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Hub congestion pricing: Discriminatory passenger charges

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ABSTRACT

This paper investigates airport determination of per-flight and per-passenger charges in a hub-spoke network. The hub airport is congestible and it levies a per-flight charge on its carriers and discriminatory per-passenger charges on the local and connecting passengers. Our main results are: (i) the socially optimal per-passenger charges should take the higher congestion contribution by connecting passengers into account, leading to a higher charge on a connecting passenger than on a local passenger; (ii) generally, the social optimum cannot be achieved when the hub only levies a per-flight charge on carriers; (iii) the optimal per-connecting passenger charge should be lower (higher, respectively) than the per-local passenger charge when the per-flight charge is large (small, respectively); and (iv) a profit-maximizing hub can impose lower per-connecting passenger charges as compared to per-local passenger charges, owing to its market power, and this possibility is further strengthened by economies of traffic density.

1. Introduction

The worldwide airline deregulation/liberalization has led to a number of strategic actions being taken by airlines, including the formation of hub-spoke networks. As a result, a large number of passengers need to transit/transfer at a hub airport in order to reach their final destinations.[1] For example, the proportion of transfer passengers is more than 50% at a number of hub airports in the United States (Table 1A). The presence of transfer passengers at the major (hub) airports of other countries is also significant (Table 1B). As carriers move from the point-to-point to hub-spoke networks, both the connecting traffic and total traffic have risen to the extent that the high traffic volume (relative to runway capacity) has caused congestion and delays at many hub airports.[2] According to the *On-time Performance Report* by FlightStats, the average on-time departure performance among the top-35 international airports was 69.3% in July 2013.[3] For the same year, the average on-time departure performance of the 29 major U.S. airports was 76.6% (U.S. Department of Transportation): The best performer, Salt Lake City airport, was 86.7%, while the worst performer, Chicago Midway, was 66.6%. In particular, Chicago O'Hare, a hub for both American Airlines and United Airlines, was 70.4%; in other words, 29.6% of the flights were delayed.

What can be done about runway congestion and delays? An "obvious" solution is to add more runway capacity, which is lumpy and time-consuming and involves large expenditures. Economists have, on the other hand, advocated the use of price mechanisms to balance the demand with the limited capacity, with early analyses by, e.g., Levine (1969), Carlin and Park (1970) and Borins (1978). These early pricing models were, understandably, developed along a line similarly to dealing with road congestion. As such, flights were treated as "atomistic" (like individual drivers in the road case). The recent literature (e.g., Daniel, 1995; Brueckner, 2002) has incorporated the fact that a congested airport is usually dominated by only a few carriers, each of which runs a large number of flights at the airport and has market power. The main insight is that congestion pricing has a partial place at an airport when carriers have market power, since carriers themselves will internalize congestion. Following this recent literature, the present

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[1] Usually, "transit" passengers refer to the passengers who arrive at, and depart from, the hub on the same flight, whilst "transfer" passengers refer to those who need to change to another flight at the hub. Both the transit and transfer passengers use the hub runways twice, one for landing and the other for take-off, and may be referred to as "connecting traffic." We shall use the three words (transit, transfer, connecting) interchangeably in this paper.

[2] As demonstrated by Zhang (2010), airport capacity required under a hub-spoke network would be more than twice as large as the capacity required under a point-to-point network.

[3] Typically, a flight is considered as on-time when the actual departure time is within 15 min of the scheduled departure time. The on-time arrival data are similar to the on-time departure data.

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Table 1A
The proportion of transfer passengers at U.S. airports (at least 50%, 2008). Source: U.S. DOT, Databank 1B, 2008.

Airport code	Airport name	Percentage
CVG	Cincinnati/Northern Kentucky Int'l Airport	0.732
CLT	Charlotte Douglas Int'l Airport	0.724
MEM	Memphis Int'l Airport	0.659
ATL	Hartsfield–Jackson Atlanta Int'l Airport	0.636
DFW	Dallas/Fort Worth Int'l Airport	0.559
IAH	George Bush Intercontinental Airport	0.544
MSP	Minneapolis–Saint Paul Int'l Airport	0.517
SLC	Salt Lake City Int'l Airport	0.514
ORD	Chicago O'Hare Int'l Airport	0.503
DTW	Detroit Metro Airport	0.500

Table 1B
The proportion of transfer passengers at major non-U.S. airports (in descending order).

