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INTERCONTINENTAL FLIGHTS FROM EUROPEAN AIRPORTS: TOWARDS HUB CONCENTRATION OR NOT?

Germà Bel · Xavier Fageda*

Abstract: Supply of direct intercontinental flights is a major determinant of the position an urban area enjoys in the global city network. This paper empirically analyzes changes in the supply of non-stop intercontinental flights from European airports. We take advantage of OAG data for air services from a rich sample of European airports to intercontinental destinations in the period 2004-2008. Data indicate a tendency towards a more balanced distribution of intercontinental flights across European airports. Results of the empirical analysis show that the largest hubs have lost market share in the considered period, after controlling for several attributes of the region, congestion and number of nearby airports.

Key words: airports, air transportation, intercontinental flights.
jel Classification: L93, R58.

1. Introduction

Quality of airport facilities and air transport services offered has a very important influence on urban economic growth. In this regard, Button, Lall, Stough, and Trice (1999) find a very significant relationship between the availability of a large airport across US metropolitan areas and employment in high-technology industries. Bowen (2002) argues that a growing proportion of commerce is carried out by means of air transport, especially for low-bulk high-value goods. Brueckner (2003) shows that good airport facilities promote intercity agglomeration economies and influence firms' location decision. Green (2007) empirically finds that passenger activity is a strong predictor of urban growth, whereas cargo activity is not. Furthermore Strauss-Kahn and Vives (2009) show that US urban areas with an airport hub (whether large or small) are much more attractive for locating headquarters.

The magnitude of the economic impact of an airport is conditioned upon

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the total number of passengers served annually and by the geographic scope of the direct flights offered. Large firms specializing in knowledge intensive activities consider both aspects when making location choices (Bel and Fageda, 2008). Indeed, such firms need large airports that offer direct flights to the main business centers of Europe, America and Asia. Bel and Fageda (2008) find that the supply of direct intercontinental flights is effectively a major determinant in the location choices of large firms' headquarters; their empirical analysis shows that a 10% increase in the supply of intercontinental flights involves around a 4% increase in the number of headquarters of large firms located in the corresponding urban area.[1]

In this light, it is significant that air services in the largest European urban areas differ chiefly in the availability of direct intercontinental flights. Most of the largest European urban areas are well supplied with a dense network of highways, high-speed train and short-haul air services. In contrast, intercontinental air traffic tends to be concentrated in a few airports. Thus, the dynamics of long-haul air services to the main urban areas in Europe are of outstanding interest.

This paper contributes to the literature by determining whether there is a tendency towards a higher concentration of long-haul air services in the largest airports or, on the contrary, a trend towards a more balanced distribution between airports of different size. To our knowledge, this is the first study on the concentration versus dispersion issue focusing on intercontinental long-haul flights, and using multivariate econometric techniques to analyze information expressly collected to carry out this work.

Some recent contributions have examined airport hierarchies in the global airline networks (Grubesic et al., 2008, 2009), and other works have used airline data to establish ranks of cities in the context of the global city network (Smith and Timberlake, 2001; Derudder et al., 2008). Instead, our analysis focuses on the tendency to the concentration or dispersal of long-haul air traffic from European airports. Our conclusions have implications for the attractiveness of urban areas to large firms specialized in knowledge intensive activities. They will also provide some expectations of the role that urban areas of different size may play in globalization trends.

We use data for direct flights to intercontinental destinations from a sam-

[1] Concerning intercontinental fligths, Lijensen et al. (2002) show that direct and non-direct flights are imperfect substitutes so that an indirect flight is not a substitute at all if it lasts twice or more as long as the direct flight. In practice, travel time differences between direct and indirect flights may be substantial. Additionally, non-direct services carry additional costs in terms of lower quality that are not captured by the total travel time. Note here that business passengers are especially sensitive to the time spent on the trip.

ple of airports associated with the largest European urban areas in the period 2004-2008. The empirical analysis allows us to assess the determinants of intercontinental traffic and to identify any tendency towards or away from higher concentration in this type of traffic.

The remainder of this paper is organized as follows. In the second section, we identify those factors that may affect traffic concentration. In the third section, we explain the criteria used to define both the sample of urban areas and intercontinental destinations, and we then examine the data relating to concentration of long-haul air services empirically. In the fourth section, we study the determinants of long-haul air services to explain the different performance of airports. Finally, the last section is devoted to concluding remarks.

2. Long-haul services from European airports: Concentration or dispersion?

Several works have examined the patterns of concentration or dispersal of air traffic in a global context and also for large markets like US or Europe. A trend to concentration of total air traffic in a small number of airports was found for up to around 1990s by several works, such as O'Connor (1995b) and O'Connor and Scott (1992), and Keeling (1995). However, other studies using airline data on total air traffic for the nineties suggest a decreasing role of very large global cities and major hubs in favor of a group of next largest cities (O'Connor, 2003).[1]

Concerning the US market, it is found a concentration of traffic in a smaller number of large airports following deregulation (Reynolds-Feighan, 2000, 2001). Similarly, Goetz and Sutton (1997) found that the largest hubs enjoyed the highest increase in traffic in the period 1978-1993. On the contrary, Chou (1993) examines spatial concentration patterns for the 54 largest cities in the US in periods before and after deregulation and he did not find an increase of concentration in terms of nodal accessibility (defined as the degree to which people in a city are able to travel to other cities through airline services).

