag carriers'[1] as the FSCs in Europe (Alderighi et al., 2012; Burghouwt et al., 2003). However, on-going deregulation has broadened the differences amongst these erstwhile flag carriers, as can be seen in the case of Aer Lingus's transformation into a LCC (Barrett, 2006; O' Connell and Williams, 2005; Wallace et al., 2006). FSCs are, therefore, defined as the former flag carriers in the EU that have joined one of the three global alliances (i.e., Star, Oneworld and SkyTeam). Meanwhile, this paper adopts Dobruszkes' (2009) definition of LCCs as carriers for which prices on investigated routes are 0.10 Euro per km at most, or half the price of FSCs. We also incorporate regional carriers (REC) into our framework in order to examine the overall market structure. A REC is defined as a carrier which operates smaller aircraft (e.g., 20-100 seats) and restrict its network to a geographically limited area (German Aerospace Center, 2008). The overview of carriers is represented in table 1.

Table 1: Overview of carriers and alliance for FSCs

Carrier Type	**Carrier Name**
FSCs	Air France (SkyTeam), Alitalia (SkyTeam), Austrian (Star), British Airways (OneWorld), Brussels (Star), Finnair (OneWorld), Iberia (OneWorld), KLM (SkyTeam), Lufthansa (Star), SAS Scandinavian (Star), TAP Air Portugal (Star)
LCCs	Aer Lingus, Air Europa Lineas Aereas, EasyJet, Germanwings, Niki, Norwegian Air Shuttle, Spanair, Transavia.com, Vueling, Ryanair, Wind Jet
RECs	Adria Airways, Aigle Azur, Air Comet, Air Dolomiti, Air Berlin, Blue1, BMI british midland, Brit Air, Cimber Sterling, Eurowings, Lufthansa Cityline, Regional, SAS Norge, Tyrolean Airways

Note: Alliance membership for FSCs is shown between parentheses.

[1] A national airline is one that is substantially owned and effectively controlled by nationals of that state in the EU (Doganis, 2001; Barrett, 2006)

The second step is to identify hubs in the networks of European FSCs. As the main purpose of a FSC's hub is to concentrate flights through synchronized waves and reroute passengers, our working definition of hubs in the European airline market focuses on the number of competitive indirect connections as presented by Burghouwt and de Wit (2005). We define hubs as airports with more than 200 indirect connections per day and served by the FSCs identified in table 1. A classification scheme based on the number of indirect connections is applied to distinguish between 'primary hubs' (>2500), 'secondary hubs' (501-2500) and 'tertiary hubs' (200-500). Table 2 presents an overview of the European FSCs' hubs. This provides the scope of our study as the HH market is taken to consist of all connections where both origin and destination are hubs (see Figure 1). As a result of the presence of 'hub hierarchy', European HH network consists of six different types of routes, i.e., primary-primary (PP), primary-secondary (PS), primary-tertiary (PT), secondary-secondary (SS), secondary-tertiary (ST) and tertiary-tertiary (TT)[2] routes.

Table 2: Categorization of hubs for European FSCs

Hub Airport	**Carrier**	**Number of weighted indirect connections per day (2003)**
Primary (8)		
Charles de Gaulle (CDG)	Air France	14005
Frankfurt (FRA)	Lufthansa	13616
London Heathrow (LHR)	British Airways	9439
Amsterdam (AMS)	KLM	8713
Madrid (MAD)	Iberia	6941
Munich (MUC)	Lufthansa	4184
Copenhagen (CPH)	SAS Scandinavian	2576
Vienna (VIE)	Austrian	2553
Secondary (8)		
Rome Fiumicino (FCO)	Alitalia	2384
Barcelona (BCN)	Iberia	2128
Milan Malpensa (MXP)	Alitalia	1946
Oslo (OSL)	SAS Scandinavian	1139
London Gatwick (LGW)	British Airways	979
Helsinki (HEL)	Finnair	957
Lisbon (LIS)	TAP Air Portugal	792
Paris Orly (ORY)	Air France	709
Tertiary (2)		
Brussels (BRU)	Brussels	452
Dusseldorf (DUS)	Lufthansa	214

Source: Burghouwt (2005)

[2] Brussels-Dusseldorf is the only route termed as tertiary-tertiary route in this paper. However, it is excluded in our research as high-speed railway is more convenient and competitive than air transport on this short-haul route.

