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Copenhagen Economics

Technical annex

# Airport Competition in Europe

ACI EUROPE
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This annex provides the technical background documentation to the study on Airport Competition.

# Overview of the technical annex

This report is the technical annex to the Copenhagen Economics report on Airport Competition commissioned by ACI EUROPE.

The technical annex report has four appendices:

- Appendix A: Identification of carrier types
- Appendix B: Methodology for airline switching analysis
- Appendix C: Methodology for route and quality overlap analysis
- Appendix D: Methodology for hub competition analysis

Appendix A

# Identification of carrier types

In chapter 2, we present a calculation of the share of total intra-European capacity by two carrier types:

- Point-to-point carriers and
- Hub-carriers

Based on OAG data for seats offered in 2011 between two airports within the European route area, we find the following shares.

**Table A.1 Share of capacity on intra-European routes 2011**

| CARRIER TYPE | Sum of SEATS 2011 | Share 2011 |
|---|---|---|
| Non-hub carrier | 324.884.874 | 41% |
| Hub carrier | 466.293.237 | 59% |
| **Total** | **791.178.111** | **100%** |

Note: CE analysis

Source: SEO Economic research based on OAG data

These shares are based on an identification of the carriers operating a hub system in 2011. These carriers are identified as hub carriers, and all other carriers operating intra-European traffic are characterised as non-hub carriers or point-to-point. The table below shows the identified hub carriers for 2011.

## Table A.2 Identified hub carriers 2011

| CODE | AIRLINE |
|---|---|
| LH | Lufthansa German Airlines |
| AF | Air France |
| AB | Air Berlin |
| SK | SAS Scandinavian Airlines |
| BA | British Airways |
| IB | Iberia |
| AZ | Alitalia-Compagnia Aerea |
| KL | KLMRoyal Dutch Airlines |
| LX | SWISS |
| OS | AUSTRIAN A/L AG DBA AUST |
| EI | Aer Lingus |
| SU | Aeroflot Russian Airlines |
| TP | TAP Air Portugal |
| AY | Finnair |
| JK | Spanair |
| UX | Air Europa |
| SN | Brussels Airlines |
| A3 | Aegean Airlines |
| HG | NIKI |
| OK | Czech Airlines |
| LO | LOT Polish Airlines |
| OA | Olympic Air |
| BT | Air Baltic |
| S7 | S7 Airlines |
| BD | BMI British Midland |
| MA | MALEV Hungarian Airlines |
| FV | Rossiya Airlines |
| KF | Blue1 |
| OU | Croatia Airlines |
| VV | Aerosvit Airlines |
| RO | TAROM-Romanian Air Transp |
| UN | Transaero Airlines |
| LG | Luxair-Luxembourg Airline |
| JU | Jat Airways |
| FI | Icelandair |
| PS | Ukraine Intl Airlines |
| JP | Adria Airways |
| J2 | Azerbaijan Airlines |
| YM | Montenegro Airlines |
| 9U | Air Moldova |
| A9 | Georgian Airways |
| JA | BH Airlines |

Note: All other carriers operating on intra-European routes are characterised as point-to-point carriers

Source: SEO Economic research based on OAG data

Appendix B

# Methodology for airline switching analysis

This annex explains the methodology for the airline switching analyses in Chapter 3.

Airline switching is essentially an assessment of entry and exit at route level. We have quantified how large a share of routes and seat capacity is being turned-over per airport per year and the general trends across the different types of airports and airlines.

**Data**

The analyses rely on the OAG database. For these analyses, we have used annual airline schedules data for the period 2002-2011. Using annual data avoids the possible problem of seasonality.

The data includes the following variables:

- Airline
- Origin
- Destination
- Seat capacity on route level
- Frequency on route level
- Year

The OAG data set contains all scheduled traffic, but does not contain unscheduled traffic that accounts for at least 5-7 percent of European passenger flight traffic.