For Europe, evidence from the nineties indicated a consolidation of hub-and-spoke networks by former flag carriers (Burghouwt and de Wit, 2005). In this vein, Burghouwt and Hakfoort (2001) find evidence for an increase of concentration of intercontinental traffic on a small number of European airports in the period 1990-1998 although such concentration trend was not ob-

[1] Derudder and Wilcox (2009) use a set of spatial interaction indices to examine the trend towards concentration and dispersal of air passenger flows, but they focus the attention on the degree of concentration in European flights at the national level.

served for intra-European traffic. However, Maertens (2010) finds evidence that smaller European airports have been able to attract intercontinental services when looking at data for 2007.

To sum up, results from previous literature about the distribution of air traffic across airports are not conclusive. Here we focus the attention on the dynamics of intercontinental traffic from European airports.

The generalized economic growth, globalization and technological changes that have characterized the beginning of the Twenty-first century have been associated with great dynamism in airline markets. Note that long-haul traffic has been the more profitable for network airlines in recent times, with high load factors and a high proportion of business travelers on such flights. By these measures, network airlines perform much better than do in short-haul services. To some extent, this success follows from the fact that network airlines do not face competition from low-cost airlines in long-haul flights, as happens over routes that begin and end in European cities.

Low-cost airlines have been able to exploit important cost advantages in competition with network airlines. Since the liberalization of the European air market, they have substantially increased their market share of intra-European routes. However, the cost advantages of low-cost airlines appear chiefly in relation to short-haul routes (Francis et al., 2007). In fact, low-cost airlines have a very modest presence in long-haul routes, where network airlines dominate.[1]

Hence, European network airlines are increasingly focusing their business in the long-haul segment of the market. This implies a concentration of flights in their main hubs. Such airport hubs are the origin of direct flights to distant sites and the destination of flights from nearby cities that feed the long-haul traffic. Thus, the efficient exploitation of connecting traffic by network airlines may well imply an increase of the concentration of intercontinental traffic from the largest European hubs.

Finally, international airline alliances tend to produce strong duplication of the geographical coverage of routes in those airports that move most of the long-haul traffic (Dennis, 2005). This could also spur an increase in concentration of this type of traffic by allowing former flag carriers to obtain some technical efficiencies.

Dispersion of services, on the other hand, may be promoted by broader

[1] However, some low-cost airlines offer non-stop services in long-haul routes, as is the case with Flyzoom and Air Transat in routes from Canada to Europe; Condor, in routes from Germany to America, and several airlines in routes from London to US. Recently, Ryanair has announced that in a near future will offer flights in routes from Europe to United States.

economic factors. Economic growth and globalization are stimulating demand for point-to-point services directly connecting cities of different continents, and the threat of foreign airlines entering at neglected airports may push former flag carriers to follow a pre-emption strategy and disperse long-haul services. Either factor presents an important barrier to concentration of intercontinental traffic.

American and Asian network airlines may also directly contribute to an increase in the dispersion of intercontinental flights services from European airports. These airlines increasingly use airports located in large European urban areas, which are not necessarily hubs of any European airline, to feed traffic to their hubs in America and Asia.

Finally, congestion at some large European hubs, like London-Heathrow or Frankfurt is another barrier to traffic concentration. In fact, environmental and urban pressures limit future capacity expansions at most of the largest European airports.

In this uncertain process of spatial distribution of long-haul traffic, the relative success of the new planes from Boeing and Airbus will also play a central role. Boeing's venture in long-haul traffic is the model B787, which could be suitable for point-to-point traffic between airports of different sizes. Indeed, it is likely that the B787 will stimulate some hub bypassing and enhance network quality of secondary hubs. However, the B787 could also lead to stronger hubs as it allows hub airlines to serve smaller long-range markets from the hub. In contrast, the Airbus A380 -larger than the B787 of Boeing- is clearly suited to the connecting traffic moved through the largest hubs.[1] In any case, these new models tend to reduce the costs of long-haul services, so either will likely contribute to an increase of demand of this type of traffic.

Additionally, increasing liberalization of traffic between continents, particularly important in the transatlantic market with the recent open skies agreement, will also influence concentration of intercontinental traffic from European airports. Until recently, bilateral agreements between governments have conditioned air traffic between continents. These agreements have usually implied the monopolization of intercontinental traffic from national airports by former flag carriers. In the post-liberalization period, this scenario may no longer be the rule. However, it is not clear what effect tougher airline competition will have on the transatlantic market.

[1] Note that the tough competition between both firms has resulted in the launch of new models of planes to compete in the long-haul traffic. Indeed, Airbus has launched the model A350 to compete with the B757 model of Boeing, while Boeing has launched the model Boeing 747-800 to compete with the A380 of Airbus.

3. Availability and changes of non-stop intercontinental flights from European airports

In this section, we analyze non-stop intercontinental flights to selected destinations from the airports of a sample of large European urban areas.[1] The criteria for determining the sample European urban areas are as follows: we include urban areas of the European Union (EU25), Switzerland and Norway with more than one million inhabitants and/or a large airport. Large airports must be one of the Top-50 European airports in terms of total traffic.[2]

Intercontinental services should not include traffic to such nearby destinations as non-EU European countries (Russia, Ukraine, Turkey, etc.) or North Africa. Thus, the analysis focuses on flights originating in airports of the sample of urban areas to a selection of intercontinental destinations. The choice criterion of intercontinental destinations is as follows: We include non-European airports having the highest amount of international traffic by geographical area (North America, Latin America, Middle East, Far East, Africa and Oceania), and located more than 3450 kilometers from any European airport. The distance threshold reflects the longest intra-European route with non-stop service: Lisbon-Stockholm.

