International Transport Forum

Airport Capacity Expansion Strategies in the era of Airline Multi-hub Networks

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1. INTRODUCTION

Many major airports are hubs for network carriers at the same time as serving a large local market. The complementarity between these functions is often seen as a prerequisite for viable hub operations, suggesting that spreading the hub network over multiple airports can be very costly and damages the corner stone of the hub operation: the creation of scope and density economies.

However, there is certainly scope for substitution of some airport services by alternative hubs, as the rise of multi-hub airline networks shows. The multi-hub network strategy is an increasingly important phenomenon in today's air transport industry. Due to the consolidation of both the European and US air transport industry, more and more network carriers operate out of multiple connecting hubs.

Hence, the strategies of network carriers need to be taken into account in assessing future demand for airport capacity. The requirements of low cost and other primarily point-to-point carriers are equally important, but different.

The objective of this paper is to add to the understanding of the network strategies followed by (multi)hub network carriers; and to draw conclusions from this understanding for the capacity expansion strategies of airports, in particular for the London Metropolitan Area. Based on our understanding of the network strategy of multi-hub airlines and hub operations in general, what can be said about airport expansion strategies in multi-airport regions? To what extent is a single airport expansions strategy to be preferred over a more decentralized capacity growth in the same metropolitan region?

The paper is outlined as follows. We start our discussion with the benefits of hubbing, both from the perspective of the network carrier as well as from the perspective of the metropolitan region. We then shift our attention to the question why airlines decide to operate out of multiple hubs. Next, empirical evidence will be provided on the actual specialization patterns in European airline multi-hub networks. Finally, the paper concludes by discussing different airport expansion strategies from the perspective of multi-hub airline network strategies.

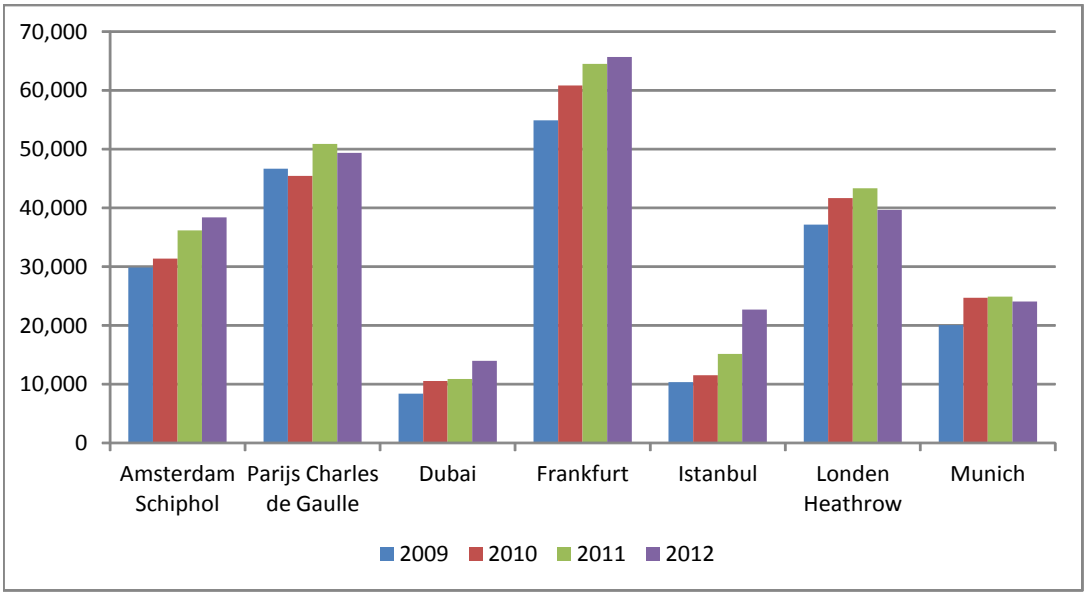
2. HUBS, NETWORK SERVICE AIRLINES AND THEIR VALUE FOR SOCIETY

2.1. Hubs: factories to create route density

Liberalization of air transport markets worldwide has contributed significantly to the rise of airline hub-and-spoke networks. Deregulation of the US domestic market in 1978 stimulated many legacy airlines to convert their networks into hub-and-spoke networks, spatially and temporally concentrated around one or multiple hubs. Liberalization of the intra-EU market during the 1990s resulted in the adoption and intensification of airline hub-and-spoke networks in Europe.

Also elsewhere in the world, the hub-and-spoke network is quickly gaining grounds. The largest hubs in Europe in terms of connecting opportunities are Frankfurt, Paris CDG, Heathrow, Amsterdam and Munich (figure 1a). Relatively nearby hubs such as Istanbul and Dubai are quickly gaining ground (figure 1b). This new generation hub carriers competes increasingly with the European network carriers on markets between Europe and Asia/Middle East/Africa, in addition to the already established competition from hubs in Europe and North-America (figure 1c). Given the fleet orders and airport investments under way, their role in the long-haul market to and from Europe can be expected to grow substantially during the next decade

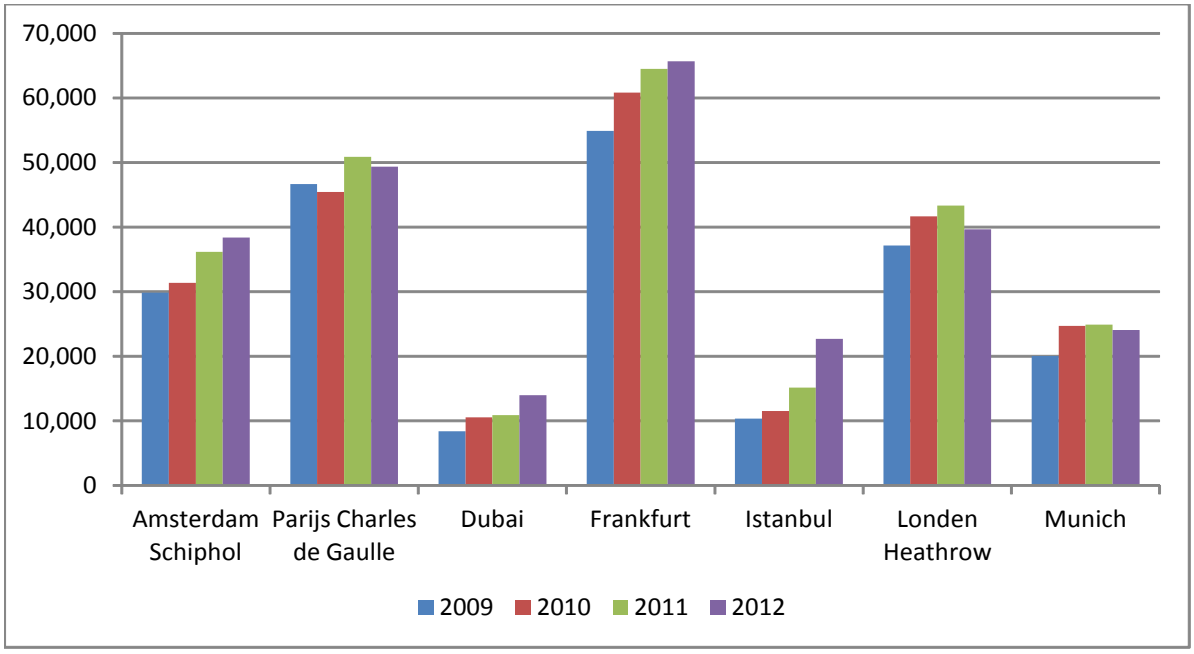
Figure 1a. **Hub connectivity of selected European and Middle East hubs**[1]



