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The development of transfer passenger volumes and shares at airport and world region levels

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Abstract

Many air travelers have to change planes. Knowledge on transfer passengers and shares at airport to worldwide levels can be useful industry, policy and research questions. However, as such data is usually not disclosed publically, the structure of transfer volumes and shares has not yet been studied in greater detail. This leaves a research (data) gap which this paper intends to close to some extent. More precisely, we aim at assessing: How total transfer passenger volumes have developed, at worldwide and world region levels; how these relate to the volumes of directly flying passengers; the leading transfer airports in absolute and relative sense; and how the latter have changed over time. We present a methodology to calculate transfer passengers from segment passenger split data provided in the "leg flow" statistics module of a global air transport statistical database which consolidates passenger booking data and estimates from various sources. Departing passenger numbers at the airport level are split into local, beyond, behind and bridge passengers, of which only the latter two count as transfer passengers. The transfer share of an airport is then calculated as the sum of this airport's behind and bridge passengers divided by all departing passengers. Applying this methodology, we estimate transfer passenger numbers and shares for all airports and world regions for the period 2002-2018. The results indicate a declining importance of transfer passengers at the global level; rising transfer volumes and shares in the Middle East region and China, driven by the growth of emerging ChiBoGu (China, Bosporus, Gulf) carriers; decreasing transfer passenger numbers in the U.S., probably due to airline consolidation and hub downsizing activities in the 00s. Finally, key hubs in cities with less touristic appeal like, e.g. Atlanta or Doha, seem to achieve higher transfer shares than gateway hubs in high-profile destinations like Dubai or New York.

Keywords: Air transport networks; hubbing; transfer passengers; transfer shares; hubs; transport geography

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1. Introduction

Despite a worldwide boom of low cost carriers (LCC) focusing on direct, point-to-point routings, many air travelers still change planes, especially on long-hauls. The volumes and shares of transfer passengers at different geographic levels can make useful air transport indicators for several industry, policy and research questions. However, leaving few exceptions aside, data on transfer passengers are usually not disclosed publically. This may be the reason why, to our best knowledge, their spatial distribution and shares, as well as their development over time, have not yet been studied in greater detail, leaving a research (data) gap which this paper closes to some extent. Against this background, our aim is to assess the following questions:

- How have total transfer passenger volumes developed at the worldwide and world region levels?
- How do these relate to the numbers of local, i.e. direct flying passengers?
- Which are the leading transfer airports and regions, both in terms of absolute transfer passenger numbers and in terms of the relative shares of transfer passengers compared to total traffic?
- How have these groups of leading transfer airports and regions changed over time?

We present a methodology to calculate transfer passenger numbers and resulting transfer shares at airport, country and world region levels from passenger volume data from the "leg flow" statistics module of a global air transport statistical database, Sabre AirVision Market Intelligence (MI), which aggregates and combines booking data from global distribution systems (GDS) and estimates for non-GDS bookings to monthly air transport demand data. For each airport and route, the database reveals the monthly number of so-called local, beyond, behind and bridge passengers, of which only the latter two count as transfer passengers. The transfer share of a particular airport is then calculated as the sum of this airport's behind and bridge passengers divided by all departing passengers. Applying this methodology, we generate transfer passenger numbers and shares for all airports and world regions for the period 2002-2018 to map the development of indirect passenger volumes, also in comparison to local traffic, and to identify and map the world's leading transfer airports and regions and relevant changes over time.

2. Literature review

Unlike other modes of transport, air transport is relatively well covered statistically. Prominent examples for air transport statistics include freely available passenger numbers, freight volumes and numbers of movements at the airport and country levels provided by Eurostat (for several European countries) or by national authorities or statistical offices. In addition, some airport operators disclose traffic figures e.g. on their websites. More comprehensive or detailed data is generally only available at a cost. Paid products like OAG (Official Airline Guide) or Innovata provide airline schedules and related capacity indicators, while ICAO Data Plus, IATA PaxIS/MarketIS or Sabre MI disclose demand, financial and/or price data at various levels. Key airport output indicators are also available in the Annual World Airport Traffic Report published by Airport Council International (ACI).