Tables 1 and 2 indicate the urban areas and the intercontinental destinations that we have used in the empirical analysis. Table 3 provides information about weekly frequencies of intercontinental departures from the airports of urban areas included in the sample. We distinguish between the summer and winter seasons, since there are some seasonal differences. Recall that the worldwide coordination of slots between airlines takes place at the half-yearly meetings of the International Air Transport Association (IATA). Data are from the last period with available information, 2007-2008 and the dynamics since the period 2004-2005. Data refer to a representative sample week for each period.

We choose the number of flights indicator instead of seat capacity or number of destinations. Note that service frequency (number of flights at some given period) is a major indicator of quality in air transport services. Indeed, a higher service frequency implies a lower schedule delay cost for travelers. The schedule delay cost for a traveler is the difference between the actual and the desired departure time of her flight. Thus, the use of frequen-

[1] Note that the use of airlines data is helpful to examine spatial patterns in the world city network even if we take into account some potential shortcomings (Derudder and Witlox, 2005a, 2005b). Our paper focuses on the concentration or dispersal of intercontinental flights in airports of major urban areas given their influence on firm's location choices.

[2] We must exclude from our analysis the airports of Bristol and Edinburgh because we do not have data on intercontinental flights from these airports in the period studied.

cies will allow us to capture both the number of destinations and the quality of service provided in each destination.

Table 1. Sample of urban areas (EU25 + Norway and Switzerland).

Alicante	London (4)	Stuttgart
Amsterdam	Lyon	Toulouse
Athens	Madrid	Turin
Barcelona	Malaga	Valence
Berlin (2)	Manchester	Venice
Birmingham	Marseille	Vienna
Brussels	Milan (2)	Warsaw
Budapest	Munich	Zurich
Koln-Bonn	Naples	
Copenhagen	Nice	
Dublin	Oslo	
Frankfurt	Palma Mallorca	
Genève	Porto	
Glasgow	Paris (2)	
Goteborg	Prague	
Gran Canaria	Rome (2)	
Hamburg	Seville	
Helsinki	Dusseldorf	
Lisbon	Stockholm	

Note: In parenthesis, we compute the number of airports in urban areas with several airports.

Table 2. Sample of intercontinental destinations.

Atlanta	Houston	Philadelphia
Bangkok	Islamabad	Río de Janeiro
Beijing	Jakarta	San Francisco
Bogotá	Johannesburg	Santiago de Chile
Bombay	Kuala Lumpur	Sao Paulo
Boston	Los Angeles	Seoul
Buenos Aires	Manila	Shangai
Caracas	Miami	Singapore
Chicago	Montreal	Sidney
Colombo	México DF	Taipei
Dallas	Nairobi	Tokyo
Denver	New York	Toronto
Dubai	New Delhi	Washington
Hong Kong	Osaka	

Table 3. Data of non-stop intercontinental flights from airports of the sample of European urban areas (weekly frequency). Period 2004-2007.

Airport (code)	**Winter season**			**Summer season**		
	Frequency (2007	**Diff. in frequency (2007-08/ 2004-2005)**	**Variation in shares (2007-08/ 2004-2005)**	**Frequency (2007)**	**Diff. in frequency (2007-2004)**	**Variation in shares (2007-2004)**
Amsterdam (AMS)	351	75	-0.04	386	76	-0.26
Athens (ATH)	38	24	0.47	53	35	0.62
Barcelona (BCN)	22	22	0.51	34	27	0.52
Berlin (TXL)	11	11	0.25	14	14	0.29
Birmingham (BHX)	34	14	0.20	33	3	-0.12
Brussels (BRU)	82	38	0.60	65	17	0.07
Budapest (BUD)	18	11	0.21	23	16	0.29
Copenhagen (CPH)	58	8	-0.14	68	18	0.08
Dublin (DUB)	81	56	1.14	74	22	0.15
Dusseldorf (DUS)	55	35	0.68	61	23	0.25
Frankfurt (FRA)	522	32	-2.42	579	66	-1.67
Genève (GVA)	19	5	0.03	18	4	0.0003
Glasgow (GLA)	23	9	0.12	33	11	0.10
Hamburg (HAM)	20	20	0.46	22	22	0.46
Helsinki (HEL)	51	25	0.41	61	37	0.63
Koln-Bonn (CGN)	5	5	0.12	7	7	0.15
Lisbon (LIS)	36	3	-0.14	55	18	0.16
Lyon (LYS)	0	0	0	4	4	0.08
London (LHR)	988	103	-3.32	1080	163	-2.04
London (LGW)	157	48	0.41	169	37	-0.01
London (STD)	29	29	0.67	26	26	0.54
Madrid (MAD)	215	51	0.12	227	54	0.10
Manchester (MAN)	87	-4	-0.68	113	11	-0.38
Milan (MXP)	144	11	-0.60	146	0	-0.87
Munich (MUC)	172	58	0.61	174	38	-0.01
Oslo (OSL)	6	3	0.05	7	0	-0.04
Paris (CDG)	611	114	-0.56	684	166	0.39
Prague (PRG)	13	5	0.06	26	18	0.33
Porto (OPO)	10	9	0.20	14	6	0.08
Rome (FCO)	123	41	0.42	177	62	0.61
Stockholm (ARN)	35	11	0.10	52	28	0.44
Stuttgart (STR)	5	-2	-0.09	7	0	-0.04
Toulouse (TLS)	0	0	0	3	3	0.06
Vienna (VIE)	72	6	-0.29	85	4	-0.40
Warsaw (WAW)	17	11	0.22	31	24	0.46
Zurich (ZRH)	206	53	0.24	186	3	-1.02
TOTAL	4 316	940	-	4 797	1 063	-

Note 1: There is no supply of intercontinental flights in any period in the rest of airports of the sample of urban areas.

