OUTLOOK ON EUROPE

AIRLINE COMPETITION AT EUROPEAN AIRPORTS

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ABSTRACT
Hub-and-spoke networks of airlines create entry barriers at large hub airports. As a result, deregulation does not necessary lead to more competition. In this paper, airline competition at European airports in the 1990s is analysed. Results show important differences between airports, which are related to size and geography. At most airports, competition increased with the successful entrance of new competitors. Yet, competition decreased at hub airports and at airports in the northern periphery in Europe.

Key words: Airports, hub-and-spoke, deregulation, competition, entropy, alliances, airlines, Europe

INTRODUCTION

Deregulation and liberalisation of markets is often associated with increasing competition, more services and lower prices. The airline industry is no exception. However, in a deregulated airline regime, scale economies possibly reinforce rather than weaken the dominant position of an airline at an airport. Hub-and-spoke networks of airlines create entry barriers at large hub airports. As a result, deregulation does not necessarily lead to more competition. In this paper airline competition at European airports in the 1990s is discussed. Results show important differences between airports, which are related to size and geography. At most airports, competition increased with the successful entrance of new competitors. Yet, competition decreased at hub airports and at airports in the Northern periphery in Europe.

DEREGULATION OF EUROPEAN AIR TRANSPORT

In the past two decades the market structure of the global aviation market has changed dramatically. For a long time, European airline business has been characterised by bilateral air services agreements between countries pairs or between carriers. The purpose of these agreements was to control market access, capacity and frequency of flights (Doganis 2001). The impetus for this change has been the liberalisation of the American airline industry in 1978. Following the developments in the United States, the European aviation market was deregulated during the 1980s and 1990s. Unlike the US deregulation that occurred rather abruptly, the European deregulation occurred in stages.

The first stage of deregulation consisted of the liberalisation of bilateral air service agreements

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with the United States. Due to deregulation developments in the US market, many EU countries adopted liberal agreements with the United States. The agreement reduced significantly the restrictive rules on capacity, tariffs and route access. For example, the Netherlands agreed upon a more liberal bilateral treaty with the United States in 1979. This treaty and its follow up in 1992 contributed to the success of Amsterdam Schiphol Airport as an inter-continental hub airport. In a second stage, a number of bilateral agreements between European countries were liberalised with respect to airfares, capacity controls and route access (Doganis 2001). The final stage, which involved the gradual elimination of bilateral agreements by means of three 'packages' of deregulation measures (1988, 1990 and 1993), has undoubtedly been the most important step towards liberalisation. As a result, European airlines[1] are now free to set airfares, to enter and exit routes, and to choose frequency and capacity. Moreover, airlines are also allowed to take cross-border majority shares in other European airlines. Finally, companies are able to set up and operate an airline in any EU member state. State aid to European carriers was abolished following a 'one-time, last-time' principle. Hereafter, airlines have been subject to the competition rules of the EU to prevent monopolistic behaviour (Doganis 2001).

HUB-AND-SPOKE NETWORKS

According to the objectives of deregulation, competition should increase as a result of the deregulating process. Lower barriers of entry enhance the possibility of airlines to compete for passengers at airports leading to lower prices. As a consequence, incumbent airlines are expected to lose market share at an airport. At the same time, though, some airlines may adopt a hub-and-spoke network in order to realise scale and network economies. In the US aviation market, a number of 'trunkline'-carriers reorganised their networks from point-to-point into hub-and-spoke networks between 1978 and 1985 (Reynolds-Feighan 2001). Flights between medium airports were increasingly replaced by indirect flights via central airports or 'hubs'. In such a network, the airline company concentrates its flights around one or a small number of transfer hubs. In this way, the airline operates synchronised, daily waves of flights connecting traffic to smaller airports called 'spokes' (Burghouwt *et al.* 2003).