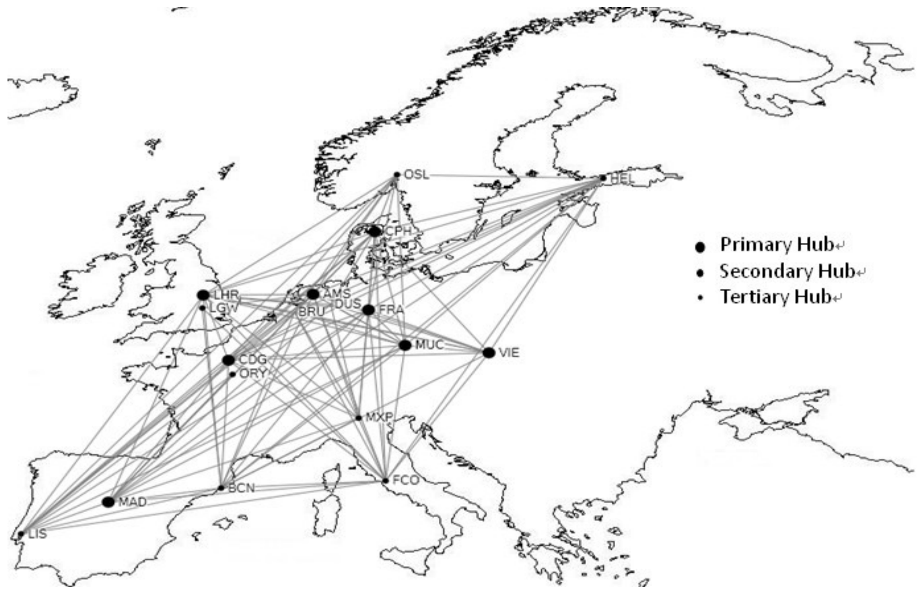

Figure 1 Non-stop connections between hubs of the European FSCs

3.2 Data collection

The main dataset used in this paper is collected through a research cooperation with Sabre Airline Solutions, and contains information drawn from Airport Data Intelligence (ADI) on actual bookings for different carriers. The Sabre ADI has at least one major advantage when analysing pricing and scheduling in the airline industry: it seeks to establish a complete dataset by adjusting and calibrating data from 1) global distribution systems (GDS), 2) travel agencies, 3) direct bookings, low-cost carriers, charter operations and 4) other non-IATA distribution channels. Sabre's ADI database provides the required data for the proposed pricing analysis, including information at the route and carrier level of passenger numbers, revenue, cabin class and distance. It also indicates the intermediate stops when connecting services are available. The unit of observation is the non-stop connections between the 18 hubs in the overall network 'produced' by the 11 European FSCs given in Figure 1. An observed route is selected only if its monthly traffic volume is at least 100 passengers, and a carrier is considered to serve the route only if its market share is at least 1%. In addition, the population of the hub cities is obtained from www.World-Gazetteer.com. The data used in this paper is for May 2009.

3.3 Methods

We establish an econometric model to examine the impact of route structure, alliances and market concentration on airfares in the European HH markets, all the while controlling for other variables such as population, regional effects, the traffic mix at the demand side, and distance at the cost side. This will be achieved by applying a stepwise regression method, which establishes the most effective set of independent variables according to their statistical contribution in explaining the variance of the dependent variable. At each step a new variable with the largest t value is added, after which the significance of all the variables in the model is (re)tested. Variables with significance level above 0.10 are subsequently removed, after which the model is refitted. The procedure terminates when there is no more scope to add or remove variables.

We draw on the decomposed Hirschmann-Herfindahl Index (HHI) to measure market concentration by accounting for unequal market shares among carriers. The decomposed HHI index is measured as:

$$\text{Decomposed HHI} = \text{H1} + \text{H2} = \text{CV}^2/\text{N} + 1/\text{N} \qquad (1)$$

Where: CV is the coefficient of variation of market shares and N is the number of carriers on a route. The first part of this equation (H1) is of particular importance as it represents the market share inequality of carriers on a route, while the second part (H2) describes the value of HHI when all the carriers have equal market share (Laderman, 1995).

