Determinants for seat capacity distribution in EU and US, 1990-2009.

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Abstract

Keywords:

1. Introduction

Air traffic is one of the factors influencing and, at the same time, showing the position of a city in the world-city hierarchy. There is a positive correlation between higher volumes of air passenger and cargo flows, urban growth and the position in the urban hierarchy of the knowledge economy (Goetz, 1992; Rodrigue, 2004; Taylor, 2004; Derudder and Witlox, 2005, 2008; Bel and Fageda, 2008). In relation to the configuration of mega-city regions, Hall (2009) remarks that it is key to understand how information moves in order to achieve face-to-face communication and, over long distances, it will continue to move by air, through the big international airports (Shin and Timberlake, 2000). This paper deals with the allocation of seat capacity among all EU and US airports over a period of 20 years. Changes in the seat capacity distribution provide a clear image about the travel opportunities from cities and regions and changing power relations in city networks.[1]

Liberalization of air transport has had a tremendous impact on traffic flows and, therefore, on the position of cities in the global arena. Until the end of the seventies air transport was dominated by a regime of bilateral air service agreements between national governments. This regime was legacy of the 1919 Paris Convention –in which national states, after the First World War, decided to keep sovereignty over their airspace–, and the 1947 Chicago Convention on International Civil Aviation that further elaborated the regulation.

In 1978, with the signature of the US Airline Deregulation Act, there was the first step towards the deregulation of the air transport market. By means of this act, US progressively deregulated its domestic market until 1985 when all controls over domestic routes and ticked prices were brought to an end. Regarding Europe, the

[1] See, for example, Weller (2009) for shifting power relations in airline networks.

deregulation of air transport through the establishment of a single intra-European market was by the agency of three interlinked deregulation packages, known as the first (1987), second (1990) and third (1993) packages, which effects where not fully applicable until the end of the 1990s.

With regard to bilateral air service agreements, US leaded the liberalization process. This development can be divided in three steps: (a) The "open market" bilateral agreements phase (1978-1991). This type of bilateral agreements generally allowed fifth freedom rights[2], open charter access and did not impose frequency nor capacity controls. (b) The "open skies" bilateral agreements phase (1991-1999). This type allowed, in addition, unlimited market access and fifth freedom rights, free pricing, and code sharing (Doganis, 2002).[3] (c) The EU-US Open Sky Agreement opened a new phase (post-2008), in which carriers registered in the EU or the US the right to operate services between any EU and US points.[4]

The liberalization and deregulation of the air traffic market in EU and US has called the attention of scholars for a long time. Studies concerned with the spatial distribution of seat capacity had focused only in one of both sides of the Atlantic, for Europe see Dennis (1994), Caves (1997), Burghouwt and Hakfoort (2001), Burghouwt, et al., (2003), Burghouwt (2005), Fan (2006), Dobruszkes (2006, 2009), Bel and Fageda

[2] Fifth freedom: the right to carry traffic between two foreign countries by an airline of a third country, which carriage is linked with third and fourth freedom rights of the airline.
Third freedom is the right to carry traffic from the home country or the airline to another country. Fourth freedom is the right to carry traffic to the home country from another country.

[3] The more deregulated environment fostered increasing levels of competition, which was translated in lower fares and increasing traffic. Despite this, the industry went through waves of mergers and consolidations that have resulted in high levels of single-firm concentration in certain markets (Goetz and Vowles, 2009). Airline ownership was changing towards privatization; therefore, airlines needed new markets and at the same time growing concentration to be self-reliant (Doganis, 2001, 2002). Mergers, marketing and code share alliances were a way of achieving both goals at the same time. This is how Northwest and KLM began cooperating in 1989 and created the first airline alliance, Wings. Subsequently, Star was founded in 1997, OneWorld in 1999 and SkyTeam in 2000.

[4] The EU-US Open Sky Agreement includes EU states, which did not have individual Open Skies agreements with the US before the agreement came into force (among others the UK, Greece, Ireland and Spain). Sixteen EU countries had already concluded Open Skies agreements with the US during the 1990-2008 period (Button, 2009).