An airline applying the hub-and-spoke logic can realise cost advantages of multiple sorts. Filling longer (intercontinental) routes with passengers originating from several spokes enables higher utilisation rates and the use of large aircraft with a lower cost per passenger per mile. What is more, the number of geographical markets that airlines serve increases exponentially with each addition of just one destination. Related to this wide coverage of destinations, airlines try to commit consumers by offering loyalty programmes.

Historically, one should carefully distinguish between the initial conditions prevailing prior to liberalisation in the United States and in Europe. In contrast to the situation in the United States, radial, star-shaped networks already existed in European countries before liberalisation took place. National carriers in Europe traditionally organised their flights using one central airport (mostly in the capital) and to some extent connecting national routes to international routes. This can be explained by the system of bilateral air service agreements, which originally required airlines to operate only from their national home base. These radial networks were not an equivalent of hub-and-spoke networks since most transfer connections were created 'by accident'. At the time, the flight schedule of the hubbing airline was not deliberately aimed at maximising the number of transfer connections at the hub by concentrating flights in a number of daily waves (Burghouwt and De Wit 2003). After deregulation, many European airlines adopted wave-system structures in their flight schedules to maximise the network economies related to hub-and-spoke network structures.

It is well known that hub-and-spoke airlines dominate to a large extent their hub airports (e.g., Borenstein 1989; Lijesen *et al.* 2001; Oum & Zhang 1995). Domination of the hub allows the hubbing airline to:

1. Optimise its wave-system structure since it controls airport slots.
2. Deter entry.

3. Exercise some control over the airport authority and its planning.
4. Charge higher prices at spoke routes.

At the other end of the airport hierarchy, airlines take advantage of the possibility to create spokes in other countries as a way to enlarge their network and to reduce their dependency on their national home market.

Over time, then, one expects airlines to further concentrate their routes at large hub airports. Competition shifts to smaller airports where airlines compete for regional markets. This process is reinforced by the advent of low-cost carriers, which primarily use smaller, regional airports as part of their cost minimising strategy. Therefore, our central hypothesis holds that competition decreased at hubs and increased at small airports.

DATA AND METHODOLOGY

We analyse the effects of deregulation in Europe during the 1990s in terms of airline competition at airports. We use data on departures of European flights[2] and leave out intercontinental flights as these still fall under a regulated regime. The data are taken from the OAG/ABC flight schedules, which lists all direct, scheduled flights for the years 1990–99 based on a representative week in July for each year. Variables include year, departure airport, operating airline and seat capacity for each flight. Though the OAG/ABC data suffer from a number of limitations (on this, see Burghouwt & Hakfoort 2001), the data can be considered as the most comprehensive source for flight information.

Competition can be measured in different ways. We will use the entropy measure as a measure of competition, because it has the advantage of decomposition (e.g., into strategic alliances).[3] Entropy is given by:

$$H = -\sum_{i=1}^{N}(x_i)\cdot\log(x_i) \qquad (1)$$

(For $x = 0$ holds that $x \log(x) = 0$)
x_i = market share of airline i
N = number of companies operating in the market

For our purposes, x_i represents the market share of an airline at a specific European airport as expressed by the seat capacity of departing flights. Maximum competition occurs when all N firms having an equal share in seat capacity, which implies $x_i = 1/N$ for all N firms, and $H = \log N$. Minimum competition occurs when one airline fully dominates an airport, i.e. $x_i = 1$ and $H = 0$. Note, however, that we deal with competition at airports (geographically) rather than on routes (economically). As such, our entropy measure indicates to what extent airlines compete for passengers at an airport. Only in the case of airlines offering flights with the same destination, the measure also expresses route competition.

Applying the entropy measure to all airports gives one entropy value for each airport in each year. The overall entropy in a year, indicating the average competition at European airports, is then obtained by the sum of entropy values weighted for the share of the airport in the total number of seats offered on European flights. This means that the entropy of larger airports will weigh more in the overall entropy index than the many small airports. We use a weighted average because we are interested in the number of passengers affected by changes in competition. For example, consider the hypothetical case that entropy would increase at the largest European airport (London Heathrow) from 1 to 2 and entropy would decrease at a much smaller airport (say, Valencia) from 2 to 1, while entropy at other airports remains constant. A weighted average reports an increase in overall entropy while a simple average would indicate no change in overall entropy.

