ARTICLE IN PRESS

Transportation Research Part A xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Congestion spill effects of Heathrow and Frankfurt airports on connection traffic in European and Gulf hub airports

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ARTICLE INFO

Article history:
Available online xxxx

Keywords:
Connection passengers
Transfer passengers
Airport connections
Airport congestion
Heathrow airport
Frankfurt airport
Gulf hubs
Hub airports
Airport competition
Air transport policy
Congestion spill

ABSTRACT

We develop two stage fixed-effects single-spill and double-spill models for congestion connection spills of London Heathrow and Frankfurt airports on 9 hub airports in Europe and the Gulf. Our panel data covers connection traffic from 1997 to 2013 for Heathrow and 1997 to 2011 for Frankfurt. The single-spill results support strongly that the connection spills from Heathrow's capacity limitations do strengthen competing hub airports of major alliance groups and to a lesser degree one Gulf hub. The double-spill model for Heathrow and Frankfurt shows nearly asymmetric *overall* spill characteristics between the two airports. Our results underline the influence of airline network strategies on congestion spills as European airline networks are shaped by alliances and umbrella mergers. Thus, the airline network perspective in airport capacity expansion decisions needs to play a greater role, as indicated by our asymmetric results for *overall* spill effects between Heathrow and Frankfurt airports.

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1. Introduction

Global air transport is expected to grow at 5.5% yearly over the next 20 years (IATA, 2014). This growth rate, in 2013 meant extra 170 million passengers per annum (MPPA), and using the same growth assumption it would reach 330 MPPA by 2025. Such growth rates in the presence of development constraints at major hub airports[1] induce congestion and delays (Barnhart et al., 2012; Hamzawi, 1992; Madas and Zografos, 2008). Accommodating extra growth poses a greater problem in Europe than in most other world regions raising questions about the scalability of the air transport network (Bonnefoy and Hansman, 2007). The airport with one of the greatest congestion problems today is Heathrow airport that is already operating at capacity (Gelhausen et al., 2013). The airport undergoes regular policy debates regarding its future (Griggs and Howarth, 2004; May and Hill, 2006) posing substantial uncertainty for the airlines.

Congestion in hub airports affects network strategies of the airlines (Elhedhli and Hu, 2005) as some unprofitable short-haul routes feed long-haul connections (FE, 2011) but cannot be sustained in highly congested hubs.[2] In this way, increasing flights offered on one route means reducing flights on another route, a trade-off. Thus, congestion plays a role in de-hubbing (Redondi et al., 2012) and growth acceleration at less congested airports. Taking Heathrow as an example, increasing value

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[1] A hub airport is by definition characterized by the connectivity of the incoming and the outgoing traffic, generating density economies (Brueckner, 2004).

[2] For example in 2010, 80% of the connections in Heathrow feeding the long-haul flights to Hyderabad were short-haul connections, and similarly 73% to Edmonton (FE, 2011).

http://dx.doi.org/10.1016/j.tra.2016.06.011
0965-8564/© 2016 Published by Elsevier Ltd.

Please cite this article in press as: Redondi, R., Gudmundsson, S.V. Congestion spill effects of Heathrow and Frankfurt airports on connection traffic in European and Gulf hub airports. Transport. Res. Part A (2016), http://dx.doi.org/10.1016/j.tra.2016.06.011

of landing slot permits and steep increases in landing fees have caused changes in the types of connecting flights offered (AC, 2013). As a matter of fact in 2010 short-haul routes with three or more flights in each direction per day were only 46 in Heathrow, compared to 78 in Paris (CDG), 67 in Amsterdam (AMS), and 74 in Frankfurt (FRA) (FE, 2011), showing clearly the effects of Heathrow's congestion on connectivity.