Some data treatment was necessary to obtain meaningful results, namely:

- A threshold value of 50 annual frequencies (on average one per week) has been applied in order to eliminate the effects of very marginal operations with just a few frequencies a year.
- Only unique flights by published carrier have been included (no duplicates of code shared flights).
- Only non-stop flights have been included to avoid double counting of capacities/frequencies.

**Methodology**

The data allows for tracking the capacity/frequency changes at the airline route-level (or any aggregations thereof) on an annual basis. It contains the identity of the published carrier, the origin, the destination, the frequency for each year 2002-2011, and the capacity for each year 2002-2011. Airline switching occurs when an airline reallocates its capacity between routes and airports.

# Appendix C
# Methodology for route and quality overlap analysis

This annex provides SEO Economic Research's explanation of the methodology for the route and quality overlap analysis. The analysis shows to what extent airports compete for OD-passengers in their hinterland. The separate hub analysis focuses on the competitive position of hub airports for connecting passengers (see next annex).

OD-passengers that can choose between multiple travel alternatives via different departure airports to a certain destination are said to have choice.

**Objective and results**

The objective is to estimate the share of passengers with choice at European airports in two years (2002 and 2011). The analysis of competing routes consists of three separate analyses, going from relatively simple to highly detailed:

- Geographic overlap: analysis of competing airports. How many alternative airports are available within a radius of two hours driving time?

- Route overlap: analysis of competing routes: to what extent do the alternative airports within the radius of two hours offer similar routes?

- Route and quality overlap: analysis of quality of competing routes. To what extent are these competing routes realistic travel alternatives?

The remaining part of this annex deals with most detailed analysis: route and quality overlap.

The route and quality overlap analysis determines what share of passengers at each of the 250 largest European airports has a realistic choice of an alternative airport, to be accessed over land, for a particular final destination. Therefore it is needed to determine the choice (market shares) of passengers for particular airports in particular markets. In principle the share airports have is equal to the share of frequencies they offer. However some frequencies are more attractive than others. This issue is addressed by analyzing generalized travel costs of each of the routes: a measure of travel costs and time. "Generalised travel costs" are representations of all travel inconveniences or costs, including travel time and airfares.

Furthermore, generalised costs have been determined in two steps. Firstly expected airfares have been estimated using an airfare model. It is acknowledged that consistent information on realised airfares is not known. There are however some systematic factors that determine – at least to some extent – the level of airfares and these factors are used in the model. The expected airfares are defined as a function of great circle distance between origin and destination, the type of connection (direct or indirect), the level of competition and whether a low-cost carrier is present on a route. Airfares are assumed to be higher for longer great circle distances, but – even with equal great circle distances – there are differences. Firstly, airfares of direct connections are generally higher than those of indirect connections, despite the longer distance flown. Secondly, airfares in competitive markets are generally lower than those in monopoly markets. Thirdly, the presence of a low-cost carrier adds extra downward pressure on fares. These systematic factors are taken into account in the airfare model. The model was calibrated using actual ticket price data (adjusted MIDT data).

The next step is converting (elapsed) travel time into monetary units, by using perceived monetary values of travel time. For each individual connection the elapsed time is determined and a further distinction is made between flight time and connecting time. The latter time component has a higher penalty and hence a higher time value. Multiplying the two time components with the respective time values results in total (monetary) time costs for each individual connection. Finally, adding the expected airfares and the monetary time costs results in generalised travel costs of each connection.

The attractiveness of a particular connection (a combination of generalized travel costs and the frequency level offered) determines what market share that connection obtains. Alternatives with low travel costs and high frequency levels get high shares and those with high costs and low frequencies get low shares. Utility functions are used to determine the share each competing connection obtains in a certain market given its generalised travel costs and frequency level. The utility functions represent the sensitivity of passengers to relative changes in generalised travel costs.