To distinguish between the entropy dynamics at larger and smaller airports, we use a categorisation of European airports developed by Burghouwt & Hakfoort (2001) based on differences in airports' size and connectivity. Cluster analysis resulted in five categories (the airports belonging to categories 1–3 can be found in the appendix, while the list of airports belonging to categories 4 and 5 are too long to include):

- Category 1: Four primary hubs. These airports have both an extensive international (intercontinental and intra-European) connectivity and a high capacity.
- Category 2: 11 secondary hubs. These large airports have extensive intra-European

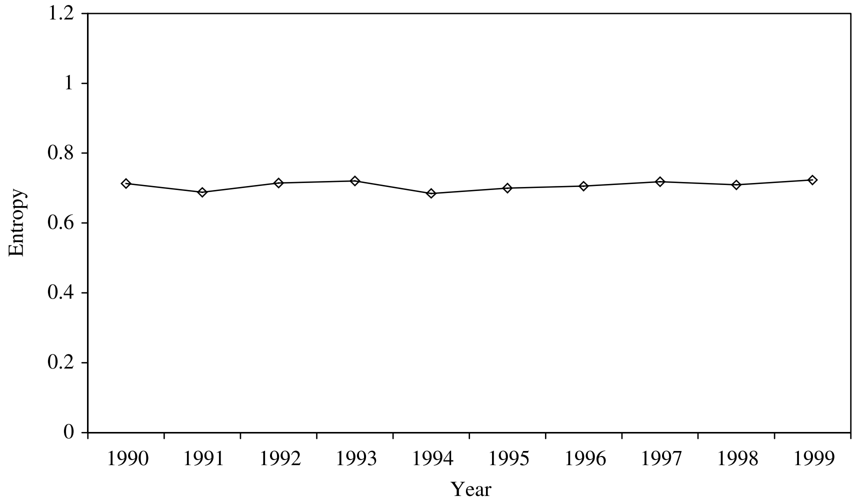

Figure 1. *Overall entropy for European airports (1990–99).*

connectivity but a lower level of intercontinental connectivity and less capacity.

- Category 3: 12 medium airports. Other national or large regional airports with a limited number of intercontinental destinations but with a reasonable level of intra-European connectivity.
- Category 4: 34 small airports. Airports with a limited number of primarily European destinations.
- Category 5: 485 very small airports.

RESULTS

Time trends in entropy – The results of the overall entropy at European airports are given in Figure 1. It is immediately clear that no trend is present with entropy being stable over time around a value of $H = 0.7$. On average, deregulation in the 1990s has neither increased nor decreased competition at European airports.

The aggregate trend, however, obscures important differences in the entropies of the individual airports and changes herein over time. Figure 2 shows the same results at the level of the five categories ranging from large international hubs (category 1) to the smallest regional airports (category 5). The categorisation proves to be informative, as different values and trends are noticeable for the different categories. Competition is clearly positively dependent on the size of an airport. The large airports (mostly located near large cities) generally have higher competition levels than smaller airports reflecting differences in regional markets.

Over time, however, competition at primary and secondary hubs is decreasing (entropy decreases), while smaller airports have attracted, on average, more airlines and competition (entropy increases). The pattern suggests that deregulation in the 1990s reduced competition at larger airports and strengthened their hub function. At the same time, we observe increased competition at smaller airports serving as a spoke for two or more airlines (rather than only for the one national carrier). The results underline the conclusions of Burghouwt & Hakfoort (2001) who found that small airports are increasingly connected to foreign hub-airports. As a result, the competition levels of airport categories tend to converge to a value around 0.8 (except for the smallest airports in category 5).