Source: SEO Netscan, 3rd week September 2012

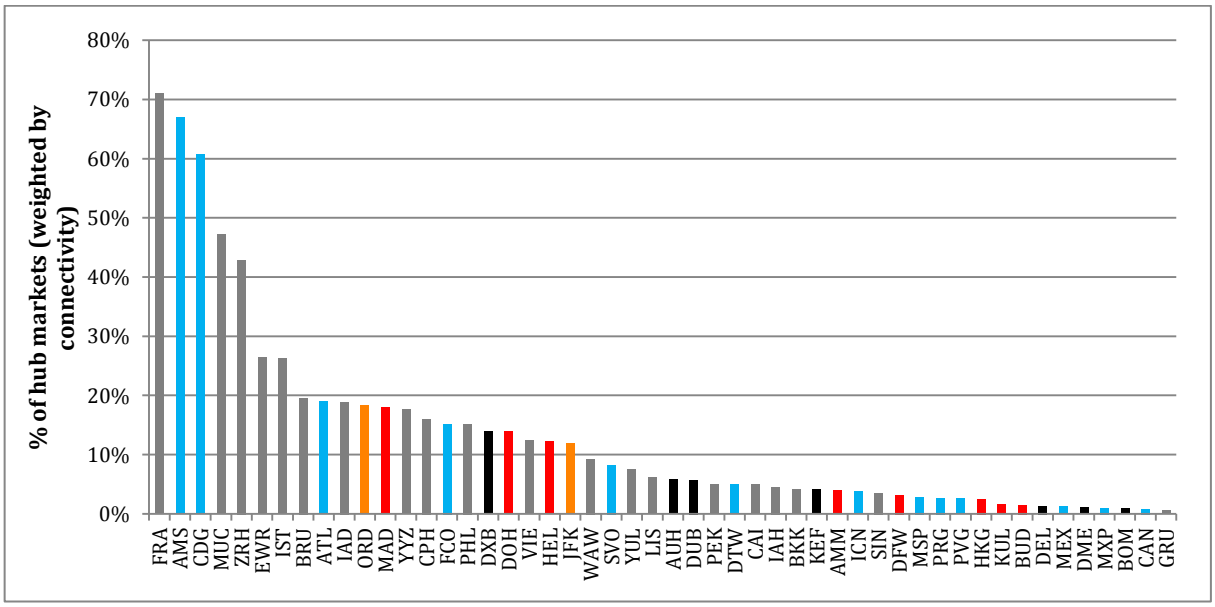
1. Hub connectivity is defined here as the number of connecting opportunities per week, weighted for the quality of each individual connection in terms of transfer and detour time, and meeting the MCT criterium as well as being an online connection within a single airline or alliance. See Redondi & Burghouwt (2013) for a discussion of connectivity measures

Figure 1b. **Development of hub connectivity : 2009-2012**



Source: SEO Netscan, 3rd week September 2012

Figure 1c. **Percentage of overlap of the connecting market via Heathrow by competing/alternative hub**



Source: SEO Netscan; OAG (2011); blue: SkyTeam hub; grey: Star hub; red: oneworld; black: hub of non-allied airline

For airlines, hubs are not a goal in themselves. They are a means for airlines to add value to on both the demand and cost side. They are "factories to create route density" according former Northwest executive Mike Levine. Airlines combine different origin-destination flows

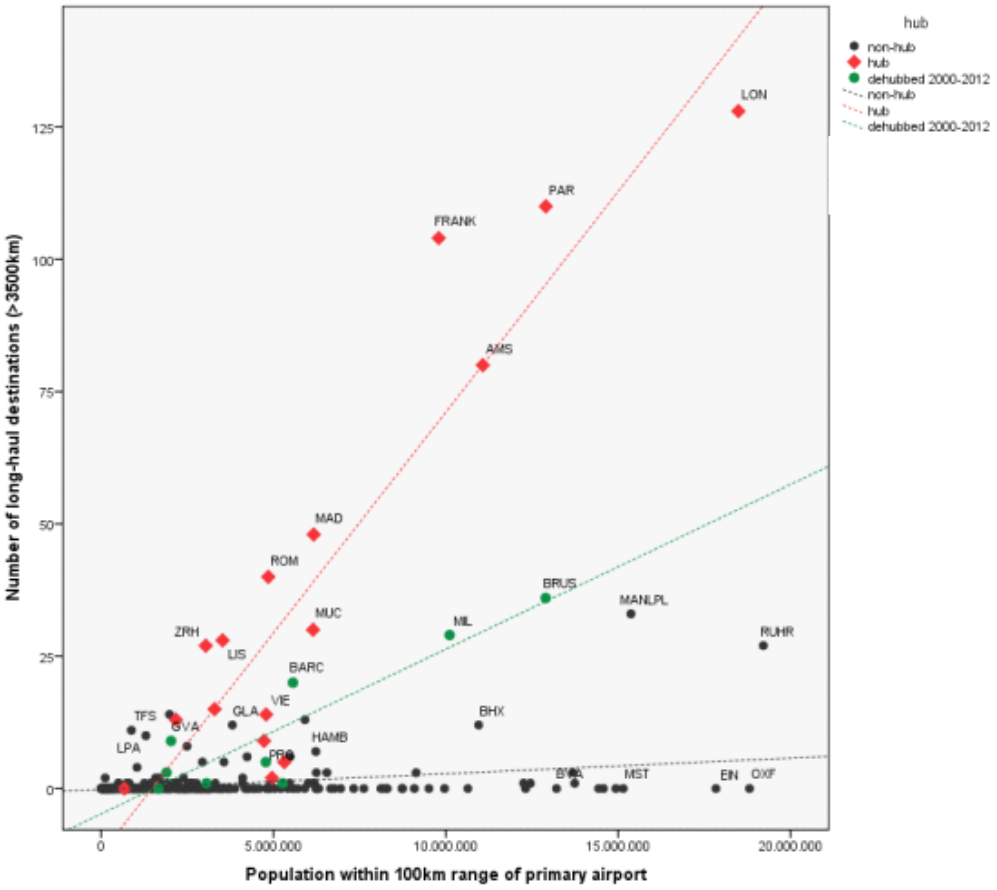
on a single route using their hubs as consolidation points. In general, hubs add value to an airline through beyond market access. Moreover, they average out natural peaking of demand, can generate rents and provide opportunities for mixing prices (Button 2002; Gillen & Morrison 2005). As Nero (1999) points out, the advantages of hubbing become stronger with a growing network, because of the externalities and spill over effects of additional spokes.

2.2. Hubs are factories to create connectivity

Hubs provide local consumers with a much wider network scope at higher frequency than would be possible based on local origin-destination demand alone (figure 2). In other words, they generate connectivity for local consumers travelling to and from the hub's metropolitan area. Hub-and-spoke operations allow metropolitan regions to grow beyond the size of their own local market in terms of connectivity.

Figure 2a shows that for large metropolitan areas, hubs add substantially to the long-haul direct connectivity of the metropolitan area. It is mainly in the field of long-haul direct connectivity where hubs add value for metropolitan regions. The difference regarding short-haul connectivity between metropolitan areas with and without large hub operations is more diffuse and smaller (figure 2b). Note that available capacity and the presence of a hub operation are closely interlinked for most large European metropolitan regions: Large metropolitan areas without a substantial hub operation have low levels of long-haul connectivity. At the same time, available peak-hour capacity does may not allow for a substantial hub operation.