(2010), for United States see Chou (1993a,b), Goetz and Sutton (1997), Reynolds-Feighan (1998, 2001, 2007), Goetz and Vowels, (2009); others looked also into particular submarkets, for Spain see Suau-Sanchez and Burghouwt (2010). Huber (2009) did a cross-sectional analysis for both sides of the Atlantic, but only for the year 2005.

For US, some authors pointed out that the adoption of hub-and-spoke networks has led to air traffic growth at fewer airports (Goetz and Sutton, 1997; Reynolds-Feighan, 1998, 2001; Goetz and Vowels, 2009). More particularly, Reynolds-Feighan (2007) found a spatial concentration of traffic between 1990 and 1997 followed by a decrease of spatial concentration between 1997 and 1998, and relative stability until 2002. However, for the earlier period from the US deregulation act in 1978 to 1989, Chou (1993a) did not find sufficient evidence of a spatial concentration in the availability of air services by the increase of hub operations.

In the case of Europe, some found a deconcentration in intra-EU seat capacity between 1990 and 2003 due to the growth of regional and low-cost airlines, whereas intercontinental seat capacity was increasingly concentrated at a limited number of large hub airports because of the network strategies of global airline alliances (Burghouwt and Hakfoort, 2001; Burghouwt, et al., 2003; Burghouwt, 2005). However, for a shorter period (2004-2008) Bel and Fageda (2010) recognized, in a set of large European urban areas, a deconcentration of intercontinental flights due to hub-bypassing strategies of selected network airlines. In this regard, Huber (2009), in his 2005 cross-sectional analysis, found a very higher concentration of intercontinental seat capacity in Europe than in US, although US intercontinental traffic remains also concentrated in few airports.

From a more global perspective, O’Connor’s (2003) analysis shows a dispersal pattern: traditional hubs lost out in favor of slightly smaller, large cities between 1990 and 2000. However, Bowen (2002) for the 1986-1996 period saw a slight different picture: while overall more cities are more directly tied to international airline networks, poorest countries worsened their relative access to them.

[TABLE 1 ABOUT HERE]

The literature review clearly shows evidence of simultaneous forces of concentration and deconcentration (see Table 1). These analyses cover limited number of years and fall short in finding the drivers behind de/concentration dynamics. Herein we add to the discussion by studying over a longer period (1990-2009) the seat capacity concentration and deconcentration patterns both in EU and US and by assessing the contributions of various airports and airline groups to these concentration and deconcentration patterns.

Deregulation and liberalization have been fostered to achieve larger societal benefits and spread economic benefits from the growth in the availability of air services. In this regard, seat capacity distribution analyses provide a good assessment on the social benefits of deregulation. The 20 years period of analysis allows us to cover, on the one hand, the open skies bilateral agreements phase and the US deregulation process (1991-1999) and, on the other hand, the birth of alliances phase and the EU deregulation process (post-1999). The extensive period of analysis also allows us to have a comparative picture of the long-term effects of the different strategies by European and North American airlines. For its instability, the 1990-2009 is a particularly worthy of note period. While the nineties were characterized by the entrance of new airlines and an increasing demand that also benefit the network carriers[5], the 00s has been a difficult decade for the airline industry, especially for the network carriers. The 9/11 events, the SARS outbreak, the rising fuel costs (Goetz and Vowles, 2009) and the EyjaFallajokul volcano[6] converted this decade in one of the periods of major losses. On the other hand, Low-cost carriers grew until they become central players in the domestic and regional markets.

2. Data and Methodology

2.1 Data

For our analysis we have used OAG (Official Airline Guide) data for the years 1990, 1995, 1999, 2001, 2003, 2005, 2007 and 2009. OAG contains several variables on direct schedules flights; including flights of network, regional low-cost and scheduled flights of leisure airlines. The variables included in our analysis are departure airport, destination airport, airline and weekly seat capacity. For the years 1990, 1995 and 1999 we have chosen as a sample week the 3rd week of July. For the years 2001, 2003, 2005, 2007 and 2009 we have chosen as a sample week the 3rd week of June.[7] It should be noted that our dataset contains scheduled non-stop direct flights, multi-stop direct flights and multi-stop direct flights with a change of gauge. All of these types of flights are direct in the sense that they have a single flight number for the whole itinerary.[8] The

