

# AIRPORT COMPETITION AND AVIATION NETWORK EVOLUTION: AN EXPLORATORY STUDY ON CONTINENTAL PORTUGAL

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## RESUMO

Este trabalho descreve um estudo exploratório sobre a evolução da rede de aviação de três aeroportos em Portugal continental – Lisboa, Faro e Porto – entre 2001 e 2010. O principal objectivo é o de avaliar a mútua influência que podem ter as decisões feitas em diferentes aeroportos da rede. O estudo realizado demonstra também a existência de concorrência entre aeroportos a partir das alterações experimentadas na rede de aviação ao longo do período de estudo. Apresenta-se um enquadramento conceptual para definir as maneiras em que os aeroportos concorrem entre si e as relações entre tais tipos de concorrência. O grau de concentração da rede é avaliada através do Network Concentration Index (NC). São também analisados documentos de planeamento produzidos pelo operador dos aeroportos, permitindo avaliar o nível de conhecimento da empresa relativamente à concorrência entre aeroportos e às estratégias seguidas pelos aeroportos.

## ABSTRACT

This work describes an exploratory study to examine the evolution of the aviation network of three airports in continental Portugal – Lisbon, Faro and Porto – between 2001 and 2010. Our main goal is to evaluate the influence that decisions taken in a given airport have over decisions made in other airports in the network. Additionally, the research shows the relationship between airport competition and the changes occurring in the aviation network during the period of study. A conceptual framework on airport competition is also presented in order to define the ways in which airports compete and the relationships between them. We evaluate the degree of concentration of the aviation network using the Network Concentration Index (NC). Similarly, we analyse planning documents produced by the operator of the airports, to assess how aware they are on airport competition and on the strategies proposed for their airports.

## 1 INTRODUCTION

Deregulation of the air market in the United States, started in 1978, generated the concentration of the airline routes into few airports creating the famous *hub and spoke* networks (Burghouwt, 2007). In Europe, however, most airlines were (and still some are) owned by national governments and tied to the main national airports (De Neufville & Odoni, 2003; Graham, 2003). Hence their networks were already, at least geographically, of a *hub and spoke* style. Therefore, after deregulation started in the 1990's, a de-concentration effect is noticeable (Burghouwt et al., 2003) mainly due to the appearance and rapid growth of Low-Cost Carriers (LCC).

LCCs disrupted the market and increased competition between airlines, pushing flight fares down. But also, their preference for airports that are cheap, simple and free of congestion introduced a new ingredient in the European air market: competition between airports. This competition was additionally propelled by other effects of deregulation and the economic environment, such as major airlines bankruptcy and mergers, and airport ownership transition towards privatisation (De Neufville & Odoni, 2003). In this new context, more than ever, airports need to remain competitive if they are to survive and be profitable, or at least sustainable, in a market with increasing volatility. Especially because airports have the most

fixed assets – runways and buildings – while airlines have the most mobile ones – aeroplanes (Bush, 2010).

This exploratory study is focused on the three main airports in continental Portugal: Faro's Algarve Airport (IATA code FAO), Lisbon's Portela Airport (LIS) and Porto's Francisco Sá Carneiro Airport (OPO). In this work, the network comprised by all the airlines serving passengers departing from these three airports and their destinations is analysed over a time span between 2001 and 2010, to assess the evolution and the impacts that the deregulated environment poses over the network, and its implications for airport competition, not only in Portugal, but in the rest of Europe.

## 2 AIRPORT COMPETITION

Airports have been traditionally considered as natural monopolies (Graham, 2003), with no real competition between them. This lack of competition is normally associated to two reasons: a) non-existence of close substitutes in the same location; and b) economies of scale in airport provision. The first reason assumes that airports are restricted to passenger demand in their own catchment area, thus in attractive locations there are already airports and it is very difficult to build a new one. The second reason considers the natural monopoly as being more efficient, since two or more airports would lead to higher costs and, in the end, the airport able to attract more traffic would force the others out of the market (Forsyth et al., 2010).

