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The impact of hub hierarchy and market competition on airfare pricing in US hub-to-hub markets

Shengrun Zhang[a,1], Ben Derudder[a], Frank Witlox[a]

[a] Department of Geography, Gent University, Krijgslaan 281 (S8), 9000 Ghent, Belgium

Abstract

This paper explores factors influencing the pricing behaviour of full-service carriers in hub-to-hub markets, which to date have rarely been the exclusive focus of research. Drawing on a 2009 dataset containing route and airfare information, we estimate a pricing model for hub-to-hub markets in the United States. Our econometric analysis suggests that an airport's position in carriers' hub hierarchies, competition from low-cost carriers, and other market structure variables influence average airfares.

Keywords:

Hub hierarchy; Airfare pricing; Competition; Full-service carriers

[1] Corresponding author. Tel.: +32 92644695; fax: +32 92644985

E-mail address: shengrun.zhang@ugent.be

1 Introduction

Air travel demand in the United States is expected to increase to 1.2 billion passengers in 2032, a near-doubling compared to the 731 million passengers in 2011 (Federal Aviation Administration, 2012). In principle, such further growth of the domestic market implies major business opportunities for US carriers. However, there are on-going concerns about the poor financial performance of US carriers. American Airlines' recent filing for Chapter 11 bankruptcy implies that the largest full-service carriers (American, Continental, Delta, Northwest, United and US Airways) have recently gone through a period of major restructuring. Part of the recent financial woes can of course be attributed to the on-going financial and economic crises that began in 2007, which have temporarily stifled demand (Dobruszkes and Van Hamme, 2011). Nonetheless, whatever the source of the poor financial performance of US carriers, it is clear that constantly (re)examining pricing strategies will be of key importance in order to reap the potential benefit of an expanding market.

The extensive literature on airfare pricing strategies in the US aviation market predominantly focuses on (i) individual carriers' overall route networks (Chi and Koo, 2009; Lee and Luengo-Prado, 2005), (ii) the United States air transportation network as a whole (Borenstein, 1989; Brueckner et al., 1992) or (iii) specific airports (Borenstein, 2005; US Department of Transportation, 2001). As a consequence, there has been relatively little research exclusively focused on how carriers determine airfares in hub-to-hub (HH) markets, where both origin and destination are to some degree dominated by a full-service carrier (FSC). A major exception is the work of Vowles (2006), who found that route structure and competition between carriers (especially from low-cost carriers) play prominent roles in determining airfares in HH markets.

In his analysis, Vowles included two route structure variables: routes where a single carrier controls both endpoints (i.e., ROUTE1, such as Newark -Houston in the erstwhile Continental network) and routes where two different carriers control the endpoints (i.e., ROUTE2, such as Salt Lake City-Cleveland for Delta and Continental). However, what remains unclear is how hubs and their service levels are defined because 'the lack of any universally accepted definition of hub can be confusing in debate' (Button, 2002, p.180). In addition, the operationalization of ROUTE1 did not consider the variation in the 'levels' of hubs within a carrier's network. However, previous research has shown that service levels do not simply vary between 'hubs' and 'non-hubs', but also amongst a carrier's hubs[1]. For instance, Shaw (1993) divides hubs into 'national hubs' and 'regional hubs' based on the 'importance' of an airport in a carrier's network, while Ivy (1993) distinguishes between 'primary hubs' and 'secondary hubs' based on the levels of transfer traffic. This 'hierarchy of hubs' suggests that the service levels of the routes connecting these hubs within a carrier's network will also be different, while the ensuing difference in HH routes may thus also impact the pricing strategies of the different carriers: it can be hypothesized that routes involving more dominant hubs can be related to higher airfares. This information is important for carriers and global alliances willing to maintain or establish multi-hub-and-spoke networks when they determine

[1] It is worth noting that this angle of defining hubs is different from that of the Federal Aviation Administration (FAA), who classifies hubs based on the share of the total number of US domestic airline passengers rather than an airport's place in a carrier's network.

airfare pricing, frequencies and capacities for inter-hub routes (Holloway, 2008).