Market concentration depends on the actual structure of individual hub airport-pair markets. Given the complex nature of market structure in the EU (partly because of the shorter distances between hubs and the alliance formation), we first perform a descriptive analysis of market structure before proceeding to the econometric analysis.

4 Results and Discussion

4.1 Exploratory analysis of market structure in the European HH markets

Market structure by route type

As competition has not been homogeneous at the route level in Europe (Giaume and Guillou, 2004), it is necessary to analyze the market structure for each HH route separately. Table 3 shows that European HH markets exhibit three types of market structure in terms of the number and type of carriers: monopoly (10% of routes), duopoly (58% of routes) and oligopoly (32% of routes)[3]. Previous research done by Alderighi et al. (2012) has shown that the entry of LCCs has increased the competition of the European aviation market. They particularly distinguish between symmetric duopoly (two FSCs) and asymmetric duopoly (one FSC and one LCC), and also between oligopolistic routes with or without the presence of LCCs. Drawing on their categorization method, we find that 8 duopolistic routes and 26 oligopolistic routes have been entered by LCCs. These fundamental statistics indicate that European HH markets are 1) served by few carriers and characterized by high

[3] For instance, Barcelona-Frankfurt is a monopolistic route as Lufthansa is the only carrier serving this route at the time of data collection. Amsterdam-Charles de Gaulle is a duopolistic routes served by two carriers – Air France and KLM. The oligopoly markets have three or more carriers in services. Note that from an alliance perspective the CDG-AMS link will be monopolistic.

concentration, and 2) penetrated by LCCs.

Table 3: An overview of market structure by route structure

	Monopolistic routes	Duopolistic routes				Oligopolistic routes			Total
		Two FSCs	FSC&LCC	FSC&REC	Total	WithLCC	WithoutLCC	Total	
PP	2	11	0	5	16	6	2	8	26
PS	5	10	6	8	24	14	1	15	44
PT	0	3	0	7	10	0	1	1	11
SS	3	0	2	2	4	4	1	5	12
ST	0	2	0	3	5	2	1	3	8
Total	10	26	8	25	59	26	6	32	101

The presence of LCCs and RECs indicates the possible inequality of market shares among carriers. We thus use the decomposed HHI to measure the market concentration when both asymmetries of market shares and the number of competitors on a route should be accounted for.

The impact of alliances on airfares

Alliances allow FSCs to form multi-hub-and-spoke networks and cooperate with carriers in the same alliance. 34 out of 101 routes in our study are connected by the same alliance's hubs in our study (table 4). We categorize five types of routes by considering both the degree of hubness and alliances: PP*Alliance (e.g., FRA-CPH), PS*Alliance (e.g., FRA-OLS), PT*Alliance (e.g., FRA-BRU), SS*Alliance (e.g., OLS-LIS) and ST*Alliance (e.g., OLS-BRU). For instance, as Lufthansa, SAS Scandinavian, Brussels and TAP Air Portugal all belong to the Star alliance, FRA-CPH is thus a PP*Alliance route whereby FRA and CPH are the primary hubs of Lufthansa and SAS Scandinavian, respectively. The same approach was applied to the other route types. Based on the disaggregated market share of the carriers in the same alliance, five allied routes are monopolistic and 21 are duopolistic. When the market shares of the alliance carriers are aggregated, about 90% of alliance routes are monopolistic and duopolistic. This is particularly noticeable on PP, PS and ST alliance routes, suggesting that airfares may vary by route structure.