Airport code	Airport name	Percentage (Year)	Data sources
FRA	Frankfurt	0.54 (2007)	Civil aviation authority, Nov. 2008
CDG	Paris Charles de Gaulle	0.52 (2011)	Global business with reuters, March 29, 2012
DXB	Dubai Int'l	Approximately 0.52 (current)	Dubai airport, official report
AMS	Amsterdam Schiphol	0.419 (2013)	Schiphol group annual report 2013
MUC	Munich, Franz Josef Strauss Int'l	0.39 (2012, 2013)	Munich airport, annual traffic report 2013
LHR	London heathrow	0.37 (2012, 2013)	CAA 2013 air passenger survey
SIN	Singapore changi Int'l	0.30 (2013)	Changi airport, official website
HKG	Hong Kong Int'l	0.26 (2013)	ICF report 2013
CPH	Copenhagen Kastrup	0.208 (2014)	Airport region mediation competence center
ICN	Incheon Int'l	0.19 (2013)	http://www.flightglobal.com/
NRT	Narita Int'l	0.185 (2013)	Narita Int'l airport, official website

Table 2A
Airport passenger charges (per passenger) at selected European airports.

London heathrow (majority private)		
Departing passengers	Final proposed 2012/13 £ GBP	Proposed 2013/14 £ GBP
Europe – destination	24.55	28.30
Other – destination	34.49	39.75
Europe – transfer/transit	18.41	21.23
Other – transfer	25.87	29.82
Source: Consultation Document Prepared by Heathrow Airport Limited, Chapter 7 – Proposed Airport Charges Tariffs for 2013/14. Date: October 26, 2012		
Munich (multi-level government owned), effective from January 1, 2015		
Domestic flight	For local boarding	17.99 EUR
	For transfer and transit	15.11 EUR
European flight [EU] incl.	For local boarding	17.99 EUR
Iceland, Liechtenstein, Norway, Switzerland	For transfer and transit	15.11 EUR
Int'l flights[Non-EU]	For local boarding	18.89 EUR
	For transfer and transit	15.57 EUR
Source: Munich Airport, Tariff regulation, Part 1		
Copenhagen Kastrup (majority private), effective from October 1, 2009 to March 31, 2015		
	Passenger Service Charge (PSC)	Passenger Security Service Charge (PSSC)
Domestic departing passengers	DKK 28.81	DKK 32.43
Transfer to domestic airport	DKK 23.81	DKK 21.41
Int'l Departing passengers	DKK 103.75	DKK 32.43
Transfer to int'l airport	DKK 41.65	DKK 21.41
Source: CHARGES REGULATIONS applying to Copenhagen, Approved by SLV.		

paper examines airport pricing for a congestible hub, taking carrier market power into account. As to be seen below, a major difference between our paper and existing studies is that we will examine airport pricing in a hub-spoke network, which allows us to treat the connecting passengers differently from the "local passengers" who fly between the hub and local airports.[4]

Our analysis is based on the observation that in the airport pricing practice, major (hub) airports impose both a flight-based charge (e.g., a take-off and landing fee and parking charges) and a per-passenger charge. For the passenger charges, an interesting fact is that while U.S. major airports charge a uniform PFC (passenger facility charge) per passenger (Zhang, 2012, Ch. 13, Table 13.4), a number of hub airports in Canada (Toronto, Vancouver), Europe and Asia impose discriminatory PFCs on local passengers and connecting passengers (Tables 2A and 2B). In particular, they charge a lower PFC for connecting (transit, transfer) passengers, with some airports even waiving such fees entirely (e.g., Dubai and Hong Kong). In addition, Copenhagen and Singapore's Changi airports impose a lower fee on connecting passengers not only for PFCs but also for security charges, while Dubai waives the security charges on transit/transfer passengers.

This discriminatory-charging strategy seems feasible and reasonable because: (i) a hub airport generally has a large number of connecting passengers as shown above; (ii) it is easy for a hub airport to distinguish the local and connecting passengers; (iii) a lower charge on connecting passengers attracts more such passengers to fly through the hub, so as to gain from the economies of agglomeration and concession revenues, the so-called "concessions effect" in the literature (e.g., Zhang and Czerny, 2012); and (iv) the hub airport's marginal cost for serving a connecting passenger may be smaller than that for a local passenger. For instance,

[4] Airport congestion has also been examined in, among others, Morrison (1983, 1987), Morrison and Winston (1989), Oum and Zhang (1990), Fan (2003), Daniel (2011), Vaze and Barnhart (2012a, 2012b), Yan and Winston (2014), and Jacquillat and Odoni (2014). For recent surveys of the literature see, e.g., Basso and Zhang (2007), Barnhart et al. (2012), and Zhang and Czerny (2012); and for studies that are more closely related the present paper, see the discussion below.