Transfer passenger volumes or shares at the airline or airport level, in contrast, are usually not revealed (Redondi, Malighetti & Paleari, 2012), except for irregular or one-off publications like e.g. Civil Aviation Authority (2008) or early contributions by De Neufville & Rusconi-Clerici (1978) or Kanafani & Ghobrial (1985), all of which have provided selected transfer data for isolated years or regions only. In addition, there are a few cases where airport operators publish their transfer volumes or shares, e.g. on their websites or in leaflets (e.g. Munich Airport, n.y.).

However, the worldwide availability of transfer passenger volumes and shares at the airport level can be of help for a number of questions and stakeholders, such as researchers, consultants, policymakers or lobbyists. In many respects, transfer passengers have different requirements than locally originating passengers (e.g. de Barros et al, 2007). Hence, in airport planning and management, transfer passengers are likely to be important drivers of airport costs and revenues (Kanafani & Ghobrial, 1985) and will also have to be considered in airport infrastructure planning and management (De Neufville & Rusconi-Clerici, 1978), or, e.g., as inputs when simulating terminal passenger flows. For example, in many cases, transfer passengers are not required to pass security again (Cattaneo et al., 2017). In addition, transfer passenger numbers may constitute an important variable when forecasting future airport traffic volumes, e.g. in the context of airport extension projects. E.g., de Neufville and Odoni (2003) point out

that airport planning processes usually require tests of different configuration options with different shares of transfer traffic. In the research field of airline economics, available data could e.g. help assessing to what extent high shares of transfer passengers have a negative impact on the financial performance of hub carriers, compared to carriers with higher shares of local demand. Such a relation seems plausible as hub operations with a high transfer rates and relatively small numbers of local passengers may be more exposed to competition than those with high shares of passengers originating from the airport's catchment (Maertens, 2012). Also, at the regulatory level, airport (price) regulation may be less needed for transfer passengers that have a more flexible airport choice – and tend to be more price sensitive – than local passengers, see, e.g. an assessment for Schiphol Airport in Müller et al. (2010). Finally, transfer passenger volumes might also be useful in the context of air transport policymaking and lobbying. For example, noise-affected residents in the vicinity of airports could point at (high) transfer passenger shares when questioning airport expansion plans, arguing against additional "import of noise" (Done, 2008).

3. Data and Methodology

3.1. Data and data quality

We use data provided in the "Leg Flow" module of the Sabre MI application (Sabre, 2014). This database is fed with validated raw booking MIDT (market information data tapes) data from GDS like Sabre, Travelport and Amadeus at passenger name record level as its main data source, adjusted with data from others sources like statistical offices, and with estimates for charter operations or direct (online) bookings. Outputs include monthly (or higher aggregated) passenger volumes and average fares by airline, booking/cabin class and month at the leg (segment/direct route) and OD (origin-destination) levels, as ticketed. The leg statistics module also allows for splitting airport segment passengers into so-called local, behind, beyond and bridge passengers (see below).

The authors have been using Sabre MI data in various research projects, allowing them to perform a number of plausibility checks and comparisons to other data sources, such as Eurostat. In general, Sabre MI data quality seems to increase with geographical aggregation levels. Hence, the transfer share estimates we provide below at world region or worldwide levels are likely to be more accurate than those at the individual airport level.

3.2. Methodology

Figure 1 illustrates the four different departing passenger types at the airport level: local, beyond, behind and bridge passengers. Local passengers do not change planes at all. Beyond passengers change planes at the segment destination, but not at their departure airport X. Behind passengers start their air trip elsewhere, then change planes at X and continue from X to their next or final destination. Bridge passengers, finally, start their journey elsewhere and change planes both at X and at the segment destination to which they fly from X. Unlike an airport's local and beyond passengers, behind and bridge passengers do count as transfer travelers. The transfer share of airport X then calculates as the sum of the airport's behind and bridge passengers divided by all departing passengers:

$$t_{X,Y} = \frac{pax\_beh_{X,Y} + pax\_br_{X,Y}}{pax\_all_{X,Y}} = \frac{pax\_beh_{X,Y} + pax\_br_{X,Y}}{pax\_loc_{X,Y} + pax\_bey_{X,Y} + pax\_beh_{X,Y} + pax\_br_{X,Y}} \quad (1)$$

where
$t_{X,Y}$: percentage of transfer passengers at airport X in the period Y
pax_all/loc/beh/bey/$br_{X,Y}$: all departing/local/behind/beyond/bridge passengers at airport X in the period Y

To calculate the number of transfer passengers and the transfer share for each airport and world region, we developed an Excel-tool which takes Sabre MI's segment-split data as input and calculates annual passenger totals for each departure airport over all segment types and destinations. For each airport, it then provides the total number of departing transfer passengers as well as the total departing passenger number and the transfer rate as output.