Decomposition – We repeated the analysis by grouping airlines into their alliances and into groups of airlines related through shareholdings. Grouping implies that the shares of airlines belonging to a group are summed causing entropy values to be smaller than before grouping. This allows one to analyse to what extent competition is decreased as a consequence of

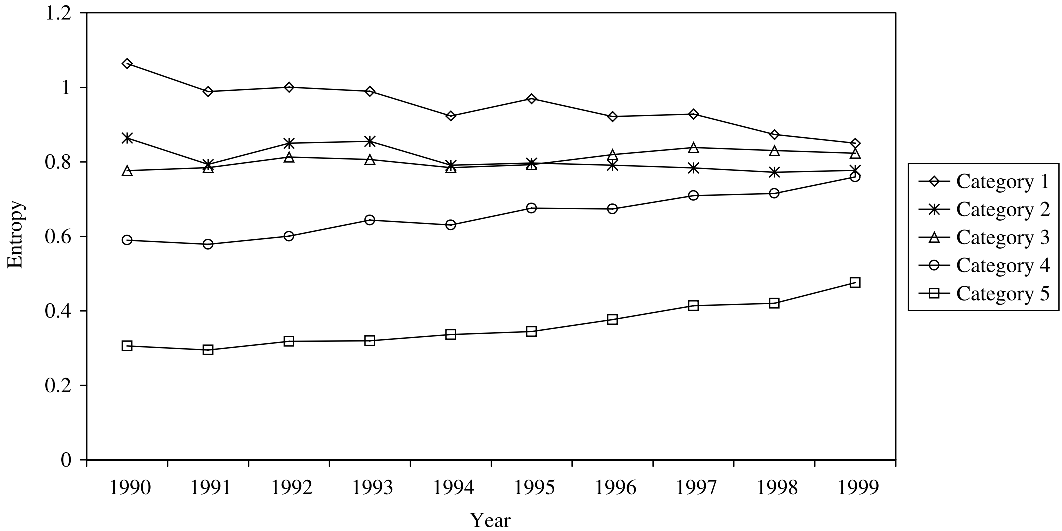

Figure 2. *Entropy values for five categories of airports (1990–99).*

strategic alliances, and as a consequence of shareholdings, respectively. Grouping provides relevant units of competition analysis since one can expect competition strategies to be co-ordinated among airlines belonging to the same alliances and among airlines with shareholdings. This means that competition at airports is best reflected by entropy values at the level of groups of co-operating airlines.

Using the data provided by the *Alliance Survey* (Airline Business 2000), five global alliances were distinguished and a number of smaller strategic alliances including only two or three airlines. The five global alliances are (starting year in brackets): KLM/Northwest (1997), Oneworld (1999), Qualiflyer (1998), SkyTeam (2000)[4] and Star Alliance (1997). Apart from the global alliances, we included all smaller strategic alliances mentioned in the survey. Concerning the shareholdings, the *Alliance Survey* has also been used as a guide. We grouped two airlines together, if an airline has a share of 20 per cent or more in the other airline.

The entropy results at the level of alliances and at the level of shareholdings are given in Figures 3 and 4. Comparing these results with the earlier entropy results before grouping in Figure 2, it is clear that grouping reduces primarily the entropy of categories 1 and 2 (the primary and secondary hubs). The reduction in entropy in Figure 3 reflects the main rationale of strategic alliances, which is to connect two airline networks via the main routes between hubs. In this way, passengers can transfer to partners' connecting flights via the hubs. Such a hub strategy of alliance partners decreases competition at hub airports. The pattern in Figure 4 shows that shareholdings, as for alliances, also reduce competition at primary and secondary hub airports.

Geography – Though we can observe clear patterns for airports of different size, one would expect the geography of airports to affect (a change in) entropy value as well. Competition among airlines (entropy) is expected to be high mainly in urban regions with 'thick' passenger markets. By contrast, peripheral regions are more likely to be served as a spoke in a single airline network characterised by lower entropy. This means that after the deregulation in the early 1990s, small airports in peripheral regions may well have witnessed a decrease rather than an increase in entropy.