[5] We use the term network carrier because it is a more general one including legacy and flag carriers. A legacy carrier, in the United States, is an airline that had established interstate routes by the time of the Airline Deregulation Act of 1978. A Flag carrier is an European airline that had a monopoly in its country before liberalization took place.
[6] Althought the EyjFallajokul volcano events were in 2010 and are outside our period of analysis.
[7] The election of the sample week has been constrained by data availability. Yet, since data concern the same summer season and the analysis is about relative distributions rather than absolute numbers, we do not consider this to be a problem.
[8] A non-stop direct flight is a flight between airport A and airport B without any intermediate stop between origin and destination. A multi-stop flight is a flight between airport A and airport B stopping at C with neither a change of aircraft nor a change of flight number. A multi-stop flight with change of gauge is a flight between airport A and airport B stopping at C with a change of aircraft, but without a change of flight number.

inclusion of this kind of flights answers to the fact that some airlines did, especially during the 1990s, a strong use of this type of flight configuration.[9] Seat capacity provided on indirect[10] connecting services with a transfer at a hub is not included in the OAG database and has not considered in the analysis. It should be noted that OAG does not provide details about realized passenger demand nor about realized supply, which may vary depending on variables such as load factor (see Devriendt et al. (2009) for a critical view on calculating load factors), weather conditions (see Abdelghany et al. (2004) for flight delays projecting during irregular operation conditions) or congestion (see Brueckner (2002) for an analysis of carrier behavior to airport congestion and Flores-Fillol (2010) for congested hubs).

The data set covers the fifty states of the US. For the EU, the EU-27[11] has been considered adding Croatia, Norway and Switzerland, but excluding Malta.

In order to analyze the changing network configurations of different types of carriers, airlines have been categorized into the following groups: (a) Network airlines, in this group have been included those airlines that are part of an alliance. See Appendix 1 for the complete list of alliance members by year;[12] (b) Low-cost carriers, in this group have been included those airlines considered low-cost carriers. Yet, it is difficult to sharply define this group, since the low-cost model is becoming a hybrid concept. Be as it may, see Appendix 2 for the complete list of considered low-cost carriers by year; (c) Other carriers, those carriers not considered in any of the previous groups.

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[9] See, for example, Suau-Sanchez and Burghouwt (2010) for an explanation of the multi-stop flights by Iberia at Barcelona airport.

[10] An indirect flight is a flight between airport A and airport B stopping at H, with both a change of aircraft and a change of flight number.

[11] The EU-27 includes as members the following member states: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the UK.

[12] Regional carriers, such as for instance Air Nostrum, have not been single-out as a separated group since in many cases they are subsidiary of a network carrier and, therefore, appear in the OAG data set with the carrier identifier of the network carrier.

In order to analyze the contributions of various types of airports to the overall concentration of seat capacity, the full list of EU and US airports have been classified into five groups using the natural breaks method and Jenks's optimization (Jenks, 1967). This method calculates the grouping of data values based on data distribution, seeking to reduce variance within groups and maximize variance between-groups. We have used the number of seats in 2009 to categorize the airport hierarchy (see Figure 1 and Table 2).

[FIGURE 1 ABOUT HERE]

[TABLE 2 ABOUT HERE]

2.2 Methodology

There are various concentration and dispersion indices to measure the spatial distribution of seat capacity among an airport population, such as the Concentration Ratio (CR) and the Herfindahl-Hirschman index (HHI) (see Wojahn (2001), Reynolds-Feighan (1998), Suau-Sanchez and Burghouwt (2010) for the use of the HHI as a measure for the spatial distribution of air traffic in an airport population)[13], the coefficient of variation, Theil's entropy measure and the Gini index (Reynolds Feighan, 2001; Burghouwt et al., 2003). The advantages and disadvantages of the various concentration and dispersion measures have been frequently addressed in the literature, both with respect to applications in the air transport industry (see Reynolds-Feighan (1998), for an thorough review) as well as in other areas of transport such as the container shipping industry (Notteboom, 2006; Sys, 2009). Recently, alternatives to these standard concentration indices have been applied in order to ''decode'' the

[13] See also Notteboom (2006) for a study of the concentration levels of European and North American container port systems, and Sys (2009) for the degree of concentration linked to the degree of oligopoly in the container shipping industry.

spatiality and complexity of air transport networks (Limtanakool et al., 2007; Martín and Voltes-Dorta, 2008; Van Nuffel et al., 2008; Derudder and Witlox, 2009; Paleari et al., 2010).