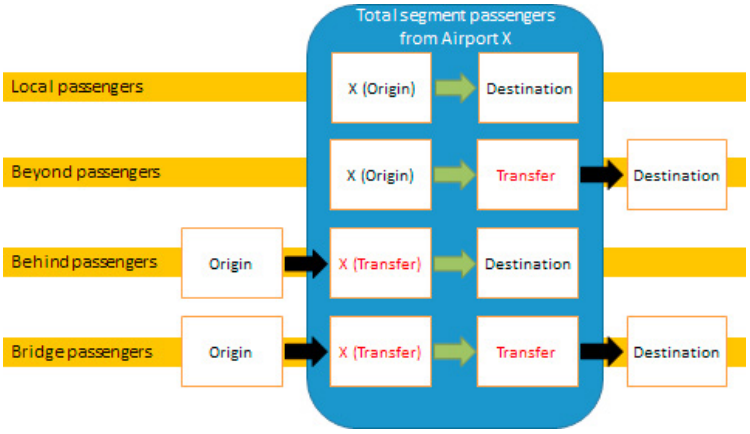

Fig. 1. Local, behind, beyond and bridge segment passengers departing from airport X.

It has to be acknowledged that the Sabre MI dataset considers only those passengers as transfer passengers whose trips are ticketed according to established IATA (Passenger Standards Conference Tariffs Manual, Resolution 40) trip break rules (see, e.g. Beaver, 2005), where e.g. origin-destination trips are split in case the stop-over exceeds 8 hours for intracontinental trips and 18 hours for intercontinental trips (see, e.g., https://de.slideshare.net/AlexisCohen8/marketis-pres). In other words: We do not consider the relatively young self-hubbing phenomenon or long stopovers as transfer routings. Research indicates that self-hubbing is increasing in markets with a good supply of LCC, and airports like Milan Malpensa or London Gatwick even promote this option (see, e.g., Maertens et al., 2016; Cattaneo et al., 2017). Hence, our methodology will actually underestimate transfer volumes at hubs with a high share of LCC and hence large self-hubbing potentials.

4. Results

4.1. Worldwide development of the total transfer passenger volume

Table 1 shows the worldwide departing airport passenger totals for the years 2002-2018, the total number of transfer passengers, the respective transfer shares and the relative changes since 2002. Mainly driven by a doubling of the number of locally flying airport passengers, the total number of departing passengers has grown by 79% between 2002 and 2018, from 2.47bn to 4.41bn. In contrast, the number of transfer passengers has only moderately grown by 10% between 2002 and 2018, from 0.58bn to 0.63bn, recovering from an interim decline to 0.48bn in the Noughties. As a result, the overall worldwide transfer share has decreased from 23% in 2002 to 14% in 2018.

The massive growth of LCC in the 00's, focusing on point-to-point flights (e.g. Dobruszkes, 2013), and the resulting withdrawal of network carriers from many secondary markets are supposed to be key drivers behind the observed trends. E.g., Iberia and Lufthansa have long ceased their (once) secondary hub operations at Barcelona and Düsseldorf, respectively (CAPA Centre for Aviation, 2013).

In addition, fast-growing ChiBoGu (short for China-Bosporus-Gulf) carriers like Turkish Airlines or Emirates now provide many routings one-stop (e.g. from secondary airports in Europe to Australia or Southeast Asia) that formerly used to be served two-stop only by traditional European and Asian network carriers (Grimme, 2011). This reduces the number of transfer points on many trips, and hence is likely to have had a negative impact on global transfer passenger numbers.

Table 1. Development of departing airport passengers worldwide (total, transfer, local; in Billions), 2002-2018.