The geographical patterns in airport entropy are analysed in Figure 5 and the change in entropy in Figure 6. Categories 4 and 5 are chosen for analysis knowing that heterogeneity is largest in the smaller airports.[5] The maps show a selection[6] of 200 airports out of a total of 519.

Figure 5 shows the entropy values averaged over the period considered (1990–99). The

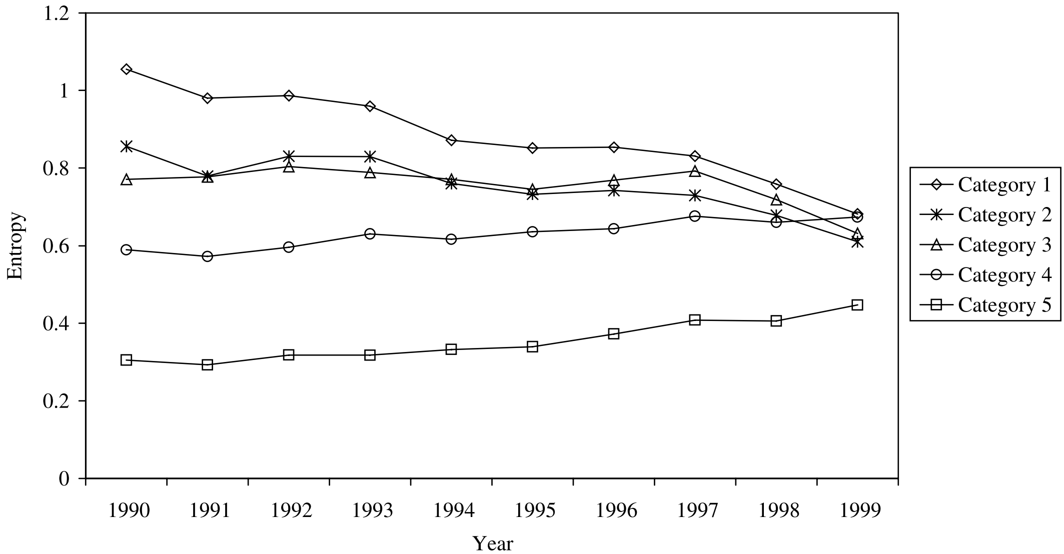

Figure 3. *Entropy at the level of alliances (1990–99).*

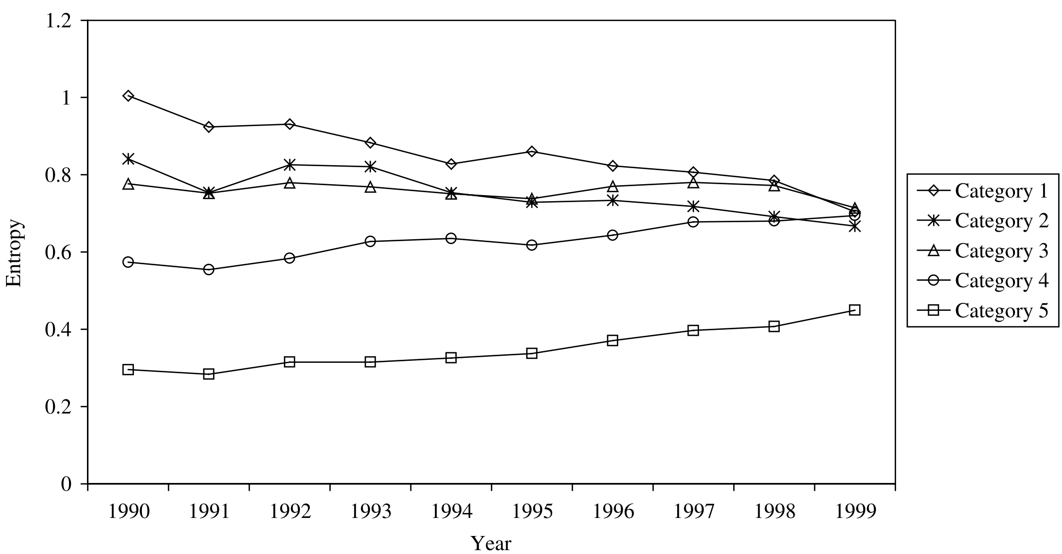

Figure 4. *Entropy at the level of shareholdings (1990–99).*

pattern indicates that airports in the urban regions in Europe (UK, Benelux, Ruhr area, Northern Italy) are indeed characterised by high entropy values. And, low entropy is found in peripheral areas in Europe (Scandinavia, Iceland, Greece and Southern Italy).