Note 2: The winter season goes from October 26th to March 25th, while the summer season goes from March 26th to October 25th. Source: Own elaboration from data obtained from *Official Airlines Guide* (OAG).

From Table 3 we can see that the overall performance of airports over the period, both in the summer and winter, has been quite good. Indeed, most of the airports have increased the number of flights per week to intercontinental destinations. Overall, total supply has increased by about 30 per cent in both seasons.[1] Note that the number of flights in the summer is generally higher than in the winter due to the additional traffic generated by tourism.

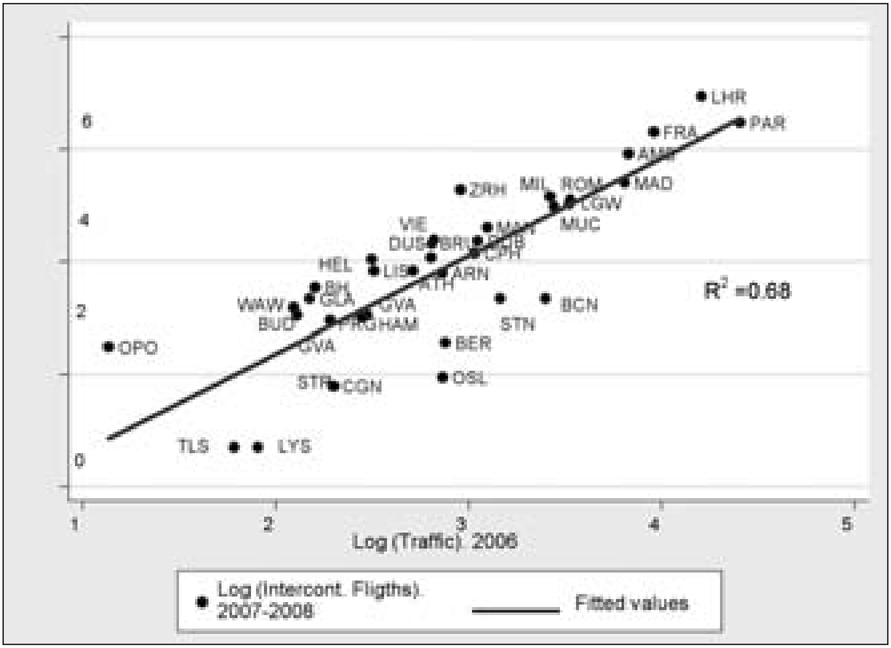
The airports with the highest number of non-stop intercontinental flights are those that act as hubs for the largest network airlines; Air France-KLM (Paris-Charles de Gaulle and Amsterdam), British Airways (London-Heathrow) and Lufthansa (Frankfurt and Munich). At a second level, we find hubs of medium-sized airlines: Iberia (Madrid), Swiss (Zurich) or Alitalia (Milan-Malpensa and Rome-Fiumicino). Demand from local urban areas generates an important supply of intercontinental flights at some other airports, as is the case with Brussels, Dublin, Dusseldorf or Manchester.

In any case, the hierarchy of intercontinental traffic across airports is closely linked to the hierarchy that prevails in terms of total traffic. Figure 1 shows the close relationship between total traffic and the supply of intercontinental flights for our sample of urban areas. However, some airports deviate from the mean relationship, because they have intercontinental flights either low in relation to total traffic (as in the case of Barcelona, Berlin, London-Stansted or Oslo) or high (as in the case of Dusseldorf, Helsinki, Manchester, Milan, Vienna or Zurich).

We cannot conclude from the information in Table 3 (columns 3 and 6) that long-haul traffic is becoming concentrated in the largest airports, since their traffic increases (in percentage) are not consistently higher than those seen in smaller airports. On the contrary, several airports now offer some intercontinental flights where they used to offer none. In this regard, we note the cases of Barcelona, Berlin, Hamburg or London-Stansted. The increases at the airports of several capitals of Eastern Europe, like Athens, Budapest, Prague or Warsaw are also notable. Note here that our definition of Eastern Europe is from a geographic point of view.

In this regard, columns 4 and 6 in Table 3 detail changes in each airports share of intercontinental flights from Europe in relation to the whole sample for the period 2004-2008. The airports with the largest supply of long-haul

[1] The 3rd and 6th columns show the difference in frequencies in absolute values instead of the relative change in percentage terms of frequency. We are aware that the latter measure would provide an easier comparison of frequencies' growth across airports. However, several airports do not have intercontinental fligths at the beginning of the period. Hence, we prefer to use the variation in shares as the measure to compare the frequencies' growth across airports.