In this paper, we apply the Gini index, which is not sensitive to the distribution of the population and reacts well to changes in all parts of a given population. The Gini index can be calculated with the matrix computation (following Reynolds-Feighan, 1998, 2001; Burghouwt et al., 2003; Burghouwt, 2005) or with the covariance computation (following Lerman and Yitzhaki, 1984, 1985; Yitzhaki, 2002; Wodon and Yitzhaki, 2002, 2003; Burghouwt, 2005, 2007). We use the second method since it allows the decomposition of the index afterwards. The covariance computation is as follows:

$$G_i = \frac{2 \times COV\left[y, F(y)\right]}{\mu}, \qquad (1)$$

where y is the total seat capacity of each airport, $F(y)$ is the cumulative distribution function for the total seat capacity per airport that will rang between 0 and 1, μ is the mean of the total seat capacity per airport. The Gini index values range between 0 and 1. Results near 0 indicate a non-concentrated distribution of seat capacity among all the airports of the population, while results near 1 indicate a high concentration of seat capacity. A value of 1 corresponds to a single hub-network where all traffic is concentrated on one hub-spoke route. Additionally, the Lorenz curve has been used as a graphical representation of the Gini index.

The Gini index is sensitive to the number of airports (n). To compare networks with different of number of airports we should correct this. The corrected Gini (G_c) is as follows:

$$G_c = \frac{G_y}{G_{\max}}, \quad (2)$$

where G_y is the observed Gini index in a network and G_{max} is the maximum Gini index given the number of airports in the network. G_{max} is calculated as follows:

$$G_{\max} = 1 - \frac{2}{n} \quad (3)$$

The Gini index is useful to have an overview of the level of concentration of particular airline networks. However, since we want to have a clear picture of which are the engines and determinants for market concentration and deconcentration (i.e. contribution of particular airlines and airport categories) we also conduct an additional analysis by decomposing the Gini by airport size subgroup and airline type. This analysis will measure the impact of airline network configurations on seat supply among EU and US airports. For the Gini index decomposition we follow Lerman and Yitzhaki (1984, 1985), Yitzhaki (2002), Wodon and Yitzhaki (2002, 2003) and Burghouwt (2005, 2007) for an adaptation of the Gini decomposition methodology to air transportation.

Subgroup decomposition of the Gini index

The subgroup decomposition of the Gini index makes possible to determine the contribution of various population subgroups on the overall concentration of seat capacity; in other words, we will know to what extent global seat capacity is shaped by inequalities within and between airport categories.[14] We distinguish five airport categories (Table 2). The following steps describe the process to break the Gini index down into different airport categories.

[14] We have not used the corrected Gini index here since it is not appropriate for decomposition. Given the stability in the number of airports per airport tier, this does not represent an issue.

The overall Gini index G_{yo} of total seat capacity y is composed of:

$$G_{yo} = \sum_{i=1}^{i} P_i S_{yi} G_{yi} + G^b \quad , \tag{4}$$

where G_{yi} is the Gini coefficient of seat capacity (y), S_{yi} is the share of the airport group seat capacity in the total seat capacity, P_i is the share of the airport group in the total airport population, and G^b is the between-groups inequality.

The share of the airport group capacity in the total seat capacity, S_{yi}, is calculated as follows:

$$S_{yi} = P_i \frac{\mu_{yi}}{\mu_{yo}} \ , \tag{5}$$

where μ_{yi} is the mean of seat capacity of the airport group and μ_{yo} is the mean of the total seat capacity.

The between-groups inequality, G^b, is calculated as follows:

$$G^b = P_i - S_{yi} \ , \tag{6}$$

which means that between-groups inequality is equal to the share of the airport group in the airport population *minus* the share of the airport group seat capacity in the total seat capacity.