					Growth since 2002		
Year	Departing Pax	Transfer Pax	Local Pax	Transfer share	All Departing Pax	Transfer Pax	Local Pax
2002	2.47	0.58	1.89	23%			
2006	2.37	0.50	1.87	21%	-4%	-13%	-1%
2010	2.79	0.48	2.31	17%	13%	-16%	22%
2014	3.43	0.56	2.87	16%	39%	-3%	52%
2018	4.41	0.63	3.77	14%	79%	10%	100%

4.2. Leading transfer regions and airports

Figure 2 shows development of the transfer market volumes and shares by world region. Over time, the figure indicates a massive loss in transfer passenger volumes (from 291m to 240m) and shares (from 51% to 38%) for North America. This may have resulted from post-9/11 capacity reductions; the International Air Transport Association (IATA) estimates the US fleet size to have shrunk by 700 units between 2000 and 2009 (IATA, n.y.). The European airports managed to maintain a share of more than 20% over time, equaling 145m transfer passengers in 2018. Asia and "other" regions have also remained stable, with 106m (17%) and 67m (11%), respectively.

Driven by the BoGu (Bosporus-Gulf) carriers, by far the winners are the airports in the Middle East region, which could quadruple their transfer passenger share to 12% in 2018, equaling 76.3m departing transfer passengers. While the North American transfer passenger numbers are – to a large extent – domestic passengers, those in the Middle East are mostly international ones.

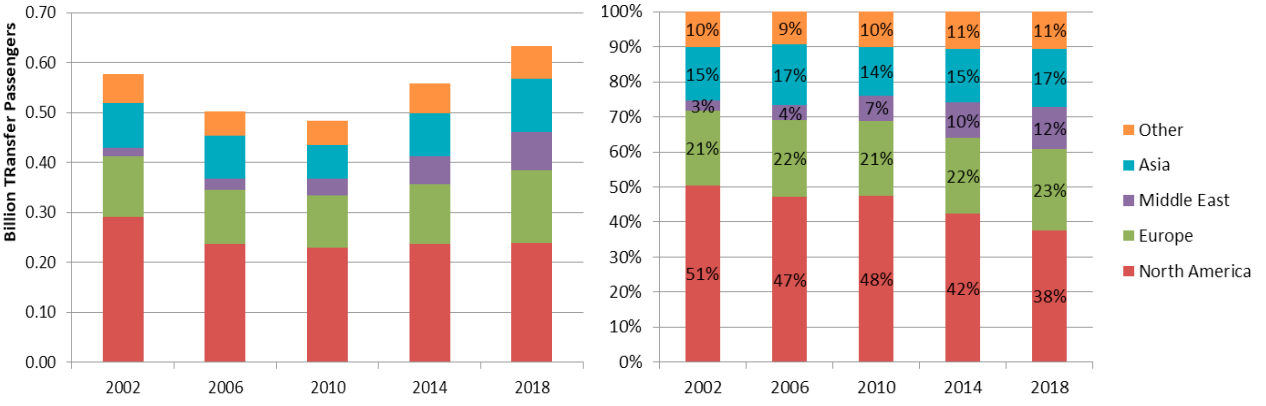

Fig. 2. Absolute and relative passenger split between transfer regions, 2002-2018.

Led by Atlanta (5%), Dubai (3.7%) and Frankfurt (3%), 73 out of more than 7,000 airports worldwide represented 80% of all transfer passengers in 2018, compared to 84 in 2002. While Atlanta (-0.9 percentage points (pp) since 2002) lost market shares and Frankfurt (+0.2) remained stable, Dubai increased its position by 3.0 pp (from 0.7% to 3.7%), reflecting the rise of Emirates.

The following table shows the transfer passenger numbers, transfer rates and worldwide shares in transfer traffic for the 25 largest airports in 2018, as well as their relative developments since 2002. The largest growers in terms of global transfer market share are the BoGu-hubs Dubai (+3.0 pp) and Istanbul (+2.0 pp), which could increase their individual transfer rates from 41% to 53% and from 35% to 47%, respectively, as well as the Chinese airports (between +0.4 pp and +0.7 pp). In contrast, most airports in the U.S. (except New York JFK) stagnated or have lost market shares and now handle a higher share of local traffic than in the past.

Table 2. 2002-2018 transfer rates and worldwide transfer market shares of the 25 largest airports in 2018.