Figure 6 displays the pattern in the *change* of entropy computed as the difference between the mean value of 1990–92 and the mean value of 1997–99. The results reflect the differential effects of deregulation on small European airports. As expected, competition decreased in most of the northern periphery. However, and unexpectedly, competition in the Southern periphery increased. In particular, small Spanish airports have witnessed increased

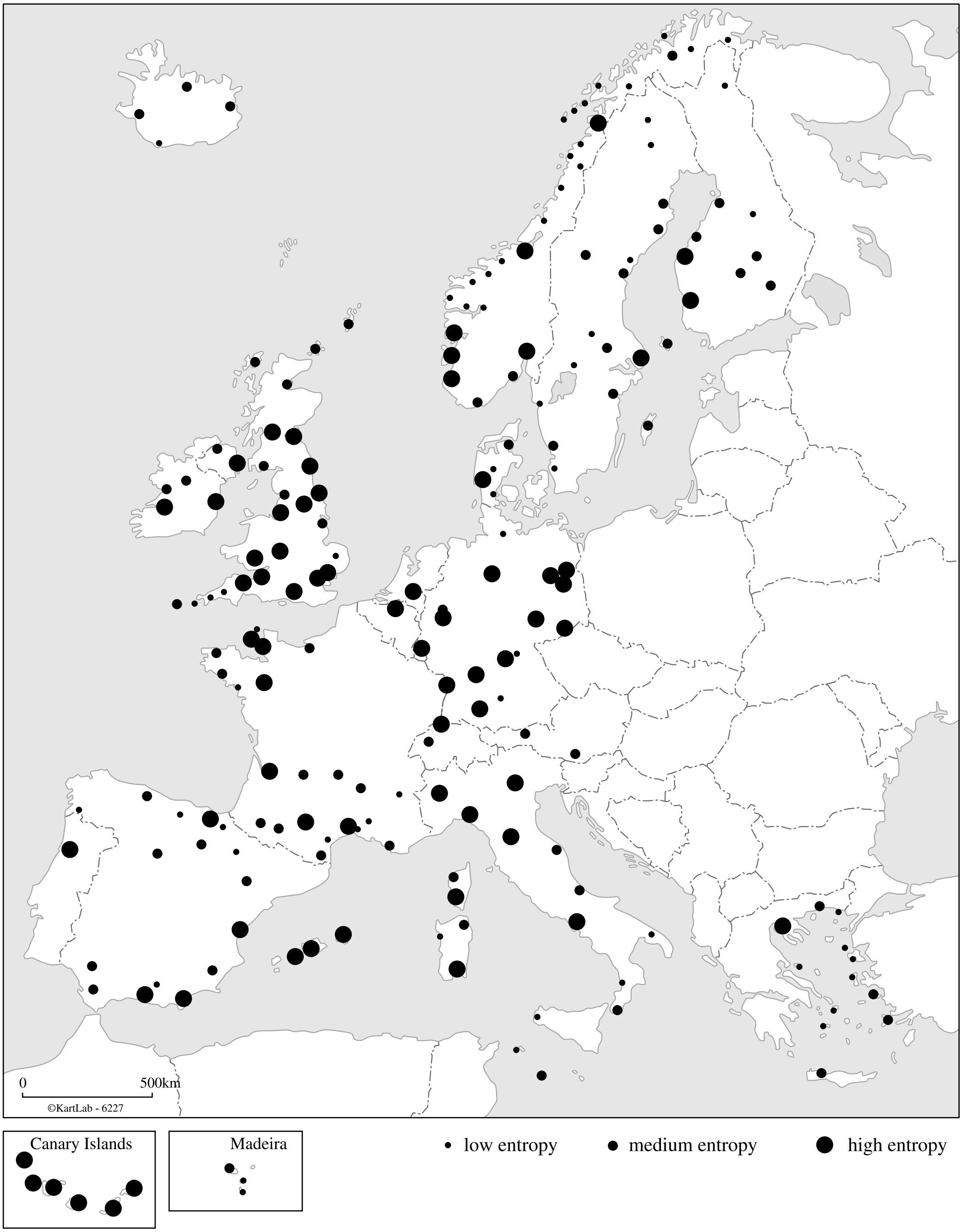

Figure 5. *Ten-year average entropy of small European airports (categories 4 and 5).*