Finally, the different airline network configurations and seat allocation policies will impact on each component (i.e. each within-airport-group inequality and between-groups inequality) in a distinctive way. Therefore, each component will weight (w) differently in the overall level of seat capacity concentration:

$$1 = \sum_{i=1}^{i} w_i + w^b \ , \tag{7}$$

where w_i is the share of each within-airport-group inequality and w^b is the share of between-group inequality in the total seat capacity inequality. The share of each within-airport-group inequality is defined as follows:

$$w_i = \frac{P_i S_{yi} G_{yi}}{G_{yo}} \tag{8}$$

The share of the between-groups inequality is defined as follows:

$$w^b = \frac{G^b}{G_{yo}} \tag{9}$$

Source decomposition of the Gini index

The source decomposition of the Gini index makes possible to measure the contribution of a particular airline network configuration to the overall concentration of seat capacity. This type of decomposition becomes very important since it is not descriptive and can be used to evaluate the impact of an airline policy change on overall seat capacity distribution. To break down the sources of the Gini index we will also follow Lerman and Yitzhaki (1984, 1985), Yitzhaki (2002), Wodon and Yitzhaki (2002, 2003) and Burghouwt (2005, 2007).[15] If the change in the seat capacity offered by an airline *x* impacts the overall level of concentration, then the effect on the Gini index will depend on its elasticity (η). The Gini elasticity is the marginal change in the overall Gini index (G_y) as a result of a small proportional change in the seat capacity of offered by an airline *x*. The Gini elasticity is as follows:

$$\eta_x = \frac{COV[x, F(y)]}{COV[y, F(y)]} * S_{xy} = \frac{b_{xy}}{S_{xy}} \ , \tag{10}$$

and

$$S_{xy} = \frac{\mu_y}{\mu_x} \ , \tag{11}$$

[15] There are also other alternative procedures available to compute the Gini decomposition by source, however they have not been chosen because are not so convenient for our case study. See, for example, Mussard et al. (2003).

where x are the number of supplied seats per week by an airline, y are the number of supplied seats per week at each airport, $F(y)$ is the cumulative distribution function for the total seat capacity that will rang between 0 and 1, S_{xy} is the average propensity of an airport in the overall airport population to be served by an airline x, μ is the seat capacity mean, and b_{xy} is the Gini regression coefficient with x as dependent variable and y and independent variable. b_{xy} varies between -1 and 1. It will equal 1 when an airline's seat capacity is an increasing function of total seat capacity or it will equal -1 when and airline's seat capacity is a decreasing function of total seat capacity. If airline seat capacity is constant, the value of b_{xy} will be 0. With regard to the Gini elasticity, if $\eta_x > 1$, a marginal increase of airline x increases the overall concentration of seat capacity. If $\eta_x < 1$, a marginal increase of airline x decreases the overall concentration of seat capacity. If $\eta_x = 1$ the airline is not affecting the overall level of concentration.

Once we have calculated the elasticity of the Gini index, which depends on the Gini index of individual airline networks and airport size of the airports served by this airline, we proceed to estimate the absolute change in the overall initial Gini index following a 1 per cent change in the seat capacity of airline x. In order to do this estimation, we compute the ΔG, which takes into account the market share of airline x in total seat capacity. Market share is key here, since a 1 per cent change in seat capacity of a large airline will have more impact on the overall Gini index than a change in seat capacity of a small airline.[16] The change in the Gini index is as follows:

$$\Delta G = \frac{S_{xy} * G_y * (\eta - 1)}{100} \qquad (12)$$

[16] It should be noted that ΔG assumes a small proportional change in the seat capacity of airline x. According to Wodon and Yitzhaki (2003) a large change may alter the cumulative distribution and ranking of airport capacity, in which case the impact measured at the margin may no longer be a valid representation of the overall impact. Still, even in such a case, the impact at the margin would give a good idea of the direction of the distributional impact of the shift.

3. General overview

The EU and the US are vast air traffic markets. In the selected week of year 2009, airlines offered more than 18 million departing scheduled seats at EU airports and 23 million at US airports. Between 1990 and 2009 the seat capacity increased by 157% in the EU and 26% in the US. These figures show the importance of air transport in these two regions and provide with an indication of the importance of the liberalization in promoting air traffic. In fact, during this period, the seat capacity distribution in the EU and US airport hierarchy became more deconcentrated (see figures 2 and 3 for the Lorenz curve). Yet, EU presents, overall, a more deconcentrated pattern than US due to the historical importance of EU member states, which used to have their own national flag carriers centered around the main airports of each member state, and to the urban structure and population distribution, which in US is mainly concentrated in mega-city regions while in the EU is more evenly distributed.