However this traditional point of view is changing. Deregulation of air transport around the world brought about a competitive pressure for airlines, leading to competition for airports, especially due to the fact that airlines were then free to choose the airports they wanted to operate (De Neufville & Odoni, 2003; Graham, 2003). Additionally, the steady growth of LCCs in deregulated markets has become an incentive for the creation of Low-Cost airports, and then, for traditional airports to embrace the LCC growth. Moreover, deregulation triggered a change in airport ownership towards privatisation (De Neufville & Odoni, 2003). New owners with different perspectives force airports to be more focused on costs and on commercial revenue, and they reinforce the need to attract and retain airlines (Bush, 2010).

In the last decades non-aeronautical revenues are becoming increasingly important for airport operators. In many cases they represent a higher income for the airports than aeronautical revenues (De Neufville & Odoni, 2003; Graham, 2003). This trend has generated an ambiguous definition of the airport's clients, creating a dilemma between airlines and passengers. Moreover, it may pose some conflicts of interests, since airport operators are willing to offer a good level of service to both, airlines and passengers, by providing quick and easy access to aircraft; while at the same time they want passengers to spend more time, and thus money, enjoying the non-aeronautical facilities (Francis et al., 2003).

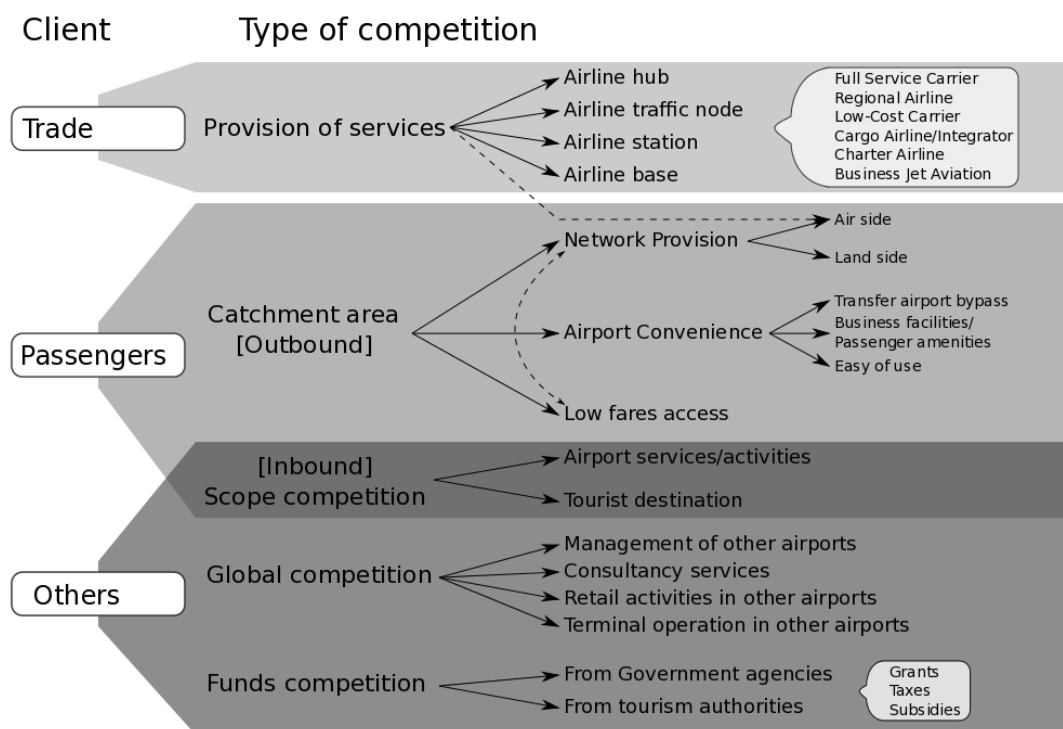
Graham (2003, p. 182) states that airports have several different costumers and she classifies those customers in three categories: the *trade* group that includes all the clients that directly use the airport facilities buying aeronautical services, such as the airlines; the *passengers* group that comprises the travellers who consume or utilize the airport product, a portion of the non-aeronautical services, and are in the airport thanks to those in the *trade* category; the third group includes *other* stakeholders that cannot only be viewed as so, but as clients, since they may play a significant role in non-aeronautical revenues and cost.