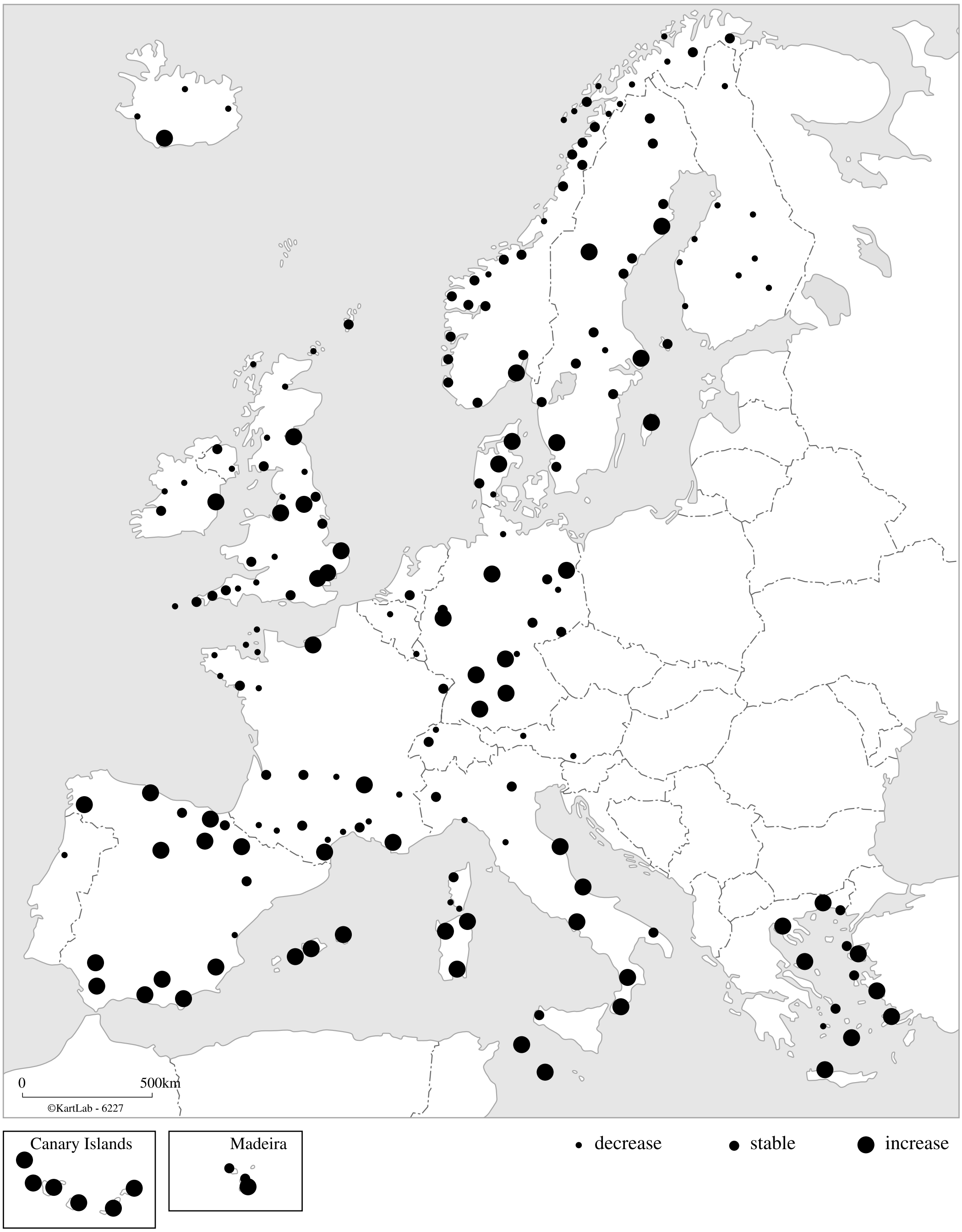

Figure 6. *Change in entropy of small European airports (categories 4 and 5).*

competition (probably due to the entrance of former charter airlines on routes previously monopolised by the national carrier Iberia). For centrally located airports, the direction of change in entropy is mixed: some national carriers successfully monopolised some regions (e.g., Brittany, Southwest France), while other regions have become a more contested area (e.g., London, Southern Germany). Again, these patterns may reflect differences in urban density, but country-specific dynamics may play a role as well. Future research should aim to explain the variety in regional airport dynamics in more detail.

Overall, the geographical pattern indicates that deregulation increased competition in southern regions – probably caused by the disappearance of the charter market as a protected segment traditionally serving tourist destinations – while most Northern regions have seen competition decreasing. To what extent these differences are reflected in price differentials remains a subject for further research, but one expects the prices to have fallen more rapidly in Southern regions compared to Northern regions.

CONCLUSION

Deregulation of the European airline markets has resulted in the adoption and intensification of hub-and-spoke networks by European airlines. We found that competition levels at airports, and changes herein over time, mainly relate to the size and connectivity of an airport, and only to some extent to an airport's location (in particular population density). Competition shifted from hub airports to regional airports. The latter act either as spokes in one or more hub-and-spoke networks, or as airports served by low-cost carriers. The two developments jointly resulted in a convergence of entropy levels. Any change in this convergence is unlikely, as global airlines continue to expand their hub-and-spoke networks.