The purpose of this paper, therefore, is to extend Vowles' research through a more refined analysis of the impact of hub hierarchies on pricing in US HH markets. We hypothesize that (1) the presence of hub hierarchies may be relevant as there may be differential impacts based on the level of 'hubness' of both points on a route, while (2) there may be duopolistic effects or intensive competition in routes connecting hubs of different carriers. In our model, we therefore adopt a more refined operationalization of the notion of 'hub-to-hub routes' and hierarchies among hubs. Our empirical framework is thereby centred on the overall HH market as 'produced' by the six largest FSCs (at the time of the data gathering) in the US.

The remainder of this paper is organized as follows. Section 2 reviews previous studies on the ways in which network structure and market competition determine airfares and yield in the US airline industry. Section 3 defines HH networks in the US and introduces our data and model. This model is operationalized in section 4, where the results of the overall HH market are used to illustrate how network structure, market competition, demand and cost variables, and market structure influence pricing strategies. In section 5, we summarize the main implications of our analysis and outline some avenues for further research.

2 Literature review

2.1 Network structure in the business models of US carriers

Network structure is related to the business model adopted by US carriers and has dramatically shifted since the industry deregulation in 1978. Although devising carrier typologies becomes an increasingly difficult task, the literature generally distinguishes between two types of carriers: full-service carriers (FSCs) and low-cost carriers (LCCs).

FSCs are associated with a hub-and-spoke (HS) network structure, whereby a significant proportion of national and international flights is concentrated at their hubs (Button, 2002; O'Kelly, 1998). HS network structures allow airlines to exploit productive efficiencies from economies of traffic density (Nero, 1999). Associated with this type of network structure, FSCs run a complex business model by bundling a series of services. For instance, they develop sophisticated yield management techniques to utilize their fleet with multiple aircraft types. In addition, they offer in-flight entertainment, VIP waiting lounges, and other 'frill' services (Hazledine, 2011).

LCCs deploy a different network strategy from FSCs: point-to-point (PP) network structures offering more direct flights (Gillen and Morrison, 2005). The PP organization has distinct productivity advantages, such as reduced transaction costs and travel time related to the absence of a transfer system (Taneja, 2004). LCCs also have a simpler business model in terms of the 'extra' services being offered beyond the mere connection. For instance, the US Department of Transportation definition of LCCs focuses on dimensions like (i) the presence of a single passenger cabin class, (ii) 'no frills' service, (iii) standardized aircraft utilization and other characteristics.

Although this distinction between FSCs and LCCs continues to stand as the foremost difference amongst carriers, the reality is far more complex. For LCCs with sound PP networks, it is possible to leverage their networks by providing connecting services between existing airports within their networks to enjoy economies of airport costs (such as Southwest's network strategy) (Boguslaski et al., 2004). This strategy is, however, markedly different from the FSCs' HS network, whereby network economies are realized by adding more new destinations to their hubs and profitability heavily depends on connecting traffic. Moreover, recently launched LCCs tend to organize HS networks (e.g., Air Tran at Atlanta, Frontier at Denver and JetBlue at John F. Kennedy) (Reynolds-Feighan, 2001). It should be noted that their entry pattern (such as JetBlue) is still dominated by providing non-stop services, while opening new one-stop connections may be considered after non-stop entry (Müller et al., 2012). Meanwhile, FSCs have launched their own low-cost subsidiaries in response to the low-cost competition (e.g. Song by Delta) (Graham and Vowles, 2006).

2.2 The impact of network structure and market competition on the pricing behaviour of US carriers

Broad literature deals with the factors influencing airfares and yields. This paper focuses on studies that explicitly consider the role of network structure and competition. In the next section we will use this review to select variables in our analysis of the HH market.

The relationship between network structure and pricing originates from the dominance of carriers adopting a HS business model at their hubs. Pricing tends to be influenced by dominance for two reasons. First, the very presence of hubbing tends to reproduce its engendered monopolistic tendencies as it deters other carriers from entering (Goolsbee and Syverson, 2008; Oum and Tretheway, 1990). Second, and more implicitly, carriers may dominate airport facilities at hubs (e.g., slots and gates), thus providing a better level of service (Ciliberto and Williams, 2010; Williams and Snider, 2011). Based on these advantages, carriers adopting a HS network can charge higher fares on routes to/from their hubs (Borenstein, 1989; US Department of Transportation, 2001), especially on the routes connecting their hubs (henceforth termed 'dominant routes'). Even though this so-called 'hub premium' has decreased over the last 10 years, some routes from/to hubs (e.g., those centred in Charlotte, Cincinnati, Minneapolis, and Memphis) are still characterized by significantly higher fares (Borenstein, 2005).