## 2.1 Towards a competition framework for airports

Several frameworks have been proposed to analyse the competitive environment within an industry (Barney, 2007). Graham (2004) performs a competitive analysis for the airport industry based on the five forces framework developed by Porter (1979). She concludes that the existence of more than one key customer for the airports, among other factors, hinder the analysis of competitive strategies under this framework.

Consequently, a perspective more focused on the clients and other particular aspects of the airport industry has been chosen as the basis for proposing a framework to define airport competition. The objective of this framework is to assist managers in analysing what are the classes of services that airports may be competing in and which clients play the main role in each of those classes, so that they can then be more effective in developing strategies to gain competitive advantage and avoid competitive disadvantage.

This framework may be viewed as one of the main contributions of our work. In fact the literature either focuses on few kinds of competition, or roughly describes how particular types of competition arise; hence our effort to put everything together, thus providing the ground for a deeper analysis of the interactions between the different ways in which airports compete.



**Figure 1:** Conceptual framework for competition between airports.

As shown in Figure 1, we suggest the existence of five different categories of airport competition and relate those categories to three types of customers of the airport product described above. Additionally, the diverse types of competition can be subdivided into more specific ways in which airports compete according to their own specific characteristics.

This means that not necessarily all airports are able to compete in each and every way. The requirements to attract one client may be conflicting with those to attract another. For instance, not many airports can compete to become a hub for a major Full-Service Carrier (FSC) and, at the same time, a base for a LCC. In the first case, the airport may need to deploy fancier facilities with a high level of service and peak capacity; while in the second case, the airline may prefer inexpensive facilities and accept a lower level of service. Only if the airport has enough space, capacity and a well-oriented planning process will probably be able to simultaneously satisfy both.

### 2.1.1 *Provision of services*

It is very important for the airport to provide services to airlines, so that the air companies are able to offer the destinations in which passengers may be interested. In other words, attracting airlines means attracting passengers who have now the opportunity to fly where they really want to go. In this way, airports compete with each other by providing different services to the airlines so they can *be* at the airport and offer their own services to passengers or other clients.

It is important to notice that airlines can be established at a given airport with different kinds of operations. We follow Burghouwt (2007), who defines the role of the airports within an airline network in three categories: firstly, a *hub* exists only when indirect connectivity comes from a conscious coordination of the incoming and outgoing schedules; secondly, a *traffic node* is a central airport in the airline network that concentrates a large share of the airline's traffic, but it does not provide time coordination; and thirdly, an *airline station* is an airport "from which only air passenger flows can originate and into which only flows that are destined for that [airport] can enter" (Burghouwt 2007, p. 14). This definition can of course be extended to cargo. Beside those three categories, we have also considered the *airline base*. The concept of airline base gains relevance for the LCCs, since most of them do not operate coordinated schedules and can have a significant number of flights from/to an airport without basing any aircraft, as Ryanair did in Faro before it based 6 planes in March 2010 (Ryanair, 2009). A base gives the airport the opportunity to have larger revenues, associated to services for aircraft and crew, which can be translated into profits, the ultimate reason to compete.

### 2.1.2 *Catchment area*

The catchment area of an airport can be defined as the geographical location of most of the existing or potential demand, i.e., the area where the airport is able to catch passengers to fly using the services provided by the airlines already operating in the airport. As the name and definition suggest, the catchment area is mainly associated to outbound traffic, namely people who use the airport as the origin for their air trips.

Firstly, airports compete for the network provision in two ways: a) the aviation network, i.e. the air side network provided to passengers; and b) the connectivity with surface transport networks. In the air side it is obvious that airports compete to offer the most desired destinations. In the land side, competition occurs because a good connection with the surface transport network makes an airport more easily accessible from longer distances, thus widening its catchment area.

Secondly, and in direct relation with the network provision in both the air and the land side, there is the competition for passengers willing to have access to low fares in their flight tickets. Airports that attract LCCs gain a competitive advantage in the sense that these airlines can offer remarkably low prices for their flights (Malighetti et al., 2009), expanding the catchment area by attracting price-conscious passengers.