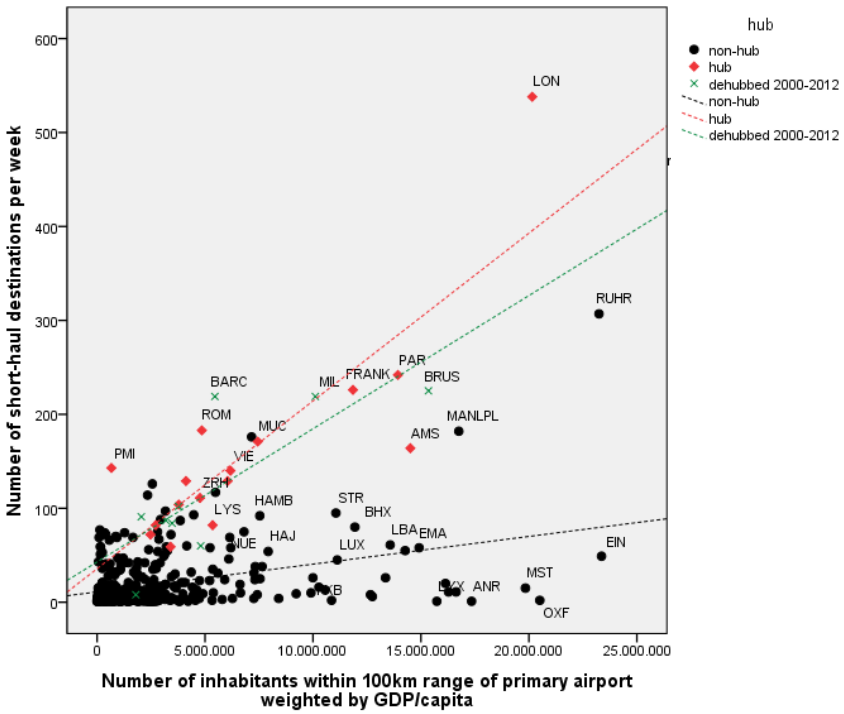
Figure 2a. **Hubs allow metropolitan areas to grow beyond the size of their local market**[2]



Source: catchment area database

2. This figure has the purpose to show the power of hubs in terms of connectivity. Many methodological remarks can be made: population within a 100km range for metropolitan areas with multiple airports is an underestimation of the real catchment area potential, as only the population has been counted within 100km range from the primary airport. For London, this means that the airport is underperforming in long-haul connectivity relative to its local market. It is also acknowledged that a 100km range gives only a first rough indication of the catchment area as other factors such as airport competition (route overlap), time sensitivity, segmentation of airport traffic and landside access quality (travel time) play a role.

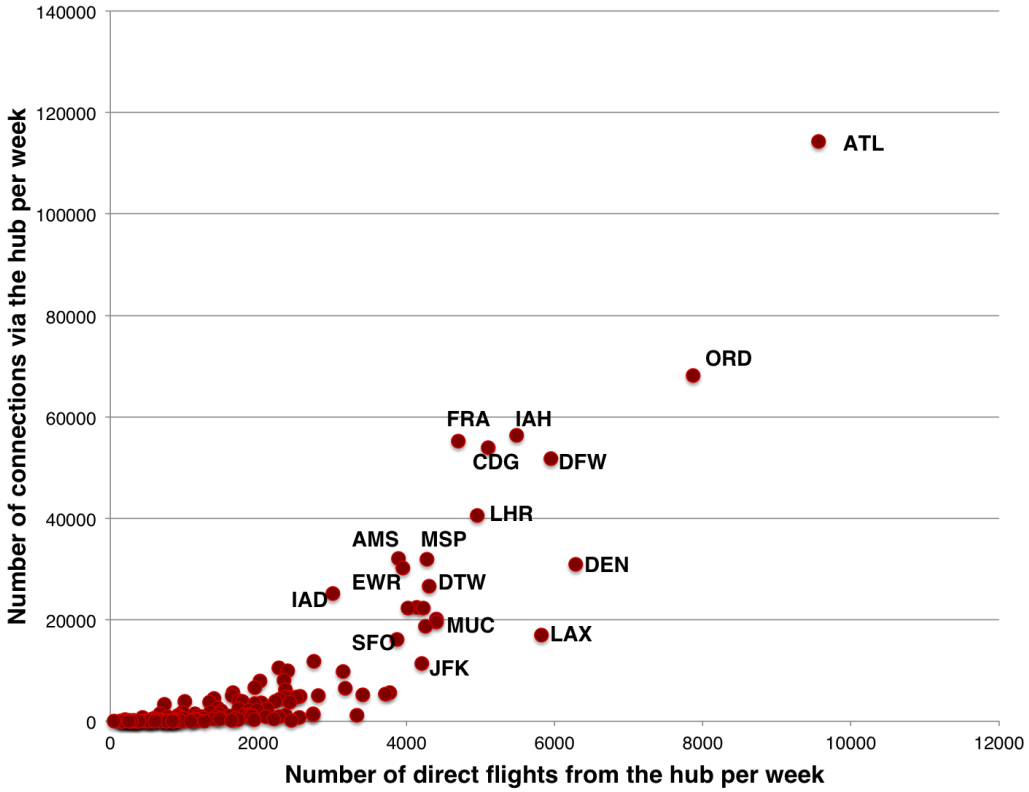
Figure 2b. **Short-haul direct connectivity versus catchment area size**



Source: catchment area database

In general, hubs reduce time travel costs for consumers by providing more direct and more frequent links, with the main distinguishing effect being present in the supply of direct long-haul connectivity. By providing connectivity to transfer passengers, hubs generate connectivity for local consumers. These connectivity advantages for local and connecting passengers tend to get bigger when hubs grow larger. They increase in a nonlinear way. One large hub generates more connectivity than the sum of two hubs of half the size (figure 3). The dominance of the hub carrier at the airport, spatial centrality of the hub and the quality of the wave-system further influence the performance of hub airports as depicted in figure 3.

Figure 3. **The multiplier effect of hubs: connections via the hub increase in a non-linear way with a growing direct network**[3]



Source: SEO Netscan 2009

Having a broad portfolio of direct routes resulting from hubbing activities delivers economic benefits. The direct benefits of reduced travel costs "ripple" through the rest of the economy. Some of the indirect effects are really additional (such as agglomeration effects), others are merely passed on from stakeholders in the air transport sector to players outside the industry. Worthwhile mentioning in the European context is the study of Bel & Fageda (2009). They find that a 10% increase in intercontinental direct routes results in a 4% growth in international headquarters in European metropolitan areas. Vinciguerra et al. (2012) conclude that connectivity by air contributes significantly to the performance of European regions in R&D activities, confirming the role that airports play for integrating cities in global networks. Furthermore, homebased hub carriers generate more employment than non-home based carriers, at least at the regional scale.

The downside of hubbing for local consumers is mainly found in the hub premiums charged by the hub carrier (Borenstein 1989; Leijsen et al. 2001) because of the market power in local markets to and from the hub. Yet, besides a form of market power, hub premiums may

3. Hub connectivity is defined as the number of connecting opportunities per week, weighted for the quality of each individual connection in terms of transfer and detour time, and meeting the MCT criterium as well as being an online connection within a single airline or alliance. See Burghouwt & Redondi (2013) for an overview of connectivity measures.

also reflect 'the monetary value of a direct versus a layover flight' (Leijsen et al. 2001) and the scarcity in airport capacity (Starkie 2006).

2.3. Success factors of hubs

Only few European airports have a hub status. This small number of airports takes account of a relatively large proportion of the direct, non-stop connectivity available to European consumers. The number of European non-hub airports is much larger, but their relative contribution to direct, non-stop connectivity is smaller. As demand is spread unequally in a geographical sense, successful hubs are nearly always located close to large urban areas: a large local O&D market gives a strong and captive demand basis on which to build the hub network, with higher yields than in the transfer segment.