A carrier's pricing strategy is, however, also strongly influenced by its competitors' behaviour (Bresnahan and Reiss, 1991). This includes the routes between hubs of different carriers (henceforth termed 'strategic routes') characterized by either fierce competition to 'steal' passengers or the replication of hub premiums because of duopolies.

The dramatic growth of LCCs has been a principal driver for shifting airfares in the US airline industry. Research by Windle and Dresner (1995) and Dresner et al. (1996), for instance, has shown that LCCs tend to lower airfares on the routes they enter. It is useful to distinguish between the influence of Southwest Airlines and other LCCs, as the former has had the most significant impact in this regard. Dresner et al. (1996) found that yield was reduced by approximately 53% when Southwest served a route, while a 38% yield reduction occurred when other LCCs were included in the model. Incumbent FSCs also continue to respond differently to the entry of Southwest compared to the entry of other LCCs. Daraban (2007) suggests that incumbents cut their fares twice as much when Southwest entered the market compared to other LCCs.

Addressing the relevance of a competitor's behaviour is, however, more intricate because of the presence of airports in close proximity to hubs. Airports are increasingly part of multi-airport systems (MAS) (de Neufville, 1995; Derudder et al., 2010), implying multiple gateways for accessing metropolitan areas. Recent research has shown that LCCs not only influence pricing and traffic patterns at the airports they serve, but also at the other airports in a MAS (Brueckner et al., 2013; Tierney and Kuby, 2008; Vowles, 2001). This competitive effect has, for instance, been observed after the entry of Southwest in the Baltimore-Midway route: the significantly lower price offered on this route connecting the Washington and Chicago metropolitan areas forced carriers operating on other routes between Washington and Chicago to reduce the fares to protect their market share, which Vowles (2001) has dubbed the "spatial Southwest effect." More recently, Brueckner et al.(2013) reappraised the impact of airline competition on domestic US airfares and confirmed that LCCs have dramatically reduced airfares whether they provide services in the airport-pair markets or at adjacent airports.

In addition to the potential effect of network and market-related processes, there are also a number of other variables that influence pricing. Operating costs related to the distance, the total demand, and market structure variables such as slot-control policies and the relative proportion of tourism-related travel are the most important examples here and will serve as control variables.

3 Methodology and data

3.1 The US hub-to-hub market

As the main function of a carrier's hub is to reroute passengers, our working definition of hubs in US domestic markets focuses on the relative volume of transfer passengers. In this paper, we adopt the classification of Lee and Luengo-Prado (2005), who define hubs as airports with more than 10% transfer passengers in a given carrier's network (see also Ivy, 1993). A further distinction is made between 'primary hubs' (>50%) and 'secondary hubs' (10%-50%). Table 1 presents an overview of the primary and secondary hubs in the US according to this classification. The table also lists 'competing' airports[2] in the wider metropolitan area (MA), and thus provides the scope of our study as the HH market is taken to consist of all origin and destination (O&D) pairs where the airports are hubs (see Figure 1).

Table 1 Categorization of hubs for US FSCs and their competing airports

Hub Airport	Carrier	Transfer Passengers (%, in 2000)	Competing airports
Primary Hubs			
Dallas-Fort Worth (DFW)	American	59.2	Dallas Love (DAL)
Chicago O'Hare (ORD)	American	50	Chicago Midway (MDW)

[2] Competing airports are defined as airports located less than 75 miles away from the hub airports. Morrison (2001) found that a distance of 75 miles provided the best fit compared with distances of 25, 50, 100 and 125 miles.

Houston-George Bush (IAH)	Continental	56.4	Houston Hobby (HOU)
Cincinnati (CVG)	Delta	75.3	Dayton (DAY)
Atlanta (ATL)	Delta	64.7	
Salt-Lake City (SLC)	Delta	63.3	
Mineapolis-St. Paul (MSP)	Northwest	53.3	
Detroit (DTW)	Northwest	50.9	
Memphis (MEM)	Northwest	76.9	
Chicago O'Hare (ORD)	United	48.9	Chicago Midway (MDW)
Denver (DEN)	United	59	
Charlotte (CLT)	US Airways	78.4	
Secondary hubs			
Miami (MIA)	American	38.2	Fort Lauderdale (FLL), Palm Beach (PBI)
Newark (EWR)	Continental	13.1	John F. Kennedy (JFK), LaGuardia (LGA)
Cleveland (CLE)	Continental	38.5	Akron-Canton (CAK)
Washington Dulles (IAD)	United	37.6	Washington National (DCA), Baltimore-Washington (BWI)
San Francisco (SFO)	United	26.5	Oakland (OAK), San Jose (SJC)
Philadelphia (PHL)	US Airways	41.9	

Source: Lee and Luengo-Prado, 2005.