Table 4: The effects of alliances on market structure by route type

	Monopolistic routes	Duopolistic routes	Oligopolistic routes	Total
Before alliance				
PP*Alliance	2	4	2	8
PS*Alliance	2	8	4	14
PT*Alliance	0	5	1	6
SS*Alliance	1	2	1	4
ST*Alliance	0	2	0	2
Total	5	21	8	34

After alliance				
PP*Alliance	6	2	0	8
PS*Alliance	7	5	2	14
PT*Alliance	2	4	0	6
SS*Alliance	1	2	1	4
ST*Alliance	2	0	0	2
Total	18	13	3	34

We also carried out an exploratory analysis to examine whether allied carriers exercise pricing power when their joint market share increases. Table 5 shows that the alliance carriers charge significant higher fares only on PP routes, but not on the other types of routes. There are two possible reasons. First, the raised market concentration on the other types of routes is offset by the economies of density, resulting in statistically insignificant impact on airfares. Second, allied carriers coordinate their pricing decisions on the main PP routes, implying that they primarily wield market power on PP routes.

Table 5: The t-test results for average fares by route type

Average fares	N	Mean $	Std.dev.	Std.err.	t-value
PP route					
Same-alliance route	8	188.75	25.16	8.89	3.161
Other routes	93	156.25	49.73	5.16	(0.008)
Difference		32.49		10.28	
PS route					
Same-alliance route	14	176.93	67.29	17.98	1.13
Other routes	87	155.91	45.18	4.84	(0.139)
Difference		21.01		18.62	
PT route					
Same-alliance route	6	156.18	28.23	11.52	-0.22
Other routes	95	158.99	50.07	5.14	(0.415)
Difference		-2.81		12.62	
SS route					
Same-alliance route	4	127.47	57.67	28.84	-1.12
Other routes	97	160.12	48.48	4.92	(0.171)
Difference		-32.65		29.25	
ST route					
Same-alliance route	2	149.25	6.00	4.24	-1.50
Other routes	99	159.02	49.43	4.97	(0.095)
Difference		-9.77		6.53	

Note: H_0: mean (diff) = 0; H_a: mean (diff) > 0; the significance level is shown between parentheses.

The results in table 5 suggest that market concentration influences airfares, but previous research has shown that without taking mediating demand and cost variables into account such simple comparative approach can be misleading (Borenstein, 1989;

Lee and Luengo-Prado, 2005). In the next subsection, we therefore establish an econometric model to assess the influence of hub hierarchies, alliances and concentration on airfares by controlling for these potentially intervening variables.

4.2 The econometric model

We establish an econometric model that explains the variability of earnings on non-stop HH routes in the intra-European air passenger markets. Earnings are measured through average one-way fares, which serve as the dependent variable in our model. The independent variables in the model combine demand, cost, route structure, and market structure variables. Continuous variables (i.e., population, business/economy traffic mix, distance and average fare) are transformed into their natural logarithms to reduce the impact of outlying observations and facilitate the interpretation of the coefficients as elasticities. The empirical pricing model for the HH network is specified as follows:

$$\begin{aligned}\mathrm{Ln(AVGFARE)} = {} & \beta_0 + \beta_1 \mathrm{Ln(Population)} + \beta_2 \mathrm{Regional\ Effects} + \beta_3 \mathrm{Ln(Business)} \\ & + \beta_4 \mathrm{Ln(Distance)} + \beta_5 (\mathrm{PP} * \mathrm{AllianceRoutes}) \\ & + \beta_6 (\mathrm{PS} * \mathrm{AllianceRoutes}) + \beta_7 (\mathrm{PT} * \mathrm{AllianceRoutes}) \\ & + \beta_8 (\mathrm{SS} * \mathrm{AllianceRoutes}) + \beta_9 (\mathrm{ST} * \mathrm{AllianceRoutes}) \\ & + \beta_{10} \mathrm{OneStop} + \beta_{11} \mathrm{H1} + \beta_{12} \mathrm{H2} + \beta_{13}\ \mathrm{LCCs}\end{aligned} \tag{2}$$

Where: β_0 is the intercept and β_i are the estimated coefficients for the independent variables. AVGFARE is the average one-way fare charged by European FSCs on a route.

Demand Variables

Population is the average population of cities where the hub airports locate, indicating the potential market size of a given route. The impact of population on airfares can be mixed. On the one hand, larger population imply that more people will buy air tickets to travel, thereby increasing prices. On the other hand, higher population enables carriers to reduce prices by using larger and more cost efficient aircraft (Wan et al., 2009). The estimated influence of population cannot be predetermined.