Besides a strong and large O&D market, other factors play a role as well for performance of airports as a hub. The literature brings forward a list of typical hub success factors (e.g. Bootsma 1997):

- Central geographical location vis-à-vis the most important traffic flows and feeder airports
- Peak-hour capacity to facilitate an efficient wave-system structure of the hub airline
- Strong hub carrier being part of a global airline alliance
- Availability of traffic rights (market access)
- Short Minimum Connecting Time
- One terminal concept
- Competitive visit costs
- Good landside accessibility
- Available options for future growth
- Airport amenities

A strong path dependency is present in the development of hubs over time: there are clear cost, demand and connectivity advantages for the hub carrier to add new flights to an already established hub. Every new flight to the hub generates an increasing number of connections via the hub. In addition, moving a hub or establishing a new one is a costly operation. The other way around, airports that have lost their hub status do not easily regain it. According to a study of Redondi et al. (2012), only very few dehubbed airports have actually regained their hub status within a five-year time period after dehubbing, and their traffic growth has been slower than airports still having a hub status.

2.4. On the optimality of the single hub solution

Multi-hub networks are not an optimal solution compared to the single hub solution, as a number of theoretical studies on airline network choice have pointed out: each additional hub in the network reduces the corner stone of the hub strategy, the density economies. Furthermore, additional hubs bring in additional complexity costs (Duedden 2006; Wojahn 2001a&b).

Some studies provide empirical support for the optimality of the single hub solution: consolidation in the US and European airline industry has forced airlines to close down

secondary hubs in relative close proximity to primary hubs (Burghouwt 2005; Dennis 1994; Redondi et al. 2010). Examples in Europe include the dehubbing of Barcelona by Iberia (consolidation at Madrid), the dehubbing of Gatwick by British Airways (consolidation at Heathrow) and the dehubbing of Milan Malpensa by Alitalia (the consolidation at Rome FCO).

In a network simulation study for Europe, Adler and Berechman (2001) find that multi-hub networks with an effective geographical division tend to have the best ability for airlines to generate profits. O'Kelly (1998, p.177) states that 'a pure single hub allocation model would result in an efficient system, but one with great inconvenience for the passenger'.

Given the multiplier effect of hub growth, one large hub attract significantly more transfer passengers than two hubs of half the size (Goedeking 2010) and one large hub generates more connecting opportunities than two hubs of half the size (figure 3). Zuidberg (2012) finds in an empirical study that a larger number of hubs contributes positively to airline units cost, all other things being equal: the more hubs, the more costly the network is to operate.

A split hub operation -spreading a hub operation of a single carrier over two airports within the same metropolitan area- generally turns out not to be a feasible solution. One the one hand, the hub carrier will not be able to serve the same amount of connecting markets/connections as would be the case with a single hub solution. Hence, by splitting the hub operation over more airports, the carrier will lose economies of density, and is likely to lose market share in the connecting market because less connections can be offered. In addition, the carrier will need to duplicate at least part of its short-haul network on both hubs. Finally, long-haul services can be made more profitable by simply moving them from the secondary to the primary hub, without occupying to many scarce slots. Dennis (2005) provides an overview of the disadvantages of the split hub operation of British Airways at Heathrow and Gatwick until 2000/2001.

2.5. Multi-hub networks

Yet, the theoretical arguments for the single hub solution 'do not leave room for the kind of multi-hub networks that many major carriers operate' as Wojahn states (2001a, p. 268). The multi-hub network structure is an increasingly important phenomenon in today's airline networks, mainly driven by the ongoing consolidation in the airline industry.

Hence, there are reasons for airlines to deviate from the single hub solution in practice:

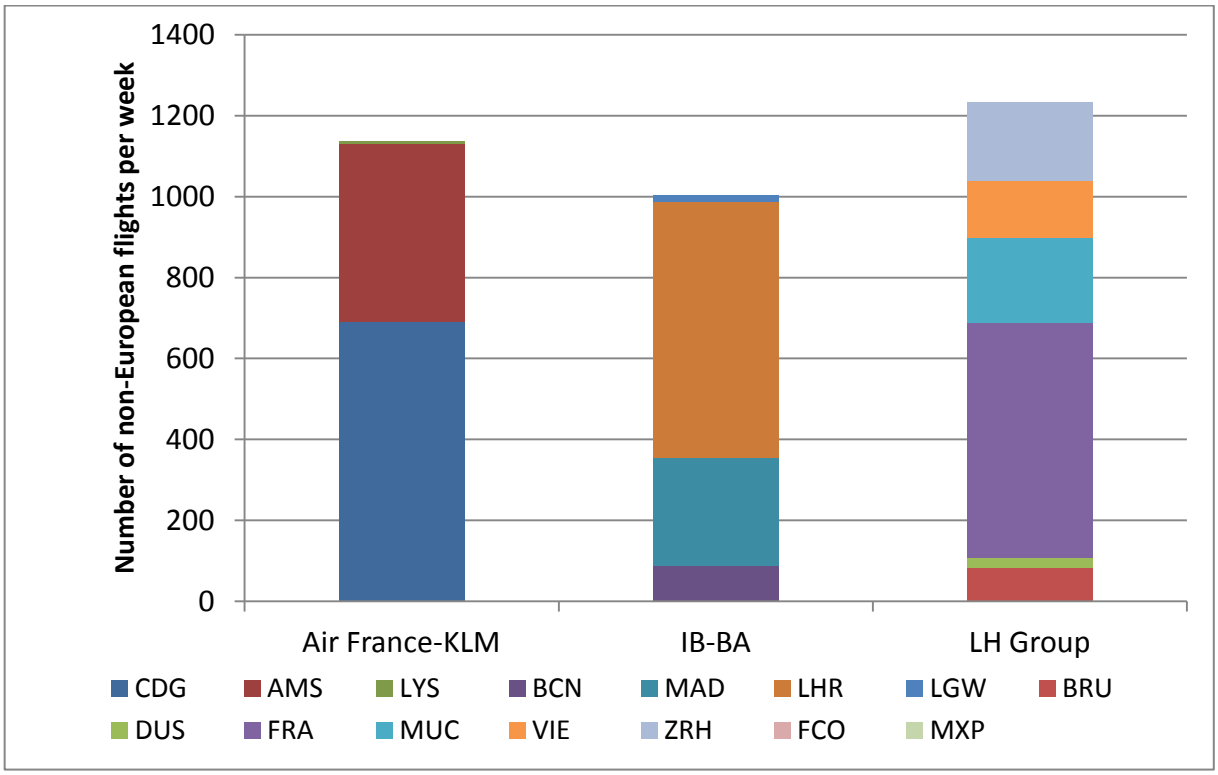
- *Spatial coverage and market access:* airlines need multiple hubs to increase spatial coverage and serve thin markets, either through multiple hubs in their own networks or through alliance hubs (Tretheway & Oum 1992). Single hub systems reach a natural ceiling when too many important transfer connections require excessive detours (Goedeking 2010). In addition, most of the world's origin-destination markets can only be served with connecting service through hubs. Many of the world's aviation markets are even too small for a single connect service and can be served profitably with multiple hub transfers only.
- *Level of demand:* Swan (2002) states that the natural development of airline networks is from skeletal to connected. Early airline network developments build passenger loads at hubs to use larger airplanes and achieve density economies. The focus is then on a minimum number of hubs. As demand grows, later network developments bypass initial hubs. Bypassing saves the costs of connections and establishes secondary hubs. Here, frequency development outweighs the loss of density economies.