In future research, the authors aim to explain the entropy levels of different airports using variables including size, connectivity, geography and population density. In this way, we intend to contribute to a more systematic understanding of the patterns discovered by the present study.

APPENDIX

Category 1: primary hubs

AMS	Amsterdam
CDG	Paris Charles de Gaulle
FRA	Frankfurt
LHR	London Heathrow

Category 2: secondary hubs

ATH	Athens
BRU	Brussels
CPH	Copenhagen
DUS	Dusseldorf
FCO	Rome
LGW	London Gatwick
MAD	Madrid
MUC	Munich
ORY	Paris Orly
VIE	Vienna
ZRH	Zurich

Category 3: medium airports

ARN	Stockholm
BCN	Barcelona
GVA	Geneva
HAM	Hamburg
HEL	Helsinki
LIN	Milan Linate
LIS	Lisbon
LYS	Lyon
MAN	Manchester
MRS	Marseille
MXP	Milan Malpensa
NCE	Nice

Notes

1. Norway and Iceland were also included without joining the EU.
2. European airports cover all airports in the EU member states plus Gibraltar, Iceland, Monaco, Norway and Switzerland.
3. For more on the entropy measure see Theil (1967, 1972) and Frenken (2004). Note that in economics, one generally speaks of market concentration rather than competition. Concentration is the inverse of competition. Common concentration measures are the concentration ratio and the Herfindahl-index (Curry & George 1983).

4. Partners of SkyTeam are not grouped in our data because SkyTeam has only existed since 2000.
5. The maps are based on entropy values measured at the airline level before grouping, as grouping hardly affects categories 4 and 5.
6. Airports with average seat capacity below 1000 and airports that did not appear each year in the data have been excluded.

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