The regional effects variable is designed to control the unobserved regional effects in nature, for instance, warm weather (Morrison, 2001) or the coastal mass tourism belt in Southern Europe (Bramwell, 2004). Specifically, Wan et al. (2009) defined airports locating in “European countries on the Mediterranean Sea coast and Portugal” as vacation destinations. We, therefore, control routes whereby either of the two endpoints is located in Barcelona or Lisbon to account for regional effects. A negative relationship between regional effects and airfares is expected.

BUSINESS (i.e. a traffic mix continuous variable) is measured as the proportion of passengers travelling for business on a HH route. We aggregated four types of tickets (i.e., first, business, discount business, and premium coach) together as 'business' passengers because carriers have largely blurred the distinction among these categories of premium tickets (Lee and Luengo-Prado, 2005). Morrison (2001) applied this variable to reflect the adoption of yield management techniques by airlines (i.e., charging business travelers higher fares than leisure travelers) and found that fares are 28 % higher on routes with 75% business travelers than comparable routes with 25% business travelers. The US Department of Transportation (2001) also concluded that high fares in hub markets can be explained by passenger mix when routes are lack of price competition. HH markets have a large proportion of demand coming from business travellers with a relatively high 'willingness-to-pay', making the demand curves for these markets steeper than is the case in respect of more price-elastic markets (Holloway, 2008). In other words, the price increase in HH markets may theoretically lead to a relatively small demand decline. The expected sign for business traffic indicator is thus positive.

Cost Variable

Distance is the non-stop distance (measured in miles) between two hubs. As distance increases, average fares can be expected to rise since carriers' operating costs with regard to fuel, in-flight service and wages will increase (Borenstein, 1989; Windle and Dresner, 1995; Vowles, 2006). The expected sign for DISTANCE is positive.

Route Structure Variables

In order to study the interactive effect of alliances and route structure on airfares, we establish five variables based on the exploratory analysis above.

The $\mathrm{PP} * \mathrm{Alliance\ Routes}$ dummy variable represents routes connected by two primary hubs served by carriers within the same alliance. As carriers operating on this type of routes may exercise certain pricing power[4], the expected sign of this variable is positive. PS *Alliance Routes, PT *Alliance Routes, SS *Alliance Routes and ST *Alliances Routes are four dummy variables detecting the effects of alliance carriers serving PS, PT, SS and ST routes, respectively. As the pricing power may be offset by the increased traffic and economies of density on those types of routes, the expected signs cannot be predetermined.

The one-stop dummy variable represents routes whereby one-stop flights are also available. We consider a HH route with more than 1000 one-stop passengers on both directions in May, 2009 as a competitive one-stop alternative. The influence of providing indirect service on airfares can be complicated. On the one hand, it may reflect carriers' entry strategy into high-yield routes whereby both endpoints are dominated by incumbent carriers and have a positive relationship with airfares. This requires the entry carriers to develop strong and competitive hubs capable of diverting passengers. On the other hand, a central hub enables its dominant carriers to provide

[4] We use dummy variables instead of market share of the leading carrier to define route dominance as it explicitly examines the relationship between route structure resulting from hub hierarchies and pricing.

competitive indirect flights on long-haul HH routes with strong directionality (i.e., North-South or South-East), and thus reduce the prices. In addition, the narrower European market and reduced use of hub-and-spoke networks may make 'hubbing' insignificant on airfares (Giaume and Guillou, 2004). The expected sign of this variable is uncertain.

Market Structure Variables

H1 and H2 are the two components of the decomposed HHI index. As more than half of the European HH markets are routes where a large FSC competes with a small LCC or REC (table 3), the market share distribution of those carriers is highly unequal. The smaller carrier is likely to reduce the price to maintain its presence, leading to a strong price competition between carriers (Giaume and Guillou, 2004). The expected sign of H1 is, therefore, expected to be negative. In a market characterized by perfect competition, higher market concentration due to a smaller number of carriers may increase the airfares on a route. Given that European HH markets appear to be imperfectly competitive, H2 may have insignificant impact on airfares.