[FIGURE 2 ABOUT HERE]

[FIGURE 3 ABOUT HERE]

If we start breaking down the analysis by carrier type (Figure 4), we can observe that both network and low-cost carriers have tended to concentrate their network in both EU and US. In the first case, the increasing concentration can be related with the growth of alliances, which allowed higher concentration of traffic in hub airports and the configuration of dog-bone international networks (Button, 2009). In the second case, low-cost carriers also reacted with a steady increase of concentration. They concentrate point-to-point operations in bases as a way to obtain scale economies in the airport base and decrease crew costs (i.e. radial out-and-back networks, see Figure 5)[17]. Most low-cost carriers enter the market with a single or dual base strategy.

[FIGURE 4 ABOUT HERE]

[FIGURE 5 ABOUT HERE]

However, this analysis by carrier type is not significant in statistical terms by itself. We should not get confused; the existence of networks operated by airlines that exhibit a concentrated level do not necessarily mean that the overall seat capacity in the airport hierarchy is concentrated. Out-and-back networks are the reason why most low-cost carriers appear almost as concentrated as network carriers (Figure 5). However, low-cost carriers have fostered deconcentration of intra-regional traffic because they allocate seat capacity in secondary airports to avoid high airport charges and costs associated with congestion.[18] Therefore, looking into the concentration level of carrier types or particular airline networks is not helping us to know if the pattern in EU and US has been towards concentration or deconcentration.

As said above, Lorenz curves (figures 2 and 3) show us that overall seat capacity is less concentrated in 2009 than in 1990. However, Figure 6 shows that the Gini index has had a different evolution depending on the destination market (continental or intercontinental).

First, intra-EU and intra-US seat capacity have deconcentrated from 1990 to 2009. Still, both regional markets show a slight concentration process from 1990 to 1999, while a stronger deconcentration dynamic from 1999 to 2009. The deconcentration dynamic has to do with the increasing intra-regional competition

[17] Out-and-back networks organize operations radiating from a single base (single-radial) or multiple bases (multi-radial). Bases do not act as hubs over which transfer traffic is channeled. Ryanair, for example, operates archetypal out-and-back radial networks from its European bases (Holloway, 2008).

[18] Nevertheless, the case of Southwest is somewhat different; its network is less concentrated since it operates a grid network linking cities both to each other and to locations in between using a combination of non-stops and multi-stops (Halloway, 2008).

(appearance of low-cost carriers) fostered by liberalization. It is worth to mention that deconcentration of intra-regional seat capacity in the US was less intense than in the EU, a possible reason could be that Southwest, the main US low-cost carrier, has historically chosen very dense, short and medium hauls markets to take advantage of economies of density (Boguslaski et al., 2004) and therefore its impact on the deconcentration of intra-seat capacity was lower. Nevertheless, it is still too early to know which are the carriers contributing this process. Section 4 analyzes in detail the contribution of each carrier to the de/concentration process.

Second, extra-EU and extra-US (i.e. intercontinental) seat capacity have overall concentrated in both markets. On the one hand, extra-EU seat capacity shows a relatively continuous concentration from 1995 onwards with a slow down from 1993. On the other hand, extra-US seat capacity followed a more unstable pattern: it deconcentrated from 1990 to 1999, it strongly concentrated from 1999 to 2001, it deconcentrated from 2001 to 2003, it concentrated again from 2003 to 2005, and it followed again a deconcentration tendency from 2005 to 2009.

These results are in line with previous findings by Goetz and Sutton (1997) and Reynolds-Feighan (1998, 2001, 2007) for the US market, and findings by Burghouwt and Hakfoort (2001), Burghouwt et al. (2003), Burghouwt (2005, 2007), Huber (2009) and Suau-Sanchez and Burghouwt (2010) for the EU market.

[FIGURE 6 ABOUT HERE]

4. Determinants for market de/concentration in the airport population

In the previous section, we have seen that airline networks, have tended to configure their networks into more concentrated structures and that while intra-EU and intra-US seat capacity have deconcentrated, extra-EU and extra-US distribution has become more concentrated. However, this analysis is not sufficient to know which airports are gaining or loosing seats nor which are the airlines responsible. In this section we decompose the Gini index to find it out.