Airport congestion leaves the airlines with several strategic options, they can: (1) increase fares; (2) operate larger aircraft; or (3) shift extra demand to other airports. The policy-maker and the airport can jointly raise taxes and fees affecting airline fares. Thus, airline fares in congested hubs like Heathrow tend to reflect congestion costs (FE, 2014; Johnson and Savage, 2006) such as higher landing fees and lower aircraft utilization due to slower turnarounds and more frequent delays. To counter higher costs and landing slot scarcity, airlines increase average aircraft sizes. In fact, average aircraft sizes have increased in all capacity limited European airports over the last 10 years (AA, 2014). Yet, there are two traits to this increase, airlines: (1) operate larger aircraft measured in seat count; and (2) operate *fewer* short-haul routes with smaller aircraft (Berster et al., 2015; Givoni and Rietveld, 2009).

Eliminating or reducing the number of short-haul routes is a loss for the airline and a potential gain for a competitor. Then again, the airline can shift lower-yield traffic from a congested hub airport to a secondary hub. In doing so it can grow frequencies, maintain short-haul connections, reduce costs (Pels and Verhoef, 2004), and even enhance service quality due to fewer congestion related delays (Brueckner and Flores-Fillol, 2007). An example of this strategy was when Lufthansa developed Munich as a secondary hub in Germany at a time when Frankfurt airport was heavily congested (capacity added in 2011).

As slot values rise due to congestion, airlines will maximize the revenue potential of each slot often reducing the scope of connectivity. In fact, UK originating intercontinental passenger traffic outside London is served by direct flights from regional airports or connecting flights through hub airports outside the UK. The often claimed trend for European hubs, although still world dominating in intercontinental connections, is loss of market-share for onward connectivity to the Gulf hub airports (ACI-SEO, 2014). This being said it is still not clear to what degree these gains are direct spills from congested European hub airports opposed to new traffic.

Thus, the spill models developed in this paper are useful to: (1) understand how the air transport network scales (decentralization effects); (2) estimate growth debit (and economic impact) of congestion spills from a congested hub airport; (3) estimate positive growth (and economic impact) from spills in other hub airports; and (4) estimate growth debit (and economic impact) in other airports when capacity is increased (lower spill rates) at a congested hub airport (e.g., Frankfurt in 2011).

Our key contribution in this present paper is the estimation of spill coefficients for Heathrow and Frankfurt airports to quantify, not only the size of lost connection traffic, but also reciprocal gains by other competing hub airports. Whereas we can follow growth trends in flight frequencies at less congested hub airports, we have lacked a methodology to quantify the extent to which growth is due to congestion elsewhere in the air transport system. More generally speaking, our contribution helps understand the behaviour of networks when central nodes (hub airports in our case) become congested causing demand spills that induce growth at uncongested nodes, allowing the network to scale with increased demand.[3]

The paper is organized as follows: following the introduction, in Section 2 we describe the modelling framework, in Section 3 we describe the data, and in Section 4 we present the results of congestion spill models for the two case airports on other hub airports in the EU and the Gulf. In Section 5 we discuss the conclusions of our research and future research direction in this area.

2. Modelling framework

In the literature we find quite a few measures of hubbing activities such as route frequencies, number of destinations offered, number of connections available within a given time window, and number of transit or transfer passengers passing through a hub. For example, see Burghouwt and Redondi (2013) for a review of the different approaches. In the present study, we consider the number of connections as a proxy of hubbing activities. A connection, defined as an opportunity to transfer from an incoming to an outgoing flight, has to satisfy some minimum quality requirements in order to attract passengers.

Analogously to Redondi et al. (2012), who used connections to study de-hubbing, we use connections in a given intermediate airport to study congestion spills, observing three quality requirements: (1) the connection must be between flights operated by the same carrier (online connections) or by different carriers belonging to the same alliance or published code-sharing agreement; (2) the time between the incoming and outgoing flights must be between 45 min (minimum connecting time) and three hours (maximum connecting time); and (3) the routing factor of the one-stop itinerary starting from the origin airport, passing thru the hub airport, and arriving at the destination airport must be 1.2 or less. The latter condition helps us avoid considering itineraries with too long detours to be attractive for passengers.

[3] The capacity of the total air transport network to scale in terms of flight frequencies is a function of the total spare capacity plus the added capacity (new airports runways and terminals).

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