Airport	Dep. Pax	Transfer Rates					Worldwide Transfer Market Share					
		2002	2006	2010	2014	2018	2002	2006	2010	2014	2018	Change (pp)
ATLANTA	51,704,863	67%	67%	68%	69%	62%	5.9%	5.7%	6.1%	5.8%	5.0%	-0.9%
BEIJING	50,797,035	10%	17%	8%	8%	12%	0.3%	0.8%	0.6%	0.6%	1.0%	0.6%
DUBAI	44,144,724	41%	42%	51%	51%	53%	0.7%	1.3%	2.4%	3.1%	3.7%	3.0%
LOS ANGELES	42,620,069	32%	27%	27%	26%	21%	2.3%	1.7%	1.6%	1.6%	1.4%	-0.9%
TOKYO HND	41,921,596	43%	19%	4%	4%	6%	3.2%	1.0%	0.2%	0.3%	0.4%	-2.8%
CHICAGO ORD	39,628,481	50%	51%	53%	49%	43%	3.6%	3.7%	3.5%	2.9%	2.7%	-0.9%
LONDON LHR	39,095,919	28%	32%	31%	32%	31%	2.0%	2.1%	1.9%	1.9%	1.9%	-0.1%
JAKARTA	37,049,117	13%	14%	6%	8%	7%	0.2%	0.5%	0.2%	0.4%	0.4%	0.2%
HONG KONG	36,870,151	30%	33%	32%	29%	29%	1.1%	1.4%	1.6%	1.6%	1.7%	0.6%
SHANGHAI PVG	36,692,491	10%	16%	9%	12%	14%	0.1%	0.5%	0.4%	0.6%	0.8%	0.7%
PARIS CDG	35,407,114	39%	39%	35%	37%	34%	2.0%	2.2%	2.1%	2.1%	1.9%	-0.1%
DELHI	35,248,750	12%	10%	13%	19%	12%	0.1%	0.2%	0.4%	0.7%	0.7%	0.6%
AMSTERDAM	34,865,439	48%	43%	43%	43%	39%	1.9%	1.7%	1.9%	2.0%	2.1%	0.2%
FRANKFURT	34,697,852	54%	55%	54%	58%	55%	2.8%	2.9%	3.1%	3.1%	3.0%	0.2%
GUANGZHOU	33,876,119	17%	20%	7%	9%	14%	0.3%	0.5%	0.3%	0.5%	0.8%	0.4%
SEOUL	33,023,089	28%	10%	20%	18%	14%	0.5%	0.4%	0.7%	0.7%	0.7%	0.2%
ISTANBUL IST	32,868,285	35%	32%	36%	41%	47%	0.4%	0.5%	1.1%	2.1%	2.4%	2.0%
DALLAS FORT W.	32,719,044	59%	57%	60%	60%	54%	3.4%	3.1%	3.4%	3.3%	2.8%	-0.6%
SINGAPORE	32,633,433	44%	38%	34%	28%	27%	1.3%	1.3%	1.5%	1.3%	1.4%	0.1%
DENVER	30,562,162	44%	48%	50%	42%	37%	1.8%	2.2%	2.7%	2.0%	1.8%	0.0%
NEW YORK JFK	30,434,964	15%	14%	22%	21%	17%	0.5%	0.6%	1.0%	1.0%	0.8%	0.3%
BANGKOK	30,214,142	30%	31%	30%	28%	24%	1.0%	1.4%	1.3%	1.1%	1.1%	0.2%
KUALA LUMPUR	29,928,305	41%	31%	21%	23%	17%	0.6%	0.7%	0.8%	1.0%	0.8%	0.1%
MADRID	28,467,852	41%	37%	33%	34%	33%	1.5%	1.7%	1.5%	1.2%	1.5%	0.0%
SAN FRANCISCO	27,715,890	31%	29%	23%	22%	23%	1.2%	1.0%	0.9%	0.9%	1.0%	-0.2%

We further observe that the global market share in transfer passengers has remained stable for the traditional Western European hubs, despite heavily declining individual transfer shares for Madrid (from 41% town to 33%) and Paris (from 39% to 34%). Despite the introduction of long haul flights in 2010, the ”biggest loser” is Tokyo Haneda airport for which the results indicate decreasing transfer rates from 43% in 2002 to 6% in 2018, and a 2.8 pp decrease in global transfer market share. A deeper look into the dataset reveals that the number of domestically connecting passengers at Haneda has decreased massively both for Japan Airlines and All Nippon Airways.