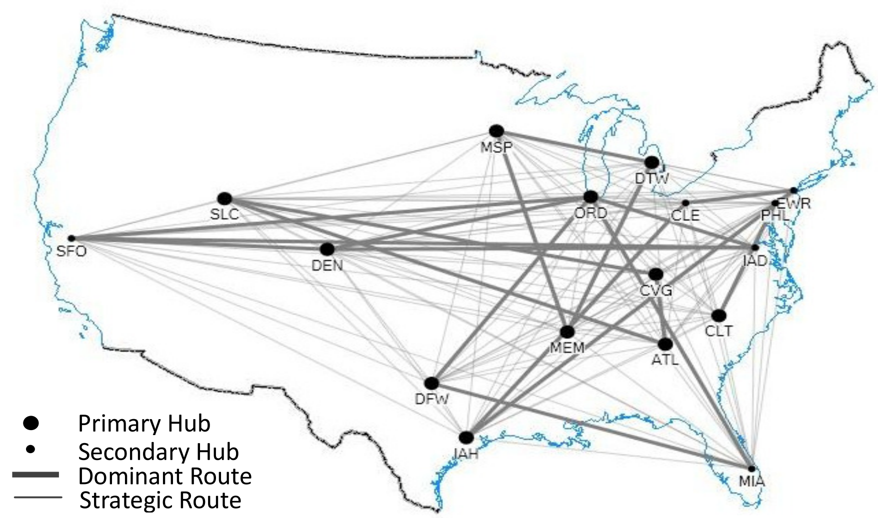

Figure 1 O&D routes connected by hubs of the six largest US FSCs

3.2 Data

The main dataset used in this paper was collected through a research cooperation with Sabre Airline Solutions, and contains information drawn from Airport Data Intelligence (ADI) on actual air travel bookings. In comparison with other commonly used datasets (e.g., DB1B data), the Sabre ADI has two major advantages when analyzing pricing and scheduling strategies in the airline industry. First, ADI datasets allow monitoring and tracking real-time fare information as passenger data is updated monthly and schedule data is renewed weekly. DB1B data, in contrast, combines quarterly fare information, and can therefore not be used by researchers to capture the rapid industry changes occurring within a three-month period. Second, the DB1B consists of a 10% sample of airline tickets. Even though a sampling of 10% is in principle quite large, it is possible that low-density routes are not sufficiently sampled (Grubesic, 2005). Datasets drawn from ADI paint a more complete picture by combining and calibrating data from 1) global distribution systems (GDS), 2) travel agencies, 3) airline direct bookings, low-cost carriers and 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 levels on passenger numbers, revenue, and distance. It also indicates the intermediate stops when connecting services are available. As the focus is on US domestic HH markets, the unit of observation is the O&D market connected by 17 hubs in the networks of US FSCs, as given in Figure 1. We do not consider the directionality of a market (i.e., Atlanta-Detroit is assumed to be the same as Detroit-Atlanta). The data used in this paper is for May 2009. There are 131 routes in total, on which about 2.2 million passengers were carried during this time period[3].

3.3 Model specification

We devise an econometric model that tries to explain the variability of earnings on HH routes in US domestic air passenger markets. Earnings are measured through average one-way fares[4], which serves as the dependent variable in our model. The independent variables in the model combine control variables, network structure indices, and market competition variables. The empirical pricing model for the HH network is specified as follows:

$$\begin{aligned}\mathrm{AVGFARE} = {} & \alpha_0 + \alpha_1\mathrm{PASS} + \alpha_2\mathrm{DIST} + \alpha_3\mathrm{VACATION} + \alpha_4\mathrm{SLOTCONTROL} + \alpha_5\mathrm{DOMROUTE1} + \\ & \alpha_6\mathrm{DOMROUTE2} + \alpha_7\mathrm{DOMROUTE3} + \alpha_8\mathrm{STRROUTE1} + \alpha_9\mathrm{STRROUTE2} + \\ & \alpha_{10}\mathrm{STRROUTE3} + \alpha_{11}\mathrm{SOUTHWEST} + \alpha_{12}\mathrm{WNMA} + \alpha_{13}\mathrm{OTHERLCCS} \qquad (1)\end{aligned}$$