Thirdly, airports sharing similar catchment areas can compete for outbound traffic by providing a more convenient service to some passengers. As stated by de Neufville (2008, p. 40) airports served by LCCs offer the opportunity to bypass bigger hubs and avoid transfers, delivering a higher quality service, in terms of travel time. Additionally, the airport can offer differentiated products that are more convenient for business travellers for example, or it can be viewed as an easier alternative for passengers wishing to stay away from the confusion caused by very large airports.

### *2.1.3 Scope competition*

The so-called scope competition refers to the possibility that airports have to attract passengers or other users solely by the characteristics of the airport itself and its surrounding environment. To some extent, this occurs in airports with a large share of inbound traffic in the total throughput. That is, the airport is serving mainly as a destination (Forsyth et al., 2010, p. 123). Normally these airports are located in or nearby tourist destinations. This kind of airports should have a close relationship with either private or governmental authorities in charge of promoting the tourism for their regions. LCCs are also playing an important role in this aspect, providing access to previously underserved regions.

Another specific way of competition regarding the scope of the airport relates to complementary services or supplementary activities that they can offer to be more attractive, either to passengers or other customers (such as local inhabitants, for example). Those services and activities can go from hotels and convention centres in a more conventional point of view (Forsyth et al., 2010, p. 123), to concerts, sport events and airport tours.

### *2.1.4 Global competition*

The airport industry is becoming increasingly composed by international groups working across the world. That means there is a well-established process of globalization for the airport industry, substantially increased with airport privatisation (De Neufville & Odoni, 2003; Graham, 2003). This expansion has led airports also to compete for the services they are offering at a global scale. The global airport companies can compete in a bid for a management contract of other airports; they can compete with their consultancy services in areas such as engineering, economics or construction; they can operate retail facilities in other airports and, finally, they can compete by operating a separate terminal in another airport.

### *2.1.5 Competition for funding*

The last type of competition identified in this work is related to the attraction of funds to develop airport expansions or upgrades, leading airports to a more competitive position. In a general way, these funds can take the form of grants with special conditions, such as very low interest rates, tax reductions or subsidies, not necessarily as state-aid but rather in some kind

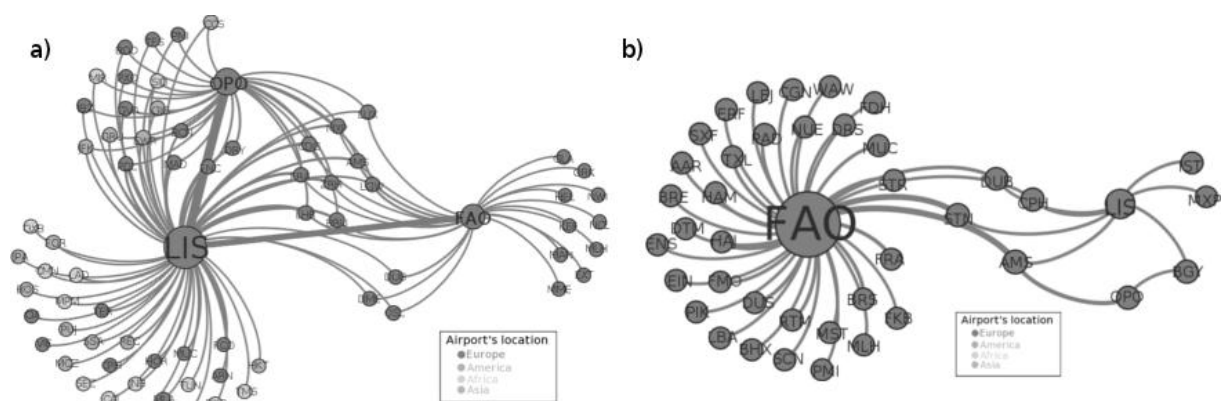
of payment made to the airport. Government agencies and tourism authorities can be interested in providing funds to the airport as a mean to promote economic development, tourism and employment in the airport's surrounding area. Additionally, some governments may be keen to invest in regional airports in order to reduce the pressure of congestion or environmental constraints in major airports (Davison et al., 2010).