Code airports:
AMS: Amsterdam, ARN: Stockholm, ATH: Athens, BCN: Barcelona, BER: Berlin (3), BHX: Birmingham, BUD: Budapest, BRU; Brussels, CGN: Koln/Bonn, CPH: Copenhagen, DUB: Dublin, DUS: Dusseldorf, FRA: Frankfurt, GLA: Glasgow, GVA: Genève, HEL: Helsinki, LGW: London-Gatwick, LHR: London-Heathrow, LYS: Lyon, MAD: Madrid, MAN: Manchester, MUC: Munich, MIL: Milan (2), LIS: Lisbon, OSL: Oslo, OPO: Porto, PAR: Paris (2), PRG: Prague, ROM: Rome (2), STN: London-Stansted, STU: Stuttgart, VIE: Vienna, WAW: Warsaw, ZRH: Zurich , TLS: Toulouse

Source: Own elaboration from data obtained from *Official Airlines Guide* (OAG).

Figure 1. Range scatter regression of intercontinental flights against total traffic.

flights, Amsterdam, Frankfurt, Paris Charles de Gaulle and especially London-Heathrow have lost market share over the period. The other airports that have lost market share initially offered a number of intercontinental flights disproportionate to their total traffic (Manchester, Milan-Malpensa, and Zurich in the winter).

On the other hand, among the airports showing the highest share increases are: (1) those that moved a large amount of total traffic in relation to their intercontinental flights in the initial period (Barcelona, Berlin, Hamburg, London-Stansted); (2) airports located in cities that are important business centers (Dublin, Dusseldorf, Brussels); (3) secondary hubs with an increasing importance for the dominant carrier (Munich, Rome-Fiumicino); and (4) airports of Eastern European cities that have benefited from European Union enlargement (Budapest, Warsaw), or from the Asian economic growth (Athens, Helsinki) because of their favorable travel time to the main Asian airports.

TABLE 4. Evolution of the concentration in the supply of intercontinental flights.

Period	CR1 (%)	CR4 (%)	HHI	Total frequencies
Winter 2004-05	26.21	63.63	0.1288	3 376
Winter 2007-08	22.89	57.28	0.1056	4 316
Summer 2004	24.56	60.47	0.1171	3 734
Summer 2007	22.51	56.89	0.1032	4 797

Source: Own elaboration from data obtained from *Official Airlines Guide* (OAG).

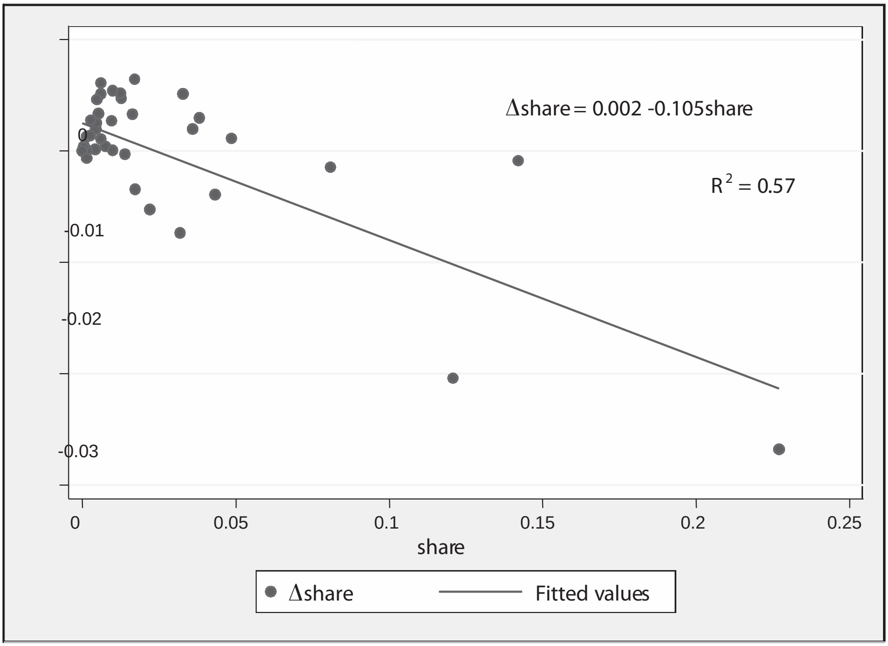
To sum up, the taxonomy of airports that have won or lost market share is diverse, but it seems that there is a tendency towards dispersion rather than concentration of intercontinental services from European airports. Several measures of concentration of traffic across airports may be used. Among them, we can mention the Gini index of concentration, the coefficient of variation, Theil's entropy measure or the Hirschman-Herfindahl index (Reynolds-Feighan, 2001). Here we use concentration indicators that are commonly used like the Hirschman-Herfindahl Index (HHI), which is constructed as the sum of the squares of market shares of airports in the sample, and the market share of the largest and the fourth largest airports (CR1, CR4). Note that these indicators are particularly well suited for examining changes in the extremes of the distribution of observations and our analysis put the attention on the variation of shares of the largest and smallest airports within the sample of urban areas.

In this regard, TABLE 4 shows a decrease in the concentration levels of the supply of intercontinental flights according to the concentration indices that we use.[1] Especially significant is the concentration rate of the four largest

[1] Note that the concentration indices are measured for our sample of urban areas and not for the entire airport population (including the airports without intercontinental fligths). However, the computation of the concentration indices would be quite similar if we were including the entire airport population since the additional airports would not add value to the sum of the squares of market shares (as it is constructed the Hirschman-Herfindahl index) and to the market shares of the largest airports.

airports, with a decrease of between four and six points in the summer and winter season, respectively.

Importantly, Figure 2 confirms the existence of a close negative relationship between the initial market share and share growth over the considered period. The market share in 2004 explains about 60 per cent of the share variation in the period 2004-2008



Source: Own elaboration from data obtained from *Official Airlines Guide* (OAG).