Where:

α_0 is the intercept and α_i are the estimated coefficients for the independent variables;

AVGFARE is the average one-way fare charged by the six largest FSCs on a route;

PASS is the total number of passengers on a connection regardless of how it was realized (non-stop or with intermediate stops), and aggregated for both directions. We calculated the Pearson correlation coefficient to explore the potential relationship between PASS and AVGFARE. The result shows that PASS is negatively correlated with fares (correlation coefficient r = - 0.189, P<0.05): increasing passenger volumes lead to higher load factors

[3] In theory, the number of observations should be 136 (i.e., n*(n-1)/2=17*(17-1)/2=136, where n is the number of airports). However, five routes (i.e., CVG-CLE, CVG-DTW, CVG-MEM, CLE-DTW and EWR-PHL) were not served by any of the six FSCs in May, 2009, and are therefore excluded from the model.

4 For the case of a roundtrip ticket, the Sabre ADI treats inbound and outbound as two separate one-way observations.

(Devriendt et al., 2009) so that the per-passenger cost of the flight declines, thus lowering the price (Borenstein, 1989). However, above all, it can be hypothesized that bigger markets will be characterized by lower prices because of fierce competition. For instance, in addition to HS networks, almost all major US FSCs will offer LAX to JFK flights, which reflect the size of the market and the concomitant importance of being present in it. Given the correlation analysis and the ever-increasing levels of competition in the airline industry, the sign of PASS can be hypothesized as negative.

DIST 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; Vowles, 2006; Windle and Dresner, 1995). Because it can readily be assumed that passengers are not willing to pay for longer routing because of intermediate stops, the model uses the non-stop distance of a route irrespective of the actual route segments (Chi and Koo, 2009). The expected sign for DISTANCE is positive.

The VACATION control variable determines whether or not the origin or destination of a HH route is a clear-cut holiday destination. Researchers have found that airfares to cities in Florida, Hawaii, Nevada and Puerto Rico are lower because those cities are likely to have high competition for holiday travellers (Borenstein, 1989; Chi and Koo, 2009; Dresner et al., 1996; Windle and Dresner, 1995, 1999). In our framework, Miami (MIA) is the only holiday destination. A negative relationship is expected between VACATION and airfares.

The SLOTCONTROL control variable determines whether the origin or destination of a HH route is a slot-controlled airport. Air carriers and other authorities impose regulatory limits on the number of takeoffs and landings each hour at the four highly congested airports (Chicago O'Hare, New York La Guardia, New York JF Kennedy and Washington National). The only slot controlled airport in our research is Chicago O'Hare (ORD), which is reported to be extremely congested, especially in the late afternoon and early evening (Johnson and Savage, 2006). The severe delays and the longer departure procedure at ORD may increase passengers' travel time and reduce the service level. This may decrease demand and lead to a decline in airfares (Chi and Koo, 2009). The expected sign of SLOTCONTROL is negative.

The three dominant route variables (i.e., DOMROUTE 1, DOMROUTE 2 and DOMROUTES 3) identify routes where both endpoints are hubs for the same carrier. The DOMROUTE 1 variable captures routes where both endpoints are the primary hubs of the same carrier (e.g., Atlanta (ATL) - Cincinnati (CVG) for Delta); the DOMROUTE 2 variable captures routes where one endpoint is the primary hub and the other is the secondary hub for the same carrier (e.g., Dallas-Fort Worth (DFW) – Miami (MIA) for American); and the DOMROUTE 3 variable describes routes whereby both endpoints are the secondary hubs for the same carrier (e.g., Newark (EWR) - Cleveland (CLE) for Continental). As the carrier is dominant at both airports, it can charge significantly higher prices on this route; the expected sign of these variables is therefore positive. However, the impact can be expected to lessen as we move from DOMROUTE 1 to DOMROUTE 3 because of the reduced dominance at the secondary hub.