Funds can also be used to enhance the competitiveness of an airport, by preparing it to compete in any of the other forms of competition already described. This may be true even if the money is not directed to the airports but to the airlines in the form of support for route development. Even though the funds of these incentives go straight to the airlines, there is no doubt that the airports attracting those airlines would enjoy a more competitive position because they would be able to offer a wider network to passengers.

### 3 AVIATION NETWORK EVOLUTION

Our network model has been constructed with the airports as nodes and the air routes linking the airports as arcs (directed links). The data set was kindly provided by the Documentation and Information Centre (*Centro de Serviços Partilhados / Informação e Documentação*, in Portuguese) of the airport operator – ANA Aeroportos de Portugal. The database includes 13 801 individual records for the 19 IATA periods between Summer 2001 and Summer 2010 with information on the operations of 442 different airlines classified as Full-Service Carriers (FSC), Low-Cost Carriers (LCC), Regional Airlines (REG) or Charter Airlines (CHA).

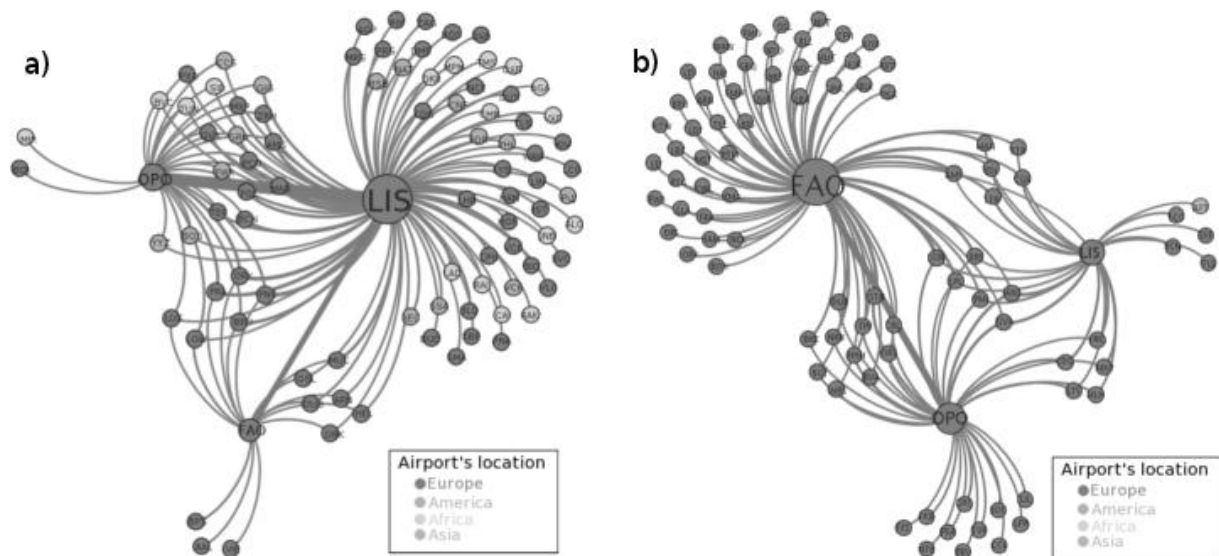
One of the most remarkable aspects in the network evolution regards the nature of the type of airline that carries most of the passengers in each route. This shows a strong competition between airlines, but also the strategy of most LCCs to use smaller airports in which they have less direct competition from FSCs. It is therefore easier for LCCs to have the largest share in a route, since quite often they are the only carrier operating the origin-destination pair (this is particularly true for Ryanair). Conversely, competition between LCCs and charter airlines seems to be more direct.



**Figure 2:** Aviation network provided by FSC (a) and LCC (b) airlines in Summer 2001.

At the beginning of the time span analysed in this study, charter airlines were mainly focused on Faro (FAO) and to a lesser extent on Porto (OPO), sharing some holiday destinations with Lisbon (LIS), such as Varadero (VRA) and Punta Cana (PUJ) in the Caribbean or Tenerife (TFS) in the Canary Islands. FSCs, on the contrary, were more tied to LIS as expected (see

Figure 2a), firstly for being the home base for TAP (and other Portuguese airlines) and secondly for providing an established feeder to the networks of other legacy carriers. To a lesser extent, FSCs were also tied to OPO. At the same time, Porto (OPO) provided more opportunities for regional airlines to be the major carriers in some routes. In this early stage LCCs were also more focused on FAO (see Figure 2b), mainly serving airports in the UK and Germany; especially because Faro provides a large enough inbound market for point-to-point services.