- Duedden (2006) further supports Swan's argument for the long-haul market. He demonstrates that long haul, direct services from non-hub airports can grab a major share of the premium market. If additional revenues from direct services from a secondary hub are larger than the additional costs of direct services, the profit maximizing network configuration can take the shape of a multi-hub network. An example of such a development is Lufthansa's intercontinental route development at Düsseldorf.
- *Frequency game:* airlines can use a multi-hub system to play the 'frequency game', if total demand to an intercontinental destination allows for daily service from multiple hubs. By well-synchronizing the flights to the same destination from both hubs, the airline can offer competitive, complementary services on many connecting markets linked to this particular destination at different times of the day (Goedeking 2010). In addition, the airline will benefit from the high-yield local market at both hubs.
- *Capacity shortages at the primary hub*: Airlines may decide to open a secondary hub in order to accommodate market growth, when capacity constraints restrict growth at the primary hub's infrastructure (Goedeking 2010). Examples are Lufthansa's secondary hub at Munich, BA's (dismantled) hub at Gatwick and Turkish Airline's transfer of a number of operations from Istanbul Atatürk to Istanbul Sabiha Gökcen Airport.
- *Strategic positioning and entry deterrence:* Strategic positioning can be a reason for airlines to continue or start operating a secondary hub. A secondary hub can be used to deter entry by 'baby-sitting' scarce slots. In addition, operating out of multiple hubs gives the airline bargaining power over the airport operators (in terms of visit costs and airport development issues), because the hub carrier has an outside option for its hub operation.
- *Better aircraft utilization:* the use of multiple hubs allows hub airlines to schedule an aircraft departure from one hub and return to hub two. From an aircraft utilization perspective such aircraft routings can be more attractive than returning to the same hub. This type of routing is often used in the US but less in Europe (Dennis 2005).
- *Bilateral restrictions and aviation law:* the hybrid aviation regime may force airlines to operate long-haul services out of multiple hubs, although from a network point of view, consolidation on a single hub is more attractive. The worldwide aviation regime is a mosaic of liberalized air service agreements, open skies treaties, regulated and deregulated national/ regional aviation markets and traditional Bermuda-type air service agreements. Until EU-US Open Skies, for example, British Airways served partner hub Dallas from Gatwick instead of Heathrow due to bilateral restrictions (Wojahn 2001b; De Wit & Burghouwt 2005). In addition, as long as the Community clause is not accepted in all relevant bilateral agreements between the EU and third countries, EC member states must rely on such traditional nationality clauses. These clauses limit the extent to which a multi-national airline can shift non-EU services between their European hubs (Mendes de Leon 2009). Finally, access to many markets is only possible by making use of hubs of alliance partners. For example, European network carriers can only access most cities in China by means of an alliance with Chinese carriers and create connections through their hubs.
- *Unions:* pressure from unions of merged airlines can be a reason for airlines to continue to operate multiple hubs, although such a decision may not be optimal from a demand and cost side perspective.

2.6. Multi-hub networks in Europe

In Europe, three major multi-hub airline networks could be distinguished in 2012, consisting of networks of multiple hubs belonging to the same airline: the Air France-KLM network centred around Paris CDG and Amsterdam, the IAG network around Heathrow, Madrid and Barcelona and the Lufthansa Group using a various European hubs. These three networks are quite comparable in size of their aggregate long-haul network, with the Lufthansa Group being the largest of the three (figure 4).

Figure 4. **Number of non-European direct connections per week by hub carriers from the respective hubs, 3rd week September 2012**[4]



Source: OAG

The Air France-KLM network is a rather balanced network with respect to long-haul connectivity supply. In the Lufthansa Group network, Frankfurt dominates, supplemented with a number of secondary and tertiary hubs. In the IAG network, Heathrow is dominant but Madrid serves largely a unique network to Latin America.

4. Services of alliance partners not included.

3. SPECIALIZATION PATTERNS IN MULTI-HUB AIRLINE NETWORKS: SOME EMPIRICAL EVIDENCE

Although various scholars have simulated the development of multi-hub networks to search for the most profitable/optimal multi-hub network combination and hub location (see e.g. Adler & Berechman 2001; Martín & Román 2004; O'Kelly 1998), empirical evidence on actual specialization patterns in multi-hub networks in Europe remains limited.

De Wit & Burghouwt (2009) show in a brief study that the combined network of Air France and KLM is specialized along two axes: (1) the size of total passenger demand between Europe and a certain final destination and (2) the relative size of the local origin-destination markets. Air France-KLM serves destinations with a sufficiently large demand from the European market from both hubs. At such destinations, Air France-KLM can play the dual hub frequency game: the connecting markets involved can be served at different moments of the day via either of the hubs, thereby benefitting from the local demand at both hubs. The European market size is large enough to feed passengers to both hubs and justify a daily frequency from both. Either Paris CDG or Amsterdam Schiphol serve the smaller destinations uniquely, which do not have enough demand (local and transfer) to justify at least a daily frequency from both hubs. The hub with the largest local origin-destination market is generally the preferred hub for a smaller intercontinental destination. Further long-haul specialization has taken place along these two axes during the last few years.

To gain a better understanding of multi-hub networks, let us briefly discuss the hub specialization in the Air France-KLM network and Lufthansa long-haul network along the two axes of total passenger demand and the relative size of the local origin-destination markets.

3.1. The complementary multi-hub system of Air France-KLM

In 2003, the merger between Air France and KLM was announced. The new airline entity operated a dual hub system consisting of the intercontinental hubs of Paris Charles de Gaulle (CDG) and Amsterdam Airport, supplemented with a regional hub at Lyon. The hub operation at Paris CDG is about 1.5 times as big as the one at Amsterdam, measured in number of connecting possibilities per week. However, in terms of the share in long-haul destinations, the difference between the two hubs is smaller. Air France-KLM announced publicly that it would continue to operate both bases as intercontinental hubs under the motto 'natural flows via natural hubs'.

The Dutch government perceived a risk that Amsterdam might lose part of its intercontinental network to Paris CDG on the longer term, mainly because of the short distance between both airports (400km) and a competitive advantage of Paris CDG over Amsterdam: the larger physical capacity of Paris CDG and the larger local market of Ile-de-France.

Therefore, the Dutch state agreed with Air France-KLM upon the so-called State Assurances in order to safeguard Amsterdam's role as an intercontinental hub. These assurances entailed the guarantee that Air France-KLM would continue to operate 42 intercontinental 'key destinations' out of Amsterdam for a period of five years. In addition, the assurances

included the guarantee that Air France-KLM would develop the hubs of Amsterdam and Paris CDG in 'an equal way'.

Against this background, figure 1 shows the specialization pattern of the hub system, based on the two axes of total European seat capacity to a certain long-haul destination (as a proxy for total passenger demand out of Europe to the long-haul destination) and the origin-destination ratio. The origin-destination ratio is the size of the O&D market to a certain long-haul destination at the primary hub, divided by the O&D market to the same destination at the secondary hub[5].