Figure 2. Range scatter regression of the variation in the share in the period 2004-2007 against the share in 2004. Mean values of the summer and winter season.

Finally, table 5 provides information about airlines that have stimulated the growth of intercontinental traffic at those airports showing increases in their share both in the summer and in winter. It must be understood that intercontinental flights services are usually organized in the form of shared codes between a European and a non-European airline. However, it can be argued that non-European airlines have played a major role in the growth of intercontinental traffic from several airports. Indeed, the national dominant airline has clearly led traffic growth only in Dublin, Dusseldorf and Helsinki. On the contrary, many airports have benefited from direct flights by American or Asian airlines to their main airport hubs, notably Delta, Continental, Air Transat and Emirates, which have an increasing presence in the European market.

TABLE 5. Airlines that add frequencies in intercontinental flights in 2004-2007 (winter and/or summer season).

Airports with positive variations of share in summer and winter	Airline
Dublin (DUB)	**Aer Lingus** (5), Continental (2), Delta (2), US Airways
Dusseldorf (DUS)	Delta, Emirates Airlines, **Lufthansa** (3)
London-Stansted (STN)	American Airlines, Eos Airlines
Brussels (BRU)	Continental, Jet Airways India (2), **SN Brussels**, US Airways
Barcelona (BCN)	Air Transat, Aerolíneas Argentinas, Avianca/Iberia, Continental, Delta (2), US Airways
Athens (ATH)	Continental, Delta, Emirates airlines, Singapore Airlines, **Olympic Airways**, Thai Airways, US Airways
Hamburg (HAM)	Air Transat, Continental, Emirates (2)
Rome (FCO, CIA)	Air Canada**,** Air Transat**, Alitalia (3)**, Alitalia/China airlines, Alitalia/Delta, Alitalia/Japan Air, American Airlines (3), Continental, Delta, United (2)
Helsinki (HEL)	**Finnair** (5)
Berlin (TXL)	Continental, Delta
Warsaw (WAW)	LOT/Air Canada, LOT/United (2)
Budapest (BUD)	Delta, **Malev** (2), Malev/Hainan airlines
Porto (OPO)	**TAP**, TAP/United
Madrid (MAD)	Aerolineas Argentinas, Air China, Air Transat, Avianca, Continental, Continental/air Europa, **Iberia** (2), Iberia/American Airlines (4), Iberia/Mexicana, South Korean airlines, 1Thai/Spanair
Glasgow (GLA)	Air Transat, Continental (2), Emirates, Fly Zoom, FlygoSpan
Koln/Bonn (CGN)	Continental
Stockholm (ARN)	Continental, Malaysia airlines, **SAS,** US Airways
Prague (PRG)	**Czech airlines** , Czech Airlines/Delta (2), Czech airlines/South Korean airlines
Genève (GVA)	Continental, Qatar Airways

Note 1: In brackets, the number of destinations where some frequencies are added.
Note 2: In bold, European airlines that do not operate with shared codes.

Source: Own elaboration from data obtained from *Official Airlines Guide* (OAG).

Along with the economic and demographic importance of the corresponding urban area, the amount of intercontinental traffic at European airports is very much influenced by the role they play in the organization of routes of the large European, American and Asian airlines. In this regard, the corresponding former flag carriers usually concentrate a relevant part of the traffic at the largest (or the two largest) national airports. However, non-European airlines may move a significant proportion of the intercontinental traffic both from these airports and, especially, from other, smaller European airports.

Thus, European airports may see significant intercontinental traffic because they play one of several roles: 1) As an airport hub of a European airline, 2) As an airport feeder of an American or Asian airline, 3) As a catalyst of the point-to-point traffic generated by the urban areas near the origin or destination of the flights.

European network airlines use some selected hubs, and no increase of these types of airports is anticipated in the near future. In fact, it is possible that some of these airports will lose this function, given the expectation of airline mergers. On the other hand, point-to-point services are important for a smaller but increasing number of intercontinental routes. Finally, feeding the hubs of Asia and America may contribute to reductions in the spatial concentration of intercontinental flights services from European airports.

4. An empirical analysis of the determinants of intercontinental traffic

In this section, we attempt to identify factors that explain the amount of intercontinental traffic generated by airports in the sample in 2004 and its variation in the period 2004-2008.

Demand for intercontinental flights may be influenced by several attributes of the corresponding region. Indeed, the amount of intercontinental traffic that an urban area can generate is closely related to population, gross domestic product per capita and whether the central city is a political capital. Additionally, the hub status of an airport may imply to generate traffic higher than what would be generated by local demand.[1]

Hence, we estimate an equation that considers the determinants of intercontinental traffic in the sample of European airports at 2004. Note that data for most of the explanatory variables is not available for 2007-2008, so this estimation refers only to the initial period. The equation to estimate the determinants of intercontinental traffic in the sample of European airports in 2004 is as follows:

[1] The geographical location of the urban area may also influence demand of air traffic. However, the relative distance to America or Asia in the sample of European urban areas here analyzed do not seem to play an important role, since the different variables used to capture this geographical effect are highly non-significant.

$$share = \alpha + \beta_1 D^{capital} + \beta_2 Pop + \beta_3 GDPc + \beta_4 D^{Large\_Hub} + \beta_5 Number\_nearby\_airports + \beta_6 Slots + \varepsilon_1, \quad [1]$$

where the dependent variable, *share*, is the share of intercontinental traffic from each airport in relation to the whole sample of airports.