The parameters in the utility functions used in the model, representing the sensitivity of passengers were calibrated using MIDT data for Schiphol over 2009.

**Relevant market and realistic alternatives**

We define the relevant market in the analysis as the market between a particular European region Z and destination airport Y. The origin regions are defined on the NUTS-2 level of Eurostat. The NUTS-2 level is a breakdown of Europe into 300 regions (for instance the Benelux is broken down into their provinces and France into its "*departements*"). The NUTS-1 level is more aggregated and has fewer regions. The NUTS-3 level is even more detailed and has more regions. It is in theory more sophisticated, but more complex in the analysis and data processing. As a compromise the NUTS-2 level is chosen, as it is detailed enough for the purpose of the analysis. The implication is that in larger NUTS-2 regions the calculated distances over land to the airports are less accurate, as they are measured only from one point in the region. But larger NUTS-2 regions are also more scarcely populated, which reduces this inaccuracy. All destinations that are offered directly or indirectly from the departure airports that are accessible from these regions are taken into account:

- *Example*: Region of Utrecht (NUTS2-code: NL31) to Madrid (MAD)

Within each relevant market, the consumer can choose between various realistic travel alternatives (close-enough-substitutes). The model covers alternatives by air and travel options that include driving a car[1] from departure Region Z to a departure airport X and flying to destination airport Y (eventually via a hub airport H when indirect): $R_z$-$AP_x$-($HAP_h$)-$AP_y$.

**Analysis scheme**

a) We use all NUTS2-regions within a 200 kms great circle distance[2] around the selected airports and analyze which departure airports are available for a trip between each NUTS2-region and each destination airport. This analysis shows for each market (NUTS2 region-destination airport) which departure airports are competing.

b) Calculation of landside access times between functional centroids of each NUTS-2 region (i.e. points in each region with the largest number of inhabitants) and departure airports within a great circle range of 200 kms. SEO has coordinates (LAT/LON) of these centroids available in-house, as well as coordinates of all European airports. Using web scraping software[3], landside travel times (road) between each centroid and departure airports within the pre-defined range from each centroid has been collected.

- Step b results in travel time matrix Region $R_z$-Departure airport X.

c) Model runs to construct all travel alternatives between Region $R_z$ and destination airport Y (see above on relevant market).

d) Model runs to calculate generalized travel costs (of access time, travel time, interval time and fare) and consumer value for each identified travel alternative.

- Steps a-d result in 'cubicle' of $R_z$-$AP_x$-$Dest_y$ with associated consumer values/utilities.

e) The shares of each $AP_x$ on the market $R_z$-$Dest_y$ can now be estimated as well as the % difference between most attractive departure airport and the 2nd most attractive alternative via another airport in terms of Generalized Travel Costs. The difference in share between the most attractive airport and the 2nd most attractive is depending on the difference in generalised costs between the most attractive and the 2nd most attractive airport.

[1] The model does not include rail connections, and thereby the model simulations underestimate the competitive pressures on airports. Rail has two different pro-competitive impacts. First, it increases competition to airports (and airlines) where it is an alternative to air travel – for example between London and Paris. Second it may increase the size of catchment areas beyond those that car enables and so increases airport overlaps and so competition between airports. Charles de Gaulle airport (CDG) in Paris, for example, is 280 kilometres from Brussels centre, and estimated driving time is 2 hours and 43 minutes. However with the high speed train service (TGV), the airport of Paris Charles de Gaulle can be reached within 1 hour and 12 minutes and with several connections every hour, and with a train station inside the airport terminal building. This implies that CDG effectively is competing for passengers from Brussels, who are willing to take the train, even though Brussels is more than 200 kilometres away by car. Similar underestimates apply to other airports with high speed rail connections. Train in general may also impose a competitive constraint on airports for short haul travel.

[2] We have chosen this threshold, as we have assumed that in practice a negligible category is willing to travel longer distances over land. Of course this is only relevant for scarcely populated regions with few airports around. In the case of densely populated regions, such distances will not have any role in the analysis, as there are airports at much smaller distances.