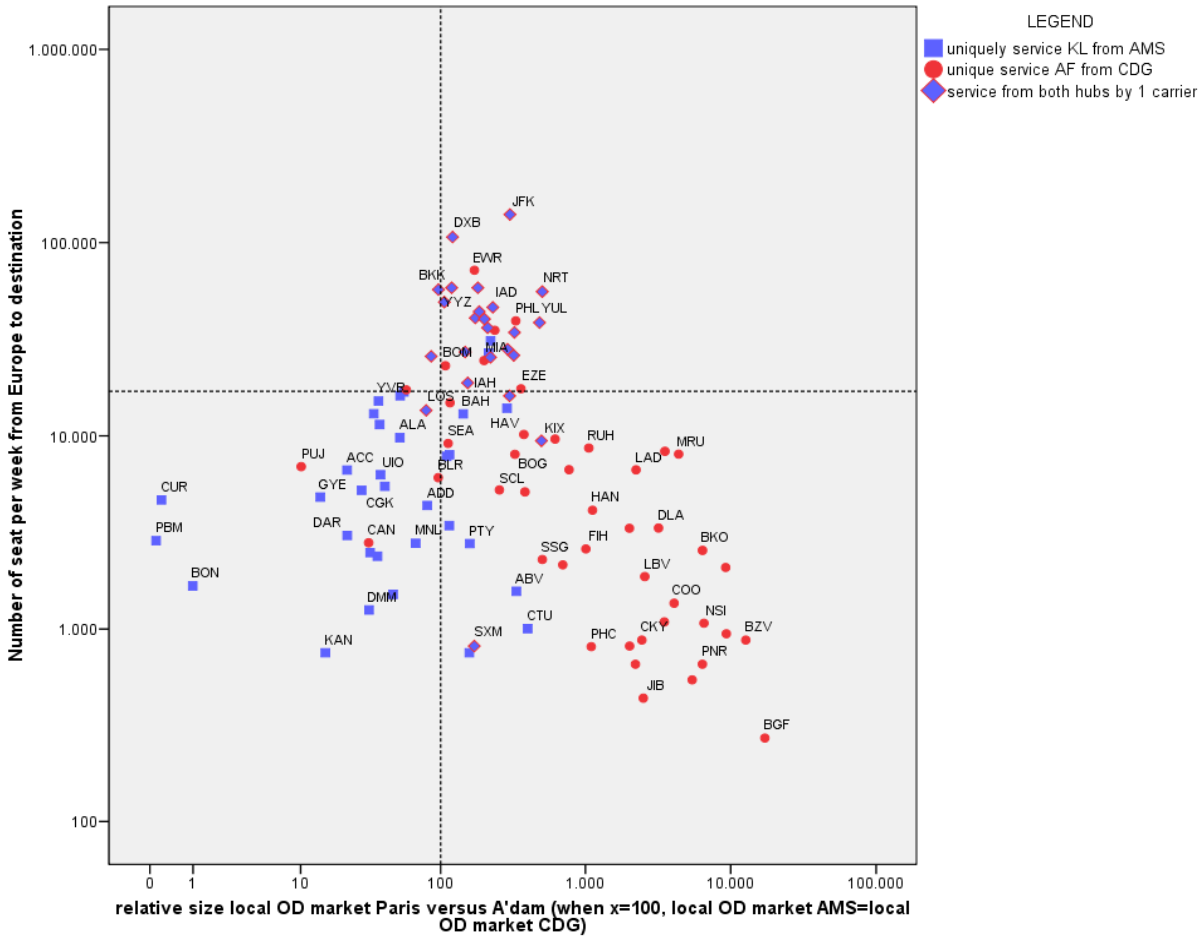
The horizontal axis shows that large European markets with more than 20.000 seats per week are generally served with direct flights from both Amsterdam and Paris CDG. In other words, the market from Europe to a certain destination is sufficiently large to serve it with at least a daily frequency from two hubs. The large European market allows the carrier to fill the flights with transfer demand from all over Europe, in addition to local origin-destination demand. The airline benefits from the high yield local origin-destination demand at both hubs and gives consumers more choice for departure/arrival time because connections are possible at different times of the day via different hubs. Finally, dual hub service allows the carrier to increase the number of connecting markets served as Amsterdam and Paris have partly a unique European feeder network (with Paris CDG focusing slightly on Southern Europe and Amsterdam on Northern Europe).

Destinations with a smaller European market potential (below 20.000 seats per week) are served uniquely from one of the hubs. The watershed between unique service from either Amsterdam or Paris CDG is in the relative size of the origin-destination market. When the market size is larger at Paris CDG, Air France-KLM serves the intercontinental destination from Paris. It is more attractive for the airline to place smaller destinations at the hub with the largest (and higher yielding) origin-destination market. Many Francophone destinations belong to this category. When the origin-destination market is larger at Amsterdam, Air France-KLM serves the destination from Amsterdam. Because the local origin-destination market of Amsterdam is on average smaller than the one of Paris, Air France-KLM serves more destinations uniquely from Paris than from Amsterdam.

Hence, from a static point of view, the Air France-KLM motto 'natural flows via natural hubs' makes sense. But also from a dynamic point of view, this holds true, looking at the shifts of destinations between both hubs over time. The destinations Amman, Beirut, Damascus, Caracas and Casablanca were all served from both hubs in 2003. These destinations are however relatively small in terms of European market size. As the origin-destination size for these destinations is larger at Paris than at Amsterdam, the airline cancelled the Amsterdam service. The reverse was true for destinations such as Manila and Jakarta. These destinations were served from both hubs before the merger and were concentrated at Amsterdam after the merger.

5. Note that our data only give insight into actual demand volumes, not into market stimulation. A new direct intercontinental service from a hub reduces travel costs for consumers and will generate additional passenger demand. In addition, the data we had at our disposal only provide insight into demand volume, not into passenger yield.

Figure 5. **Hub specialization profile Amsterdam versus Paris CDG (Air France-KLM) (long-haul routes)** [6]



Source: OAG and MIDT; own calculations

The tertiary hub in the Air France-KLM system is Lyon. In 2008, Air France-KLM served no long-haul destinations from Lyon and just one non-European destination (Casablanca). Even the largest intercontinental markets have no direct service. The main reason seems are the availability of excellent landside access (TGV connection between Lyon and Paris CDG), a limited local market, a small European feeder system and limited peak-hour capacity at Lyon. For virtually all long-haul destinations, origin-destination demand at Paris is much larger than at Lyon[7]. Hence, the Lyon-hub fulfils a role as a European origin-destination airport and regional hub between the French regions and Europe, in a geographical market that Paris CDG cannot cover because of its location or too lengthy transfer times.

6. The cases in the 'wrong' quadrant (such as Newark and Mumbai) are slightly misleading: most of them were actually served by SkyTeam alliance partners from Amsterdam.

7. This may partly reflect the availability of high-speed rail feeder system. Local passengers travelling from Lyon to Paris CDG by TGV are counted as local Paris passengers in our data.

3.2. Overflow hubs in the Lufthansa system

Does the same pattern hold for the multi-hub system of the Lufthansa Group? We will consider the specialization between Frankfurt and Munich, as well as Frankfurt and Dusseldorf.

In 2008, the multi-hub system of the Lufthansa Group consisted of four hubs: a primary intercontinental hub at Frankfurt, two secondary intercontinental hubs at Munich and Zurich and a tertiary hub at Dusseldorf. The development of Munich was mainly because of capacity restrictions at Frankfurt and the development of the new Munich airport during the 1990s. Zurich was added to the system as a result of the merger between Lufthansa and Swiss in 2005. In 2009, Vienna and Brussels were added to the multi-hub system as a result of the mergers with Austrian and Brussels Airlines. Here, we consider briefly the Frankfurt, Munich and Dusseldorf hubs.

Munich and Dusseldorf have a small unique long-haul network. They mainly play a role as 'overflow' hubs to Frankfurt. In contrast to the Amsterdam-Paris CDG multi-hub system, 'natural' origin-destination flows seem to lack at Munich[8] (figure 2). Only in markets with a high demand between Europe and the long-haul destination (such as New York JFK and Dubai), Lufthansa provides direct, non-stop service from both Frankfurt and Munich. In addition, the threshold for direct service is higher than for the Amsterdam-Paris system.