**Figure 3:** Aviation network provided by FSC (a) and LCC (b) airlines in Summer 2010.

By Summer 2010, the consolidation of LCC's own networks is evident (see Figure 3b). FAO shows itself as a low-cost airport with few routes dominated by FSCs, as it is the case of Lisbon for the feeder services of TAP. By this time LCCs have clearly overcome charter airlines, which remained dominant in only three routes to Manchester (MAN), Glasgow (GLA) and Birmingham (BHX). Lisbon remains a legacy airport (see Figure 3a) but clearly shows the strong presence of easyJet in routes like London/Gatwick (LGW), London/Luton (LTN) and Geneva (GVA); Air Berlin in Palma de Mallorca (PMI) and Germanwings in Cologne-Bonn (CGN). Charters remain dominant only for the Caribbean destination of Cancun (CUN).

Porto, on the other hand presents an interesting mix between FSCs and LCCs, with a clear reference to the network of Ryanair, sharing with Faro destinations such as Paris/Beauvais (BVA), Brussels/Charleroi (CRL), Frankfurt/Hahn (HHN), Milan/Orio al Serio (BGY, also known as Milan/Bergamo) and so on; but also Geneva (GVA), Milan/Malpensa (MXP), Paris/Charles de Gaulle (CDG) and Lyon (LYS) as some examples of the expansion of easyJet and other LCCs like Transavia. At the same time they keep FSCs connections in Europe and other continents. Also interesting is the regular link between FAO and OPO that appears for the first time in the decade, as a service by Ryanair.

Summing up, the aviation network of Lisbon, Porto and Faro has evolved in a way that clearly offers evidence of the development of the low-cost revolution in the Portuguese market. LCCs have found new customers for air transportation and encouraged regular travellers to fly more frequently. They have generated a fierce competition between airlines that is driving charter

operators out of the intra-European market. They are responsible for the growth in passenger figures for OPO and for a big proportion of the growth in LIS. They are carrying most of the tourists coming to Algarve and possibly providing FAO with an opportunity to increase the number of residents flying abroad.

### 3.1 Network concentration

The Network Concentration Index (NC) is used to analyse the evolution of the spatial distribution of demand (passengers flow) for each of the airports under study. The NC is a normalized Gini Coefficient – originally a measure of income disparity, widely used in economics and social sciences, thus the comparison between different networks is independent of their size. Considering the passenger demand for each route ( $y_i$ ), the Gini coefficient ( $G$ ) for the aviation network of a particular airport can be computed as follows (where  $n$  is the total number of airports in the network):

$$G = \frac{2 \sum_{i=1}^n i y_i}{n \sum_{i=1}^n y_i} - \frac{n+1}{n} \quad (1)$$

This simplified version of the Gini index (simplified because it does not require a definition of a function for the Lorenz curve to integrate) holds true for a uniform population on  $y_i$  ( $i=1$  to  $n$ ), meaning the  $y_i$  have no null values, and are arranged in non-decreasing order ( $y_i \leq y_{i+1} \leq y_n$ ). Both conditions are easily achievable with the available data set.

Since any route includes at least two airports, as Burghouwt (2007, p. 42) points out, the Gini index can never reach its theoretical maximum value of 1. Moreover, assuming an equal distribution of incoming and outgoing traffic in any given airport, he concludes that “the maximum Gini score increases with the number of airports” in the network, since no airport is part of the network without sharing at least a small fraction of the traffic. Such maximum value ( $G_{max}$ ) is computed as:

$$G_{max} = 1 - \frac{2}{n} \quad (2)$$

$G_{max}$  is then used to normalize the Gini index in the Network Concentration Index (NC):