[3] This software allows us to collect large quantities of travel times from the internet, using an automated search process on route planning websites. We cannot look back in time using webscraping technology. We assume road travel times to be equal in both years of analysis.

f) As no OD statistics between each NUTS-2 region and each destination city are available, a proxy has to be defined to weigh the results of step e according to the size of each market. We have used a simple gravity model for this:

$$Market_{Rz,DestY} = C * Potential_{Rz}{}^{\alpha} * Potential_{DestY}{}^{\beta} * Distance_{Rz,DestY}{}^{-\gamma}$$

The potential of Region Z will be measured in number of inhabitants at the NUTS-2 level, whereas the DestY in the number of available seats. C can be calibrated using total OD-airport traffic as available from airport statistics (ACI). Total airport traffic volumes (statistics) need to be reduced by number of transfer passengers as far as hub airports are concerned.

**Uncertainties regarding assumptions**

The results of the analysis are based on state-of-the-art generalized travel cost /network modeling. Our model has been applied in various cases. However, since this concerns an analysis for a large number of airports and since we do not have standardized passenger choice data available for all of the airports, we need to make assumptions on a number of parameters in the model. Such assumptions affect to a smaller or larger extent the outcomes of the analysis.

In the table below, we have included an overview for the most important uncertainties regarding the assumptions and to which degree these uncertainties impact the results.

| Element of uncertainty | Implication for the study |
|---|---|
| **200km upper boundary airport access distance: assumption is that passenger are not prepared to travel to a departure airport over more than 200km** | This may underestimate competition between airports. Although past research has shown strong distance decay in airport choice, there may be passengers travelling more than 200 kms. to airports, who are omitted from the analyses. It is expected that in this category the share of passengers having a choice among more airports is likely to be higher than average. Hence the level of could be underestimated. |
| **Market size: assumption is made that market size generated in a region is proportional to its population.** | The implicit assumption is that the "propensity-to-fly (PTF)" is equal for all regions. In reality the estimation of market size is more complex. Firstly because PTF is lower for regions far away from airports. Secondly, regional economic structures, and the extent to which they generate passengers can be different. The assumption that the PTF is equal for all regions is therefore likely to overstate market size in 'far away' regions. As passengers in these regions are to a lower extent captive to one airport, the share of passengers being captive may be underestimated and hence competition level at airports attracting passengers from these regions may be overestimated. |
| **Travel times between Nuts-2 centroids and airports are calculated for car travel** | This may affect results for those airports/regions very well integrated into HST-network (e.g. Brussels region to Paris). This reduces travel time from regions (with access to HST) to these airports. The market shares of airports with a HST-link may therefore be underestimated in the regions that are well-served by this HST-link. The level by which market shares are underestimated is likely to be limited, looking to the overall picture as relatively few regions have access to HST-travel. However, in particular cases with HST-access, the potential underestimation may be more significant. |
| **Model uses 'average' traveller instead of *business* and *leisure* traveller (with different values of time / values of frequency as part of the generalized travel cost)** | This will affect cross-section results (differences in share of footloose passengers *between* airports), in particular for those airports with either a pronounced orientation to *leisure travelers* (e.g. BCN, CRL) or to *business travelers* (e.g. LCY). The analysis has used "the average passenger" (implicitly assuming the leisure/business orientation being stable over time). However, as also argued in the main report, the leisure share has increased over time. This may have possible implications for the increase in competition level. As leisure passengers are less sensitive for travel time, they are, more than business passengers, willing to travel longer distances over land to airports |