The three strategic routes variables (i.e., STRROUTE 1, STRROUTE 2 and STRROUTE 3) identify routes where both endpoints are hubs for different carriers. The STRROUTE 1 variable captures routes whereby both endpoints are the primary hub for different carriers (e.g., Atlanta (ATL)-Charlotte (CLT), as ATL and CLT are the primary hub for Delta and US Airways); the STRROUTE 2 variable captures routes whereby one endpoint is the primary hub for a particular carrier and the other endpoint is the secondary hub for another carrier (e.g., Atlanta (ATL)-Philadelphia (PHL) because ATL is a primary hub for Delta and PHL is a secondary hub for US Airways); and the STRROUTE 3 variable identifies routes where both endpoints are the secondary hubs for different carriers (e.g., Miami (MIA)-Newark (EWR), as MIA is a secondary hub for American and EWR is a secondary hub for Continental). The expected sign and strength of such routes on pricing is harder to predict than for routes between hubs for the same carrier. These routes may have lower average fares because of fierce competition to 'steal' passengers, but nonetheless maintain higher fares because the monopoly of the previous set of HH routes is merely replaced by a duopoly. For instance, the Miami (MIA)-Philadelphia (PHL) market is dominated by American and US Airways with nearly equal market shares (48.6% for American and 46.7% for US Airways), and pricing strategies may go both ways (and also be contingent on other factors).

The SOUTHWEST variable measures the effect of the presence of Southwest when it is directly present in a market. The expected sign is negative.

The WNMA variable (WN is the IATA code for Southwest) measures the effect of the presence of Southwest in competing markets. For instance, the Oakland (OAK)-Cleveland (CLE) route would be a competitor to the San Francisco (SAN)-Cleveland (CLE) route, since OAK is within the San Francisco MA. The expected sign is negative.

OTHERLCCS is a variable examining the impact of the direct presence of low-cost carriers other than Southwest on a HH route. Low-cost carriers are taken to be present in a market when they collectively have a market share that is larger than 1% of passengers in a market (Ito and Lee, 2003; Lee and Luengo-Prado, 2005; Windle and Dresner, 1995). The other low-cost carriers included in this paper are Air Tran, Frontier, Jet Blue, Virgin America and Sun Country. The expected sign is negative.

4 Result and discussion

Summary statistics for the variables used in the model are presented in table 2. Both dependent and independent variables (i.e., AVGFARE, PASS and DIST) are transformed into natural logarithmic form to facilitate the interpretation of the coefficients as elasticities. We also perform two diagnostic tests for heteroscedasticity and endogeneity to produce a robust and unbiased model. First, the White test is applied to check for heteroscedasticity in the model (White, 1980). The result shows that the null hypothesis of homoscedasticity cannot be rejected at the 5% significance level. Second, we conduct the Durbin-Wu-Hausman test to detect possible endogeneity of explanatory variables (PASS in particular may potentially be endogenous) (Hausman, 1978). The result shows that the null hypothesis of exogeneity cannot be rejected at the 5% significance level for PASS.

Table 2 Descriptive statistics of variables for the overall markets (monthly data)

	Mean	Std.	Min	Max
AVGFARE ($)	186.02	51.46	80.64	354.25
PASS	16933.97	15793.95	252.14	80821.64

DISTANCES (miles)	1001.52	562.64	212.72	2591.52
VACATION	0.12	0.33	0	1
SLOTCONTROL	0.12	0.33	0	1
DOMROUTE1	0.06	0.24	0	1
DOMROUTE2	0.07	0.26	0	1
DOMROUTE3	0.02	0.12	0	1
STRROUTE1	0.35	0.48	0	1
STRROUTE2	0.42	0.50	0	1
STRROUTE3	0.08	0.28	0	1
SOUTHWEST	0.03	0.17	0	1
WNMA	0.29	0.46	0	1
OTHERLCCs	0.11	0.31	0	1

Table 3 summarizes the key statistics for the overall model applying the Ordinary Least Squares (OLS) regression, whereby 10 out of 12 independent variables are found to be statistically significant at the 10% level, collectively explaining about 70% of the variation in the pricing in the US HH market.