The LCC dummy variable examines the impact of the presence of LCCs. LCCs are taken to be present in a market when they collectively have a market share larger than 1% of passengers in a market (Ito and Lee, 2003; Lee and Luengo-Prado, 2005; Windle and Dresner, 1995). The expected sign of this variable is negative.

4.3 Discussion of results

Stepwise regression is applied to find the subset of independent variables that best predict the airfare variation in the overall European HH markets. Table 6 presents the summary statistics for the variables.

Table 6 Descriptive statistics of variables

	Minimum	Maximum	Mean	Std. Deviation
Average Fares ($)	53.700	371.950	158.827	48.959
Population (thousands)	581	5601	1985	1343
Regional Effects	0.000	1.000	0.240	0.428
Percentage Business (%)	1.700	59.130	19.564	14.742
Distance (miles)	186	1834	683.525	341.938
PP*Alliance	0.000	1.000	0.080	0.271
PS*Alliance	0.000	1.000	0.140	0.347
PT*Alliance	0.000	1.000	0.060	0.238
SS*Alliance	0.000	1.000	0.040	0.196
ST*Alliance	0.000	1.000	0.020	0.140
Onestop	0.000	1.000	0.120	0.325
Market Share Inequality (H1)	0.000	0.665	0.082	0.108
Equal Market Share (H2)	0.167	1.000	0.469	0.202

LCCs	0.000	1.000	0.330	0.471
# obs	101			

Table 7 summarize the regression results, whereby 8 out of 13 independent variables are found to be statistically significant, collectively explaining 51.1% of the price-setting of FSCs in the European HH markets.

Table 7 Coefficients for the stepwise regression model

	Unstandardized Coefficients B	**Standardized Coefficients Beta[5]**
(Constant)	5.031*** (0.725)	
LnPopulation	-0.103*** (0.039)	-0.202
RegionalEffects	-0.246*** (0.060)	-0.344
LnBusiness	0.070* (0.038)	0.180
LnDistance	0.217*** (0.059)	0.368
PP *Alliance	0.232*** (0.086)	0.206
Onestop	0.172** (0.074)	0.183
H1	-0.626*** (0.220)	-0.220
LCCs	-0.107** (0.052)	-0.164
R Square	0.511	

Note: Standard errors are reported between parentheses.
*, **, *** Significance at the 10%, 5% and 1% level, respectively.

Demand Variables

The negative coefficient of population indicates that carriers operating on the European HH routes can fulfil economies of scale by using larger and more cost efficient aircraft. As the number of average population increases 1% in the European HH markets, the prices are predicted to fall by 0.1%[6]. Routes centred on what are identified as predominant 'vacation destinations' are negatively related to airfares and are about 27.9% lower than the other routes. We also find that the 'traffic mix' is indeed a factor in the price setting of European FSCs in their HH markets. The estimates show that an increase of 10% in the proportion of business passengers leads to an increase of about 0.7% in fares charged by European FSCs. The relative small coefficient reflects the reality that the travel behaviours of business passengers is changing and more sensitive to fare (Gillen and Morrison, 2005). In the European airline markets, researchers have found that business travellers working for small companies are more willing to trade in-flight service, frequency and FFP points for lower fares than those working for larger companies (Mason, 2001), suggesting a shift of pricing strategies for FSCs.

[5] Standardized coefficients are applied to estimate which of the independent variables has a greater effect on the dependent variable when the variables are measured in different units of measurement.

[6] When both independent and dependent variables are natural logarithmic transformed, back-transformation is compulsory to accurately interpret the results. The equation is $\left((1+1\%)^{\beta}-1\right)*100\%$. For all the dummy variables, the equation applied to interpret the results is $\left(e^{\beta}-1\right)*100\%$.

Cost Variable

Distance is positively related to the airfares as shorter routes are cheaper to run (in absolute terms) than longer ones. An increase of 1% in the route's length leads to an increase of about 0.22% in fares. The elasticity of less than one shows, however, that the airline's cost of carrying a passenger does decrease in relative terms with the distance of his/her trip.