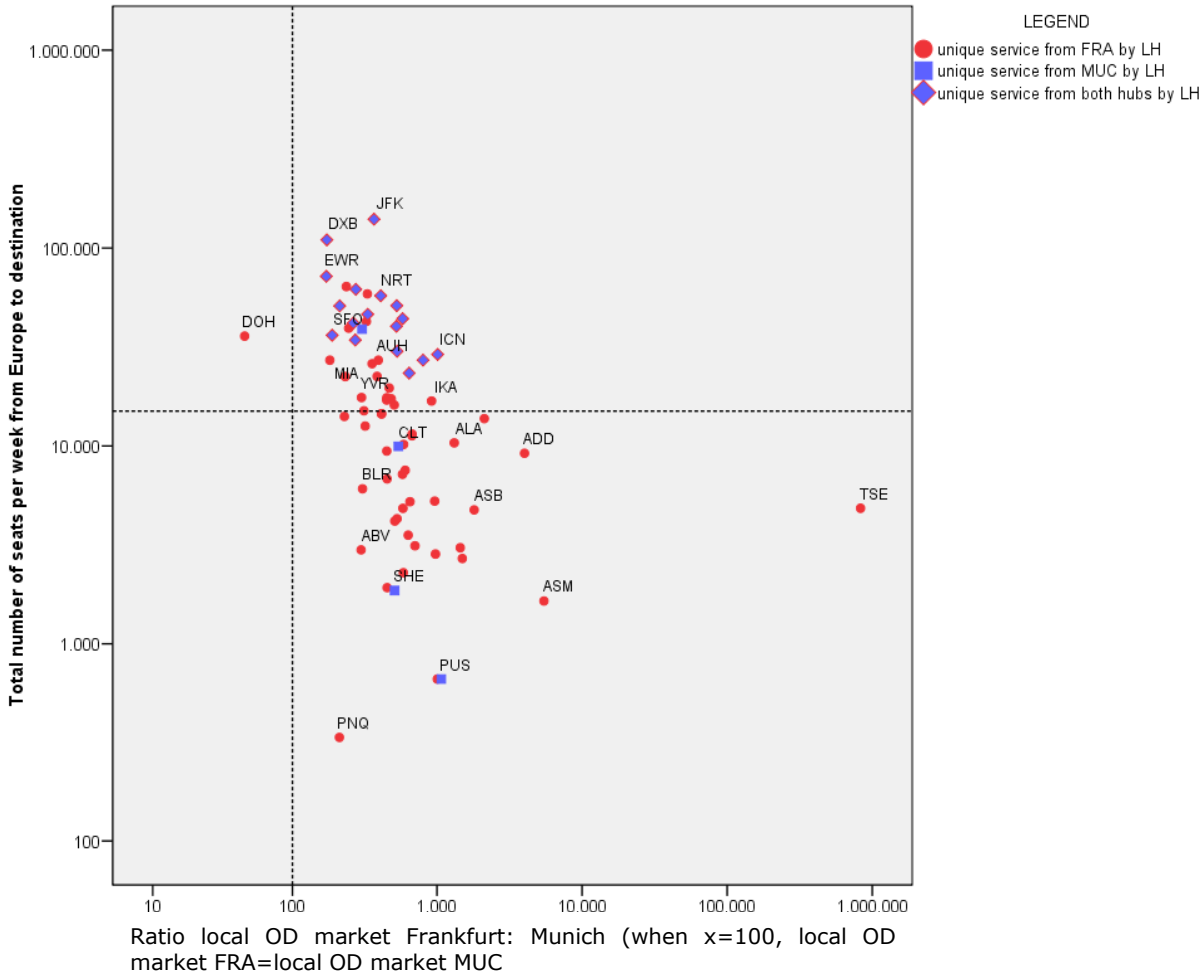
Dusseldorf is a tertiary hub in the Lufthansa system and has few long-haul direct services. The threshold for direct service at Dusseldorf is higher than at Munich (60.000 seats per week). This can be explained by Lufthansa's much weaker feeder system at Dusseldorf, which in turn can be understood by the limited peak-hour capacity at Dusseldorf. These limitations do not allow developing an extensive feeder network. Hence, long-haul flights are constrained to the largest, premium origin-destination markets. Furthermore, dual hub service is likely to be first provided at a competitive frequency from Munich and only when total European market is large enough, at Dusseldorf as well. Finally, excellent high-speed rail connections are available between Dusseldorf and Frankfurt Airport[9], reducing the need for direct long-haul flights from Dusseldorf in particular as far as leisure and VFR passengers are concerned.

In sum, Munich and Dusseldorf are *overflow hubs* for Frankfurt as far as the long-haul network is concerned. This contrasts with the role of Amsterdam as a strong *complementary hub* in the network of Air France-KLM, having its own specific role in smaller markets.

8. Note that our data only give insight into actual demand volumes, not into any market stimulation as a result of a direct flight out of Munich. In addition, passengers travelling by high speed rail from Munich to Frankfurt Airport to take their long-haul flight are counted as local Frankfurt passengers.

9. A 75-90 min train journey

Figure 6. **Hub specialization profile Frankfurt versus Munich (Lufthansa) (long-haul routes)**



Source: OAG and MIDT; own calculations

3.3. The consolidated multi-hub specialization pattern

We have consolidated the results for the various individual multi-hub specialization profiles into one aggregate profile (figure 7). In other words, the destinations in Air France-KLM system, the Lufthansa system, the Iberia system and Alitalia system have been put together in one hub specialization profile. For each destination for a combination of two hubs part of the same multi-hub network (e.g. AMS-CDG or FRA-MUC), it is shown if the destination has single hub service from the primary hub (the largest of the two), single hub service from the secondary hub (the smallest of the two) or dual hub service.

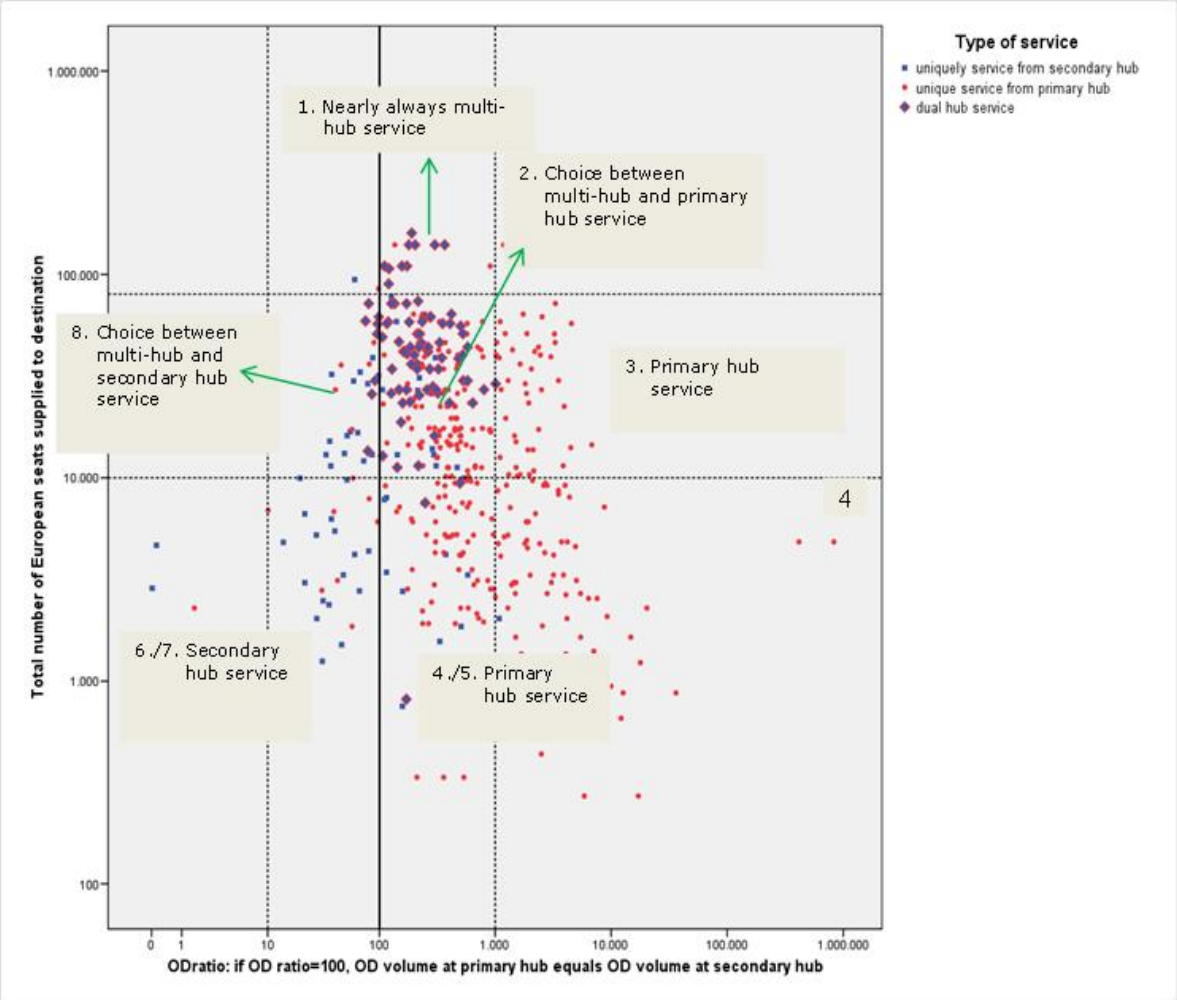
From the consolidated figure, a number of conclusions can be drawn:

- Multi-hub service is the case for long-haul destinations with a large demand from/to Europe (vertical axis) and where the size of the local origin-destination market of the primary hub is less than 10 times larger than the secondary hub (quadrant 1). These markets have enough European demand to tap into through feeder flights. They are

also the markets with strongest local origin-destination demand (for example, New York).

- in markets where the primary hub has an advantage in the local market and the size of the destination is somewhat smaller, either primary hub or dual hub service is the case (quadrant 2). The larger the European market size, the higher the chance of multi-hub service. The size of the feeder network at the hub, its geographical location and possibly the strength of the yield on the local origin-destination market are likely to be important factors that influence the choice between single or multi-hub service.
- when the advantage of the primary hub becomes larger (quadrant 3), unique service from the primary hub seems to be the rule. In markets where the local market advantage of the primary hub is over 10 times larger than that of the secondary hub, primary hub service is the case. The same holds true for destinations with a very small European market potential and an advantage of the primary hub in the local market (quadrants 4 and 5).
- on destinations with a smaller European market size potential and an advantage of the secondary hub in the local origin-destination market, service from the secondary hub only is generally the case (quadrant 6/7). Note that the destinations in these quadrants are mainly found in the Amsterdam- Paris Charles de Gaulle and Frankfurt-Zurich multi-hub combinations.
- for destinations with a larger European market potential, secondary hub service tends to dominate, but primary hub and multi-hub service are possible as well.

Figure 7. **Consolidated multi-hub specialization profile**



Source: OAG and MIDT.

4. MULTI-HUB NETWORK SERVICES AND THE IMPLICATIONS FOR AIRPORT CAPACITY EXPANSION STRATEGY

From the discussion on hub systems follow a number of considerations and discussion items regarding airport capacity expansion strategies for the London area:

Split hub operation results in connectivity loss

Spreading one airline's hub operation over multiple airports in the London metropolitan area will result in a disproportionate loss of the hub connectivity potential, as well as associated economies of scope & density. This implicates that for a globally operating hub airline, sufficient peak-hour capacity needs to be available at a least one of the airports in the London metropolitan area. If this capacity is not supplied, it will sustain an underperformance of direct long-haul connectivity vis-à-vis other European hub airports. Consumers in the London metropolitan area will need to transfer via hubs inside and outside Europe to reach to their final secondary (long-haul) destinations, resulting in additional travel costs. Long-haul traffic from other UK airports will increasingly leak away via hubs inside and outside Europe.

Hub operation less important for short-haul connectivity level in the Metropolitan area

For short-haul operations, the size of the hub operation is important but to a smaller extent. For the short-haul segment, a large local O&D market may still translate into a large short-haul connectivity level provided by various carriers at different airports in the metropolitan area, even without a large hub operation. Given the large local market in the London area, it is likely that the short-haul network will be supplied in both a concentrated and deconcentrated airport capacity expansion scenario.

Large London O&D market likely to make London the preferred hub in a multi-hub network, provided that sufficient capacity is available
Given the fact that the London area has the largest O&D market in Europe, an airport in the London area with sufficient peak-hour capacity can be expected to become the primary hub in the multi-hub system of a transnational multi-hub carrier for the majority of the long-haul destinations. That means that most long-haul destinations will be at least served from the London hub, and in case of larger destinations, also from the secondary hub. Only for markets where the secondary hub has a specific geographical and/or O&D advantage, the secondary hub may have a preference. Given the large O&D market between Spain and Latin America as well as the better geographical location for accommodating Europe-Latin America traffic, Madrid is likely to be the preferred hub for Latin American destinations within IAG.

Second hub carrier?

Given the vast O&D market from the London area, it could be argued that London is one of the few metropolitan areas in Europe where expansion of multiple airports with a peak-hour capacity sufficient to sustain a long-haul hub operation -or a new airport sufficiently large to support two hub carriers- could possibly give room to a competing hub operation in the

London area besides IAG. The fact that the main markets to/from London hub are fully liberalized (Europe and North-America) does at least not constrain such a scenario.

Selectivity policy to enhance connectivity

Geographical concentration of an airline's hub operation at a single airport in the Metropolitan area is essential condition for a successful hub. Yet, this condition does not necessarily hold for point-to-point operations. Carriers that mainly carry point-to-point traffic can (and do) use alternative airports in the Metropolitan area.

Hence, when a choice is made for expansion of the existing London airports instead of building a new airport, one could think about ways to further optimize the use of the current airport system by influencing the airport traffic distribution. Ideally, network operations with a high connectivity contribution will make use of the primary airports (Heathrow and Gatwick), whereas point-to-point operations use mainly the other airports elsewhere in the area.

Such a selectivity policy is currently explored in the Netherlands with the aim to use Amsterdam Schiphol mainly for network-related and business traffic when capacity problems arise in the future. Market-based and administrative demand management tools can be used to influence the traffic distribution between the airports in the Metropolitan region[10]. On the market-based side, pricing, airport incentives and slot are options. On the administrative side, one could think of local rules in the slot allocation, traffic distribution rules based on EU Regulation 1008/2008 and traffic quota. However, especially an administrative selectivity policy is not without risks. Government interventions in the traffic distribution between European airports do not have a particularly strong track record in achieving the desired results[11] and they may limit downstream competition.

Sticky airlines

When a decision would be taken to construct an entirely new airport, the question remains what to do with the capacity at the already existing airports. Opening a new airport while keeping the old one open bears the risk of severe underutilization of the new facility, even if the old facility is close to capacity. The existing primary airports are located more conveniently vis-à-vis the city centre, with better landside infrastructure in place and firmly embedded in the regional economy. When airlines have the choice, they may not want to move to the new facility.

The airport planning cases of Milan Malpensa versus Linate, and most notably the planning disaster of Montreal Mirabel illustrate very well the risk of building greenfield airports far away from the city centre, while keeping the old facility open. In contrast, closing the old airport when opening a new one has proven to be much more successful as the cases of Denver, Kuala Lumpur and Hong Kong illustrate.

10. See e.g. Gillen (2007)

11. See e.g. the traffic distribution rules for the Milan airport system

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