In the previous section, we have seen the existence of a close negative relationship between the variation in the share of intercontinental traffic in the period 2004-2008 and the share that each airport held in 2004. This implies a clear empirical trend towards a lower concentration in intercontinental services from European airports. However, more information can be obtained from this basic relation with the estimation of a reduced form equation that relates the variation in shares in the period 2004-2008, *Δshare*, with the factors that explain the share obtained in 2004:

$$\Delta share = \alpha' + \beta'_1 D^{capital} + \beta'_2 Pop + \beta'_3 GDPc + \beta'_4 D^{Large\_Hub} + \beta'_5 Number\_nearby\_airports + \beta'_6 Slots + \varepsilon_2 \quad [2]$$

The explanatory variables of equations [1] and [2] are the following:

1) $D^{capital}$, which is a dummy variable that takes a value of 1 for airports located in the political capital of the corresponding country.

2) *Pop*, which is the population of the corresponding region (NUTS 2).

3) *GDPc*, which is the gross domestic product per capita of the corresponding region (NUTS 2).

4) *Large_Hub*, which is a variable that takes a value of 1 for large hub airports. Using data from Official Airlines Guide and Eurostat, we define as hub airports those airports that meet all these conditions: 1) They have a traffic higher than the mean sample traffic, 2) The share of the dominant airline is higher than the mean sample share of the dominant airline, 3) The share of airlines integrated in alliances (Star Alliance, SkyTeam, Oneworld) is higher than the mean sample share of airlines in alliances. In this regard, airports of our sample that meet these conditions are the following: Amsterdam, Copenhagen, Frankfurt, London-Heathrow, Madrid, Milan-Malpensa, Munich, Paris-Charles de Gaulle, Paris-Orly, Rome-Fiumicino and Zurich.[1]

5) *Number_nearby_airports*, which is the number of airports that lie fewer than 100 km from each airport and which are managed by different operators. We only consider airports with passenger traffic greater than 150,000 individuals. This traffic threshold is the same as that used by Eurostat for differentiating between main and small commercial airports. It has been shown

[1] Note that we do not have data on the proportion of the total traffic in an airport that is connecting traffic. That data is not available on systematic basis.

that this variable provides a sound measure of the degree of competition between airports (Bel and Fageda, 2010).

6) *Slots*, which is discrete variable that provides an approximate measure of the degree of congestion at the airports of the sample. This variable may take the following values: It takes the value zero for non coordinated airports, the value one for scheduled facilitated airports and the value two for coordinated airports. The International Air Transport Association (IATA) classifies the various airports according to the degree of excess demand when establishing the procedures for the allocation of slots. Thus, a distinction is drawn between: (1) non-coordinated airports where there is no excess demand and the allocation of slots is at the discretion of the airport operator; (2) airports where flight schedules have to be supervised; and (3) coordinated airports where excess demand requires the application of standard procedures for slot allocation ('grandfather rights', 'use-it or lose-it', criteria for new slots and new entrants, etc). This provides an approximate measure of the congestion levels at the airports, although it may also reflect the use of administrative rules to allocate slots to airlines. Unfortunately, we have not been able to gather other comparable data about the scarcity of capacity at the airports of the sample.

We can expect a positive sign for the variables for population, GDP per capita and the political capital in the equation that has as dependent variable the shares of intercontinental traffic. Indeed, these variables may be capturing the size of local demand for intercontinental traffic. However, it is not clear the sign of these variables in the equation that has as dependent variable the variation in the shares of intercontinental traffic. Concerning the variable of large hubs, it is expected a positive sign of this variable in the equation that has as dependent variable the shares of intercontinental traffic. If our hypothesis of de-concentration of intercontinental traffic is not rejected, we should expect a negative sign for the variable of large hubs in the equation that has as dependent variable the variation in the shares of intercontinental traffic. The variable for slots should take a negative value in the equation that has as dependent variable the variation in the shares of intercontinental traffic since scarce capacity may prevent from expanding the supply of intercontinental traffic. Finally, the variable of number of nearby airports may take a negative value in both equations if airport competition is provoking an airport substitution effect in the supply of intercontinental traffic.

Data for intercontinental flights have been obtained from the web site of Official Airlines Guide (OAG). Data refer to a representative sample week for each period. Total traffic statistics are available in the web site of Eurostat.

Data on the economic and demographic attributes of European regions have been obtained from "European Regional Prospects Report 2006", published by Cambridge Econometrics. Data of population is measured in terms of number of inhabitants (thousands) and data of GDP per capita is measured in terms of an index where the value 100 is given to the mean value of GDP per capita of all countries in the European Union (UE-25)

The estimation has been made using the Seemingly Unrelated Regression method (SURE). This allows us to estimate the two equations as a system with the same explanatory variables but different dependent variables (*share, Δshare*), using ordinary least squares. The SURE method takes into account the correlation between the residuals of both equations.[1] Hence, the estimation is more efficient than estimating each equation separately using ordinary least squares. Note that we estimate equations [1] and [2] for: 1) The whole sample of airports, 2) The sample of airports excluding those airports with no intercontinental flights in any period. We argue that these airports with no intercontinental flights may distort the estimation since the dependent variable for these airports take the value zero but the explanatory variables show different values.