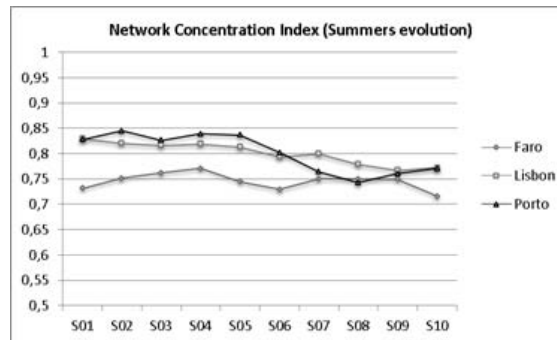
$$NC = \frac{G}{G_{max}} \quad (3)$$

Like the Gini index, NC varies between 0 and 1, with 1 for a single radial network with traffic concentrated on one route. A lower value of NC indicates a more even spread of traffic over the airports (a de-concentration effect) and the opposite for an increase in NC (a concentration effect). A value of 0 for NC corresponds to the case in which all airports have equal shares of traffic (Burghouwt, 2007, p. 42).

As seen in Figure 4, it is noticeable how the level of concentration diminished for Porto airport (OPO). The decrease in the route concentration can be associated to the physical improvements developed by the airport in the year 2005 allowing for a stronger service on a wider number of routes. The growth of LCCs in OPO and LIS can also be a factor contributing to a lower level of network concentration in three ways: offering the opportunity to expand the network, increasing demand in new routes and switching demand from

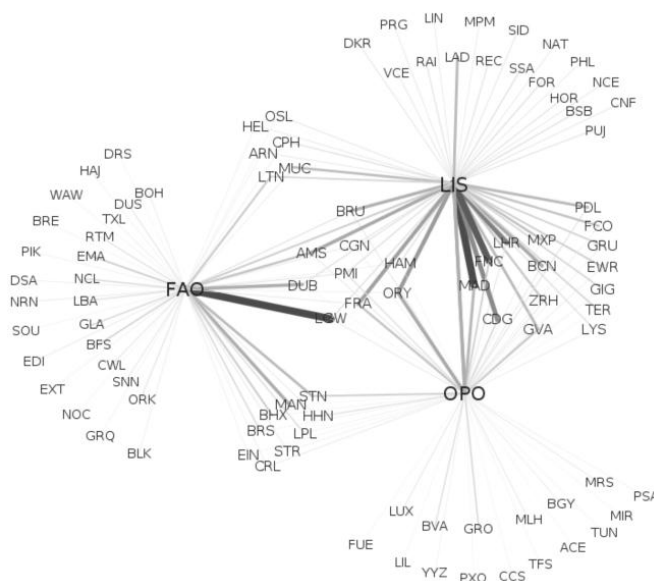


established routes to the new ones. The latter alternative (switching demand) is not evident though, since most of the LCC traffic comes from an emergent demand (so the LCCs mainly take new travellers, or the same passengers travelling more frequently), but these airlines are not yet able to gain a significant amount of current demand for FSCs. In Faro (FAO), on the other hand, a de-concentration effect is not visible since most of the demand shifted from charters to LCCs operating in similar networks.



**Figure 4:** Network Concentration Index evolution for the Summer periods.

Figure 5 shows the Top 50 routes per airport in Summer 2009 when the three airports showed a similar level of concentration, as seen in Figure 4. In this network representation, the colour and thickness of the arcs are proportional to the traffic in each route, i.e., the bolder and thicker the line, the higher the number of passengers using the link.



**Figure 5:** Top 50 routes per airport, in terms of passengers, in Summer 2009.

By Summer 2009, Porto and Lisbon reduced the relative significance of their mutual route (LIS – OPO) while traffic figures grew more evenly in the other routes. Faro, on the contrary, was by then more concentrated in its route to London/Gatwick (LGW), since the other top routes dramatically declined in the number of passengers, and the growth in the remaining connections was not enough to compensate inequalities in the largest destinations.

## **4 CONCLUSIONS**

### **4.1 Airport decisions**

The exercise of applying network theory to evaluate the evolution of the aviation network in continental Portugal has shown that changes appear as a product of commercially-oriented decisions in other airports. Among these decisions are the establishment of airline bases (especially LCCs) or the change in the role of hubs from long-haul to medium-haul or vice versa.