| | |
|---|---|
| | with low airfares. Hence – by the increased leisure share – the relative willingness to travel longer distances over land increases. This results in more choice of the average passenger and hence more competition. As the model has only used the 'average passenger' and ignored the increase in leisure share, it has also underestimated the increase in competition level. |
| **Model estimates airfares (as part of generalized travel cost)** | Will not significantly affect results.<br>Variables in airfare model have been calibrated on actual ticket price data |
| **Single Value of Time / / Value of Transfer time for all countries** | This affects cross-section results (differences in share of passenger choice *between* airports). Average values of time and hence the share of the market being footloose may have been shifted over time. The above point has indicated that the average value of time has declined by the increasing share of leisure passengers. Additional downward shifts in these values of time would occur if countries with low time values would have had a larger market growth than countries with high time values. If this is the case this is an additional downward shift in average time value and hence an additional underestimation of the increase in competition. |
| **Parking charges equal for all airports** | In principle we would need actual parking charge information, but we ignore this as it would add substantial complexity to the analysis: it would require additional assumptions on what share of passengers travel by car and indeed park the car at the airport. Moreover, we need to know how many days passengers park their cars. This requires a much more complex analysis. In order to keep this aggregate analysis as simple as possible, we implicitly assume that parking charges are equal for all airports.<br><br>Also here the main interest is in change over time and assuming the difference in charges between the airports remain reasonably stable over time the results can be expected to be reasonably robust. |

**Conclusion regarding uncertainties**

The results which have been derived with regard to competition between airports are partly based on simplifying assumptions. This means that actual competition levels for particular airports may differ from those estimated. The model used, however, has analysed the main systematic factors, which have an impact on competition level considered in aggregate and its development over time. As the table above has indicated, some assumptions may tend to increase estimates of competition while others work in the opposite direction.

Most of the factors mentioned above do not affect the analysis over time and our comparison between 2002 and 2011 has no bias in one direct or the other. If anything, the assumption of a fixed proportion of leisure passengers implies that we underestimate the growth in competition between the two years.

Appendix D

# Methodology for hub competition analysis

This annex provides the description from SEO Economic Research on the methodology for the hub competition analysis. The analysis shows the degree of competition between hub airports in the relevant transfer markets where European hubs compete. The key question being answered is: *to what extent are passengers able to choose between different realistic transfer options?*

Especially on thick transfer markets with many passengers, passengers can often have the choice of several different hub airports. In the hub competition analysis, a travel option in a certain transfer market is considered to be realistic if its generalized travel time costs (excluding ticket price) are within 30% of the travel option with the lowest generalized travel time costs on that market.

**Objective**

The main objective of the analyses is to:

- Determine the degree of hub competition in relevant transfer markets <u>based on generalized travel time costs</u>
- Describe how hub competition has evolved between 2002 and 2011

**What is hub competition?**

Where multiple airlines offer indirect connections via their hubs in a specific transfer market, there is a certain degree of hub competition (e.g. it is possible to fly from Manchester (MAN) to Bangkok (BKK) via Zurich (ZRH) and via Helsinki (HEL)).

The degree of hub competition in a certain transfer market depends on the number of substitute hubs offering realistic travel in that market.

**Analysis scheme**

1. All hub connections via the following European hub airports have been included in the analysis: London Heathrow (LHR), Paris Charles de Gaulle (CDG), Frankfurt (FRA), Amsterdam (AMS), Madrid (MAD), Munich (MUC), Brussels (BRU), Rome Fiumicino (FCO), Zürich (ZRH), Copenhagen (CPH), Lisbon (LIS), Helsinki (HEL), Vienna (VIE), Prague (PRG), Budapest (BUD) and Warsaw (WAW).