Table 3 Overall model

	Unstandardized Coefficients B	Standardized Coefficients Beta
(Constant)	3.869*** (0.197)	
LnPASS	-0.042*** (0.016)	-0.179
LnDISTANCE	0.255*** (0.027)	0.544
VACATION	-0.318*** (0.047)	-0.379
SLOTCONTROL	-0.162*** (0.053)	-0.193
DOMROUTE1	0.367*** (0.064)	0.320
DOMROUTE2	0.328*** (0.063)	0.302
DOMROUTE3	0.474*** (0.118)	0.212
STRROUTE2[5]	0.039 (0.035)	0.069
STRROUTE3	0.211*** (0.062)	0.213
SOUTHWEST	-0.402*** (0.085)	-0.252
WNMA	-0.062* (0.035)	-0.103
OTHERLCCs	-0.081 (0.053)	-0.092
R Square	0.694	

Note: Standard errors are reported in the parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

CONTROL VARIABLES

[5] STRROUTE1 is excluded from the model due to its high collinearity with STRROUTE2.

The coefficient for PASS is negative: as the number of total passengers in the US HH markets increases by 1%, prices are predicted to fall by 0.04%[6]. The impact of distance, in turn, is indeed positive, and indicates that 1% increase of the distance results in an average increase in fares of 0.25%. And finally, the coefficients for VACATION and SLOTCONTROL are, as anticipated, negative: HH routes involving Miami and Chicago O'Hare imply smaller 'hub premiums'.

HUB HIERARCHY

Routes where both nodes are hubs for the same carrier do indeed result in significantly higher fares[7]. However, our results show that this effect is uneven in the sense that hub *hierarchies* also play a significant role: the standardized beta coefficients[8] reveal that DOMROUTE1 has a bigger impact than DOMROUTE2, which in turn has a bigger impact than DOMROUTE3. Fares on routes between a carrier's primary hubs are on average 44% higher than general fares, while these for primary-secondary routes are raised by 39%. Although the standardized beta coefficient is lower on secondary-secondary routes, the price increase is bigger (61% for DOMROUTE3). This can be explained by the specific nature of the two secondary-secondary routes in our dataset; i.e., Cleveland (CLE)-Newark (EWR) for Continental and Washington Dulles (IAD)-San Francisco (SFO) for United. In May 2009, Continental carried about 96.6% of the passengers (as measured in our Sabre Database) in the CLE-EWR market, while United had the largest market share with 62.8% in the IAD-SFO market. Both examples are therefore specific in the sense that, although connecting secondary hubs, the routes are de facto monopolies, hence the disproportionally inflated fares.

MARKET COMPETITION

Routes between hubs for different carriers do not result in higher fares, except for an average increase of 23% on secondary-secondary routes.

Southwest drives down prices in the US HH markets: its direct presence cuts prices by 49% (all other things being equal) and its presence in the competing markets reduces prices by 6%. It is worth noting that the other LCCs have no significant impact on prices in the overall markets, which corroborates Daraban's (2007) research on the particular effect of Southwest.

5 Conclusion

This paper explored the factors influencing the pricing strategies of US full-service carriers in specific hub-to-hub markets. The results confirm Vowles' (2006) observations regarding higher airfares in these markets, but also extend his findings by showing that hub hierarchies play a role. As hypothesized, the monopolistic effects on airfares diminish as the hubs become less crucial in a carrier's network. Meanwhile, duopolies in routes connecting the hubs of different carriers have no or limited effects on airfares. This indicates that the variant ability

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

[7] We performed a separate regression model excluding the variable PASS and found that the regression results as a whole did not change.

[8] 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.

of FSCs' hubs to reroute passengers leads to inter-HH route heterogeneity, which further drives the pricing variation in HH markets. We suggest that inter-HH route heterogeneity should also be incorporated when studying the 'hub premium' issue. Our model controls for other crucial pricing factors, such as the competition from low-cost carriers and market structure, and thereby corroborates earlier research regarding the differential impact of Southwest viz. other low-cost carriers.

The air transport world is, of course, in constant flux, and future research should thus assess the impact of these changes on our observations. In the US, for instance, further rounds of consolidation (e.g., the Northwest/Delta merger) and rapidly unfolding new trends (e.g., the increased impact of self-hubbing) could well alter the profoundness of the patterns revealed here. In addition, given the unfolding integration and concomitant consolidation of other markets (the European Union, and increasingly the ASEAN region), the time seems ripe for analyses of the pricing effects of emerging hub-to-hub markets in these regions as well.

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