4.3. Airports with highest transfer rates

We finally share those 20 airports out of the global Top 200 passenger airports in 2018 that account for the highest transfer rates, and compare this group to the year 2002. In 2002, every other airport of those twenty with the highest individual transfer rates were located in the U.S., including the whole Top 5 (Charlotte 76%, Atlanta 67%,

Dallas 59%, Houston 58% and St Louis 56%). These were joined by key European hubs (Frankfurt, Amsterdam, Copenhagen and Zurich) with transfer rates between 44% and 54%, and by three airports in Central/South America (Panama 54%, Sao Paulo 52% and Brasilia 44%). The only Middle East/Asian airports to appear in the list of the airports with highest transfer rates were Abu Dhabi (52%), Doha (47%) and Singapore (44%).

Table 3. Airports with the highest transfer rates 2002 vs. 2018.

Year	2002		2018	
Position	Airport	Transfer rate	Airport	Transfer rate
1	CHARLOTTE	76%	PANAMA CITY	77%
2	ATLANTA	67%	DOHA	76%
3	DALLAS FORT WORTH	59%	ABU DHABI	72%
4	HOUSTON IAH	58%	CHARLOTTE	67%
5	ST LOUIS	56%	ADDIS ABABA ***new***	66%
6	PANAMA CITY	54%	ATLANTA	62%
7	FRANKFURT	54%	FRANKFURT	55%
8	ABU DHABI	52%	DALLAS FORT WORTH	54%
9	COPENHAGEN	52%	DUBAI ***new***	53%
10	SAO PAULO GRU	52%	HOUSTON	50%
11	SALT LAKE CITY	51%	MUSCAT ***new***	47%
12	DETROIT	50%	ISTANBUL ***new***	47%
13	MINNEAPOLIS / ST PAUL	50%	CHICAGO	43%
14	CHICAGO	50%	MOSCOW SVO ***new***	42%
15	AMSTERDAM	48%	DETROIT	41%
16	DOHA	47%	MUNICH ***new***	40%
17	ZURICH	44%	AMSTERDAM	39%
18	SINGAPORE	44%	CHICAGO	38%
19	BRASILIA	44%	HELSINKI ***new***	38%
20	DENVER	44%	DALLAS FORT WORTH	38%

For 2018, the list only contains eight U.S. airports with considerably lower transfer rates. Frankfurt (55%) is still more dependent on transfer passengers than Paris CDG or London Heathrow, both of which are still not among the Top 20. A reason for this could be the higher decentralism in Germany compared to the UK or France, making it more difficult for FRA to generate sufficient local traffic. Panama, Doha and Abu Dhabi could increase their transfer rates to 77%, 76% and 72%, respectively. In the case of Doha and Abu Dhabi, this is due to strong capacity growth provided by Qatar Airways and Etihad Airways, which highly surpasses local demand. Panama is less known and smaller than the Gulf hubs but has developed into an important regional hub by Copa Airlines. New to the Top 20 are seven airports: three more in the Middle East (Dubai, 53%, Istanbul, 47%; and Muscat, 44%), three specialized/more niche hubs in Europe (Moscow Sheremetyevo, 42%; Munich, 40%; and Helsinki, 38%; and Addis Ababa in Ethiopia (66%), reflecting the network growth of Ethiopian Airlines.

5. Conclusion

Airport transfer passenger numbers or shares are usually not available from official sources but might be useful for many reasons, such as airport planning and forecasting, policymaking, or just airport categorization. To fill this data gap, we derive transfer passenger shares from ‘segment split data’ provided by the Sabre MI database. This

database, compiled from MIDT data and estimates for non-GDS bookings, is widely used by airlines, airports, researchers and consultants for market analyses. We used the methodology to map the development of transfer traffic worldwide over the period 2002-2018, and to identify the world's leading transfer airports and regions and any significant shifts. At an aggregated, worldwide level, transfer passenger volumes grew only slightly, while the number of direct flying airport passengers doubled. The results further show declining transfer rates and global transfer market shares for most of the largest U.S. hubs, as well as an increasing role of the BoGu (Bosporus-Gulf) region. The main European hub airports were stagnating, but more specialized/niche hubs like Moscow or Helsinki could increase their relative positions.