Route Structure Variables

Prices are found to be about 26.1% higher on primary-primary routes operated by carriers within the same alliance than the other routes, indicating that alliance carriers wield some pricing power due to reduced market competition. The insignificant influence of the other types of alliance routes on airfares can be explained by the less intense use of hub-and-spoke network in intra-European airline markets compared to the US, corroborating the findings of Giaume and Guillou (2004). For instance, Paris Orly (ORY) and Brussels (BRU) are de facto specialized hinterlands for African markets rather than intra-European hubs (Burghouwt and de Wit, 2005). On the other hand, smaller airports have become more important in carrying intra-European traffic. Piga and Bachis (2007) found that lower fares are charged by LCCs on the routes from their hubs such as Stansted for Ryanair due to cost advantages.
In addition, the one-stop variable has a positive relationship with airfares, indicating that carriers choose high-yield routes to enter by providing one-stop flights. Overall, prices on HH routes with the coexistence of nonstop and one-stop services are 18.8% higher than for the other routes. Lufthansa at Frankfurt and Swiss at Zurich contributed most of transfer traffic on those routes due to their strong hub operations. As European FSCs gradually intensify the configuration of their hub-and-spoke network with less waiting time and lower routing factor, indirect connections can become more attractive in intra-European markets (Burghouwt and de Wit, 2005).

Market Structure Variables

The market concentration measured as the market share inequality (H1) has a negative impact on fares, which contrasts with the US experience in which concentration leads to higher airfares. Assuming that there are two routes (i.e., route 1 and route 2) whereby each of them is served by three carriers. The market shares of the carriers for route 1 are 0.5, 0.25 and 0.25, whereas those for route 2 are 0.4, 0.3 and 0.3, respectively. In other words, the distribution of market shares among carriers on route 1 is more unequal than that on route 2. Based on equation 1, the value of H1 for route 1 (i.e., 0.063) is higher than that for route 2 (i.e., 0.01) by 0.053, implying that the average fares charged by FSCs on route1 is 3% (i.e., 0.053 multiplied by the coefficient of H1 in table 7) lower than that on route 2. This finding also supports the exploratory analysis of the market structure of European HH markets whereby 64% of

routes served by FSCs confront competition from at least one LCC or regional carrier. The large difference of market share forces the only carrier to reduce their prices to compete with FSCs.
The presence of LCCs can largely influence FSCs' pricing decisions in the European HH markets. Their head-to-head competition with FSCs drives prices down by 11.3%.

5 Conclusion

The main purpose of this paper was to explore factors influencing the pricing of the European full-service carriers in the specific hub-to-hub markets. We find that four factors (i.e., route type, market share inequality, competition from low-cost carriers, and providing competitive one-stop alternative routings) contribute to explain the pricing in Europe's HH markets. As a consequence, we conclude that through strategic alliances, FSCs in Europe do charge higher fares on the routes connected by their primary hubs. However this finding only holds for connections between primary hubs, which may be related to the fact that – in contrast to the US market that has a longer history of deregulation and straddles a larger geographic area – an extensive multi-hub-and-spoke network does not yet exist (at least in terms of its potential pricing consequences).
Our finding that the market share inequality is negatively related with airfares corroborates the results obtained by Giaume and Guillou (2004). The specific characteristics of the European HH markets suggest that more new entries should be encouraged to compete with the incumbent FSCs. The low-cost carriers function as a main force for driving prices down in the HH markets, and will likely continue to influence the more extensive markets due to the enlargement of the European Union (i.e. the so-called 'new Europe, new low-cost air services' discussed by Dobruszkes (2009)).
Finally, even though nonstop HH routes generally have high barriers to enter, we find that carriers, such as Lufthansa and Swiss, who have established strong hubs tend to enter some routes with high profitability by providing one-stop routings (i.e., the positive relationship between one-stop variable and prices). However, it is unclear how these carriers attract sufficient passengers to order these one-stop tickets along with sacrificing the longer travel time, given the short distances between airport-pairs in Europe. Future research may therefore focus on examining how FSCs in Europe set pricing strategies on one-stop connecting flights by considering factors, such as, travel time, the competition from nonstop flights (Lijesen et al., 2004) and passengers' willingness to pay (Garrow et al., 2007).

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