The growth in the importance of the connections between the airports in continental Portugal and low-cost airports in Europe, such as Brussels South Charleroi (CRL), Paris/Beauvais (BVA), London/Luton (LTN), London/Stansted (STN) on Frankfurt/Hahn (HHN); demonstrates that the decisions of those airports to become LCC bases had an impact in Porto (OPO), in Faro (FAO) and, to a lesser extent, in Lisbon (LIS). Indeed, the commercial decisions in the Portuguese airports reflect the desire to support the low-cost expansion. However, the impact on capacity expansion decisions has not been as strong as it should, at least in the sense of supporting LCC development.

Other airports in the aviation network show the willingness to promote the activity of LCCs, without giving away their services to FSCs. This is the case of Amsterdam/Schiphol (AMS), Paris/Charles de Gaulle (CDG) and Madrid/Barajas (MAD). An evaluation of their planning processes to provide infrastructure that satisfies the new clients' requirements might prove valuable for implementation in the Portuguese airports.

The change in the role of some airports regarding the Portuguese market, as said above, is also found in the aviation network. The decision to use Lisbon (LIS) as a feeder for London/Heathrow (LHR) and Paris/Charles de Gaulle (CDG) in long-haul routes had a visible impact in the connections from the other Portuguese airports. In fact, Porto (OPO) and Faro (FAO) reacted by having stronger routes to London/Gatwick (LGW) and Paris/Orly, respectively.

### **4.2 Airport competition and the aviation network**

It is interesting to note that the evidence of airport competition, found in the network analysis, is not restricted to the Portuguese airports. Therefore, airport competition, in general, not only exists but also takes several forms. Many of those forms differ from traditional views in which airports compete, through airlines, by catching demand in their surroundings, or by hosting airlines with network strategies that favour one airport at the expense of others.

Airport competition, in a wider perspective, has been boosted by the steady growth of low-cost carriers, and a trend towards privatisation and commercialisation of airports that force them to pursue goals beyond the exclusive provision of infrastructure. Both the growth of LCCs and the privatisation trend are favoured by a deregulated environment in which airlines are free to choose airports.

Low-cost carriers have made air transport become a mode for the masses, far away from the glamour of its initial days. Their ability to attract emergent demand for air traffic called the

attention of many airport operators. There are many “new” airports that are increasingly eager to attract LCCs in order to improve their passenger figures and, in turn, be more attractive to other customers. This phenomenon is widely visible in Europe where several war-time airfields are now being used for commercial operations.

The network analysis performed in this study not only shows the emergence of such new entrants, but also illustrates the growth of low-cost airlines in Portugal. In the IATA season of Summer 2010, LCCs accounted for nearly 70% of passengers departing from Faro, almost half of those travelling from Porto, and over 10% of the demand from Lisbon. This trend has also favoured a more intense competition between the three airports, even if they are owned by the same organization.

### **4.3 Airport competition and airport management**

For the Portuguese airports under analysis, the network provision in the air side (the range of available destinations), together with the access to low fares, seem to drive a big proportion of the competition between the airports (especially between Lisbon and Porto) and between them and their Spanish neighbours. Additionally, the scope competition (for tourism attraction) is the strongest form of competition faced by the Faro airport.

In what concerns airport management, airport competition seems to be a rather new concern. Although airports are strongly affected by the uncertainty of the aviation industry, they have been traditionally more reluctant to accept competition with other airports, while delivering the burden of market development solely to airlines.

ANA - Aeroportos de Portugal, the operator of the three airports analysed in this study, has been implementing the concept of airport marketing to adequately address competition, especially with the Spanish neighbours of Porto and Faro. We think Porto is the airport that has been more engaged in marketing strategies to attract new airlines, routes and passengers. Nevertheless, at a national level, ANA is also implementing an incentive scheme to support airlines in their route development activities. Even if the operator is clearly aware of airport competition, there is still the need to provide adequate infrastructure according to the different requirements of the customers.

To summarise, commercial and physical decisions in one airport can all together significantly affect decision-making in other airports. If managers are aware of the different kinds of competition arising between airports and if they are able to match good commercial deals with the proper, efficient, infrastructure, they will make airports clearly more competitive.

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