The major weakness of the methodology and the Sabre MI dataset used is the non-consideration of self-connecting passengers, which often use LCC offering attractive one-way fares, and of stopover passengers. This might, on the one hand, lead to an underestimation of the number of actual transfer passengers for airports with high shares of LCC, like, e.g. in Europe, London Stansted, Barcelona, Milan or Cologne/Bonn. On the other hand, results for airports in places many passengers choose for stopovers, like Dubai, Abu Dhabi or Singapore, are also likely to be lower than in reality.

References

Beaver, A., 2005. A Dictonary of Travel and Tourism Terminology, CABI Publ, Wallingford/Cambridge, ISSN 9780851990200.

CAPA Centre for Aviation, 2013. Lufthansa, Air France-KLM, IAG adopt short haul initiatives to combat LCCs: Airlines in transition, 7 February 2013, https://centreforaviation.com/insights/analysis/lufthansa-air-france-klm-iag-adopt-short-haul-initiatives-to-combat-lccs-airlines-in-transition-96612 (retrieved 27 April, 2018).

Cattaneo, M., Malighetti, P., Paleari, S., Redondi, R., 2017. Evolution of the European network and implications for self-connection, Journal of Air Transport Management, 65, 18-28.

Civil Aviation Authority, 2008. Connecting passengers at UK airports, London, November 2008, http://www.caa.co.uk/docs/5/Connecting_Passengers_at_UK_Airports.pdf (retrieved 27 April, 2018).

De Barros, A.G., Somasundaraswaran, A.K., Wirasinghe, S.C., 2007. Evaluation of level of service for transfer passengers at airports. Journal of Air Transport Management 13, 293-298.

De Neufville, R., Odoni, A.R., 2003. Airport systems: planning, design and management. McGraw-Hill.

De Neufville, R., Rusconi-Clerici, I., 1978. Designing airport terminals for transfer passengers. Journal of Transportation Engineering 104 (6), 775-787.

Dobruszkes, F., 2013. The geography of European low-cost airline networks: a contemporary analysis. Journal of Transport Geography 28, 75-88.

Done, K., 2008. Important role of transfer passengers. Financial Times, November 10, 2008, https://www.ft.com/content/3fd43fd2-af6e-11dd-a4bf-000077b07658 (retrieved 16 June 2020).

Grimme, W., 2011. The growth of Arabian airlines from a German perspective – A study of the impacts of new air services to Asia, Journal of Air Transport Management, 17 (6), 333-338.

IATA (n.y.), The Impact of September 11 2001 on Aviation, available at http://www.iata.org/pressroom/Documents/impact-9-11-aviation.pdf (retrieved 27 April, 2018).

Kanafani, A., Ghobrial, A. A., 1985. Airline hubbing - Some implications for airport economics. Transportation Research Part A: General 19 (1), 15–27.

Maertens, S., 2012. Estimating the market power of airports in their catchment areas – a Europe-wide approach, Journal of Transport Geography, 22, 10–18.

Maertens, S., Pabst, H., Grimme, W., 2016. The scope for low-cost connecting services in Europe – Is self-hubbing only the beginning?, Research in Transportation Business & Management, 21, 84-93.

Munich Airport, (n.y.), Faszination Flughafen, https://www.munich-airport.de/_b/00000000000000000747414bb585a9537/zahlen_und_fakten.pdf (retrieved 16 June, 2020).

Müller, J., Bilotkach, V., Fichert, F., Niemeier, H.-M., Pels, E., Polk, A., 2010. Study of the economic market power on the relevant market(s) for aviation and aviation-related services on the Amsterdam Airport Schiphol. Study commissioned by the Netherlands Competition Authority (NMa), Berlin.

Redondi, R., Malighetti, P., Paleari, S., 2012. De-hubbing of airports and their recovery patterns. Journal of Air Transport Management 18 (1), 1-4.

Sabre, 2014. Sabre AirVision Market Intelligence, Version 5.7. User Guide.