2. Additionally, connections via the following airports competing with above mentioned connections have been taken into account when measuring the degree of hub competition: Addis Ababa (ADD), Amman (AMM), Atlanta (ATL), Abu Dhabi (AUH), Bangkok (BKK), Mumbai (BOM), Cairo (CAI), Guangzhou (CAN), Delhi (DEL), Dallas (DFW), Moscow (DME and SVO), Doha (DOH), Detroit (DTW), Dublin (DUB), Dubai (DXB), Newark (EWR), Buenos Aires (EZE), Sao Paulo (GRU), Hong Kong (HKG), Washington (IAD), Houston (IAH), Seoul (ICN), Istanbul (IST), New York (JFK), Johannesburg (JNB), Reykjavik (KEF), Kuala

Lumpur (KUL), Lima (LIM), Mexico City (MEX), Minneapolis (MSP), Nairobi (NBO), Chicago (ORD), Beijing (PEK), Philadelphia (PHL), Shanghai (PVG), Singapore (SIN), Montreal (YUL) and Toronto (YYZ).

3. In order to identify the hub connections, all flights from and to the above mentioned airports have been extracted from the Official Airlines Guide (OAG) database for the third week of September for the years 2002 and 2011.

4. The Netscan connectivity model has been used to identify all the viable hub connections at the above mentioned airports. Note that Netscan only considers connections between flights of the same airline/alliance (online connectivity).

5. For every single hub connection the generalized travel time costs have been calculated.

6. All connections with generalized travel time costs within 30% of the travel option with the lowest generalized travel time costs have been taken into account. Connections with generalized travel time costs above this threshold have been considered unviable and have been deleted.

7. Aggregated results of the analysis show the percentage of the hub markets at which one, two, three or four or more alternatives are available for passengers. This has been demonstrated for 2002 as well as for 2011 in order to show the development over time.

8. Additionally, results for 2002 and 2011 for one specific hub market (e.g. MAN-BKK) are presented to illustrate the travel options for passengers on a single market and how those travel options can develop over time.

## Box D.1 The Netscan connectivity model

The Netscan connectivity model[4] has been used to identify the connecting (indirect) markets via the abovementioned airports and to calculate the generalized travel time costs for every single connection.

Generalized travel time costs result from the in-flight time and the transfer time of a connection times a certain value of time, which differs for in-flight and transfer time.

Source: SEO Economic Research

### Data

Flight data from the Official Airlines Guide (OAG) for the years 2002 and 2011 is used.

[4] See e.g. for a description of the Netscan connectivity model: Veldhuis (1997). "The competitive position of airline networks". *Journal of Air Transport Management* 3(4); Burghouwt and Redondi. Connectivity in air transport networks. An assessment of models and applications. *Journal of Transport Economics and Policy*, *forthcoming*,

### Uncertainties regarding assumptions

The results of the analysis are based on the Netscan connectivity model. The model has been applied successfully in various studies and academic publications. The model makes a number of assumptions. Such assumptions affect to a smaller or larger extent the outcomes of the analysis. In the table below, we have included an overview for the most important assumptions and their implications for the study.

| Element of uncertainty | Implication for the study |
|---|---|
| **Minimum connecting time (MCTs). The Netscan model uses predefined MCT's.** | Does not significantly affect the overall results.<br>In reality, MCT's may differ up to the individual connection level and are highly dynamic over time. However, MCT's at this level of detail were not available for this study. Some connections identified by NetScan as 'viable' may in reality not be viable connection possibilities, and the other way around. Hence, NetScan may give an overestimation of the number of realistic alternatives in some hub markets and underestimation in others. As about 35,000 hub markets have been included in our model, over- and underestimations are likely to be averaged out in the overall results. |
| **Alliance vs. codeshares.** | Does not significantly affect the overall results.<br>Connectivity analysis is done at the level of the global airline alliance (connections via a hub take place within the same airline or alliance). For the sake of simplicity, we do not consider route specific codeshare agreements outside alliances. We note that the share of connections made by passengers outside alliances is relatively small. |
| **Generalized travel time costs: Netscan uses generally accepted value of times for perceived in-flight time and perceived transfer time.** | Does not significantly affect overall results.<br>Using different values of time will not have a substantial impact on the generalized travel time costs of connections in comparison with each other. After all, in that case, the value of time for every connection changes. |