Looking at data, it is not found a strong correlation between the explanatory variables (the correlation matrix is available upon request from the authors). The only exception is the variable of number of nearby airports, which shows a relatively high correlation with the variable of GDP per capita. Hence, our estimation includes some specifications that exclude the number of nearby airports as explanatory variable. TABLE 6 shows the results of the estimation of the two equations of the system.

From these results, we see that population and gross domestic product per capita influence positively on the amount of intercontinental traffic moved in 2004, although the statistical significance of the variable of GDP per capita is very modest. Aside from local demand, the development of hubbing operations substantially influences the amount of intercontinental traffic. On the contrary, being a political capital does not play any central role.

However, we find that airports located in political capitals increased their share substantially in the period 2004-2008 (although being the political capital did not influence the initial, 2004 values). This likely reflects the positive evolution in the capitals of several countries of Eastern Europe. Importantly, hub airports show a negative variation in their share of intercontinental traffic. Thus, we find evidence that hub airports are losing market share in the considered period. This result fits well with the analysis of the previous sections.

[1] Since the SURE method takes into account the correlation between the residuals of both equations, it is not possible to apply the robust and cluster options to the estimation.

Table 6. Estimation results (SURE).

	Share (1): All sample	Share (2): All sample	Share (3) : Sub-sample of airports with intercontinental flights at any period	Δshare (1): All sample	ΔShare (2): All sample	ΔShare (3): Sub-sample of airports with intercontinental flights at any period
$D^{capital}$	0.0020	-0.0008	0.00028	0.003	0.0041	0.0044
	(0.011)	(0.010)	(0.013)	(0.0017)**	(0.0017)**	(0.0024)*
Pop	2.54e-06	2.98e-06	7.12e-06	1.62e-08	-9.61e-08	-2.11e-07
	(1.91e-06)	(1.83e-06)*	(2.60e-06)***	(3.07e-07)	(3.05e-07)	(4.78)e-06
GDPc	0.00014	0.00022	0.00029	-1.73e-06	-0.000022	-0.000037
	(0.00016)	(0.00014)$^{+}$	(0.00018)$^{+}$	(0.000026)	(0.000023)	(0.000034)
D^{Large_Hub}	0.052	0.05	0.051	-0.006	-0.006	-0.0056
	(0.013)***	(0.012)***	(0.014)***	(0.002)***	(0.0021)***	(0.0027)**
Num_nearby_airports	0.0055	-	-	-0.0014	-	-
	(0.0055)			(0.0009)$^{+}$		
Slots	0.0027	-0.00088	-0.0037	-0.00092	8.51e-06	0.00072
	(0.102)	(0.0091)	(0.014)	(0.0016)	(0.0015)	(0.0026)
Intercept	-0.035	-0.031	-0.048	0.0035	0.0027	0.0032
	(0.029)	(0.028)	(0.037)	(0.0046)	(0.0047	(0.0069)
N	53	53	36	53	53	36
R^2	0.42	0.42	0.49	0.23	0.20	0.22
F (Joint Sig.)	38.79***	39.12***	34.72***	16.42**	13.38**	10.16*

Note: Significance at 1% (***), 5% (**),10% (*), 12.5% ($^{+}$).

In addition to this, airport congestion does not seem to influence neither the shares nor variation of intercontinental traffic. However, we must be cautious with the interpretation of results for this variable. First, part of the airport congestion effect may be captured by the variable of large hubs. And second, our variable is just an approximate measure of airport congestion. Finally, the variable for the number of nearby airports is just modestly significant in the equation that has the variation of shares as dependent variable. This may imply that competition from nearby airports to attract intercontinental traffic is soft.

5. Concluding remarks

Air services have a major impact on urban economic growth and that impact depends both on the amount and quality of those air services. Concerning location choices of large firms devoted to knowledge intensive activities, the quality of air services is strongly related to the availability of non-stop intercontinental flights to a vast number of major destinations.

Long-haul traffic has been traditionally monopolized by former flag carriers, which tend to concentrate their operations in hubs. In this regard, the competitive advantages that low-cost airlines obtain in short-haul flights do not seem to transfer to long-haul traffic, and no substantial change is expected in the near future. However, the demand for point-to-point intercontinental flights increases with economic growth and globalization. Additionally, American and Asian network airlines have increased their presence in the European market, since traffic from the large European urban areas may increase the profitability of operations in their own hubs. Finally, congestion in the largest hubs must be taken into account. Less predictable are the effects of the new models from Airbus and Boeing and the increasing consolidation of open skies policies for air traffic between different continents, but both will likely influence intercontinental services from European airports.

The analysis of data for non-stop air services from a sample of the main European urban areas towards selected intercontinental destinations in the period 2004-2008 shows a clear tendency towards a decrease in the concentration of long-haul flights. This is indicated by concentration indexes and the strong negative correlation between the share of traffic in 2004 and the variation in the period 2004-2008.

Along with the loss of relative position experienced by the largest airport hubs, there has been high growth in intercontinental traffic from airports that had a null or very modest initial supply. In the same vein, we find that large airports with a hub status have lost share over the period, while airports located in political capitals tend to gain share.

From our analysis, it seems that not only the largest urban areas with the largest airport hubs have opportunities to play an important role in globalization trends. In this regard, it is crucial for smaller urban areas to promote long-haul air services in their airports. The amount of and changes in intercontinental traffic moved by an airport depend upon exogenous factors related to the economic and demographic attributes of the corresponding regions. However, we should not forget the importance of elements controlled by airport managers: like the provision of capacity, marketing activities, prices or the allocation of space (slots, gates, check-in counters and so on).

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