4.1 Where are the seats being allocated?

Here we analyze to what extent airline network strategies affected the airport hierarchy.

Regarding intra-EU seat capacity, the deconcentration was result of decreasing the within-group inequality of 1st-4th tier airports and a decrease of between-groups inequality. This decrease was more important than the increase of within-group inequality of 5th tier airports (Figure 7). Additionally, the share of 1st-4th tier airports in the Gini Index decreased, while the share of 5th tier airports slightly increased (Table 3). Hence, intra-EU seat capacity did deconcentrate, but this deconcentration process did not benefit all 5th tier airports in the same way. Some were benefited to a higher extent than others.

[FIGURE 7 ABOUT HERE]

[TABLE 3 ABOUT HERE]

Intra-US seat capacity shows a different picture; in fact, the deconcentration of intra-US seat capacity was much less intense than of intra-EU. For intra-US seat capacity the deconcentration was result of a stronger decrease of within-group inequality of 3rd and 4th tier airports than the decrease of inequality at 1st and 5th tier airports and the increase of between-groups inequality (Figure 8). Additionally, the lower intensity of the deconcentration can be attributed to the market share growth of 2nd and 3rd tier airports –and also 4th tier airports until 2003– (Table 7). However the share of 5th tier airports decreased. Hence, intra-US seat capacity did deconcentrate;

this deconcentration was less intense than in the intra-EU case because it affected mainly 2nd to 4th tier airports, although affected 5th tier airports in a more even way.

[FIGURE 8 ABOUT HERE]

[TABLE 4 ABOUT HERE]

Concerning extra-EU seat capacity, the decomposition by airport group confirms the concentration pattern of seat capacity. On the one hand, both within-group inequality and its share in the overall Gini index decreased. On the other hand, between-group inequality and its share increased (Figure 9 and Table 5). Given the increase on market share (Table 7) of 1st tier airports, the increase of between-groups inequality and between-groups share in the Gini index can be attributed to the above-average growth of the 1st tier airports in relation to the other tiers. Additionally, it is worth to note the increase of the share of 4th tier airports in the Gini index. The 4th airport tier contains airports such as Málaga and Valencia, which got direct services of Delta from its Atlanta and New York-JFK hubs. These services are benefitting particular airports because within-group inequality grew. This is in line with the findings by Bel and Fageda (2010) about the deconcentration effects of hub-bypassing strategies. Certainly, liberalization not only allowed higher inter-EU and inter-US competition, it has also created, specially since the EU-US Open Sky agreement[19], a scenario in which foreign carriers have an increasing influence on the availability of air services. Foreign airlines usually operate dense routes from major airports, although hub-bypassing strategies of particular carriers might be considered an exception. These strategies avoid airport congestion, take advantage of economic growth of non-hub regions and the introduction

[19] From the 2007 to 2009 the corrected Gini index of seat capacity for flights from US to EU dropped from 0.710 to 0.695 and for flights from EU to US fell from 0.767 to 0.761. These could be the first noticeable effects of the EU-US Open Sky, still more time is needed to evaluate the mid- and long-term consequences. To have a more clear idea of the potential impacts of the EU-US Open Sky Agreement see Volume 15 (2) of the Journal of Air Transport Management edited by de Wit and Burghouwt (2009), and Pitfield (2009).

of smaller size and efficient long-haul airliners.[20] Hence, extra-EU seat capacity did concentrate; this concentration took place in the 1st tier, although some 4th tier airports are benefiting from new strategies that complement the traditional hub-and-spoke network configuration.

[FIGURE 9 ABOUT HERE]

[TABLE 5 ABOUT HERE]

Again, the picture for extra-US seat capacity is different than for extra-EU seat capacity. Extra-US seat capacity concentrated, but much less than in the extra-EU case. In fact, the 2nd tier was the airport group with a higher increase of market share, while 1st and 4th tier decreased their market share (Table 7). Although the share in the Gini index increased for 3rd and 5th tier airports this slight increase was not enough to compensate the increasing between-groups inequality (Table 6) and was not translated in more market share, but on a higher within-group inequality. Hence, extra-US seat capacity did concentrate, but less intensely than in extra-EU because in US this concentration took place in 2nd tier airports and because some particular airports in the 3rd and 5th tier benefited from some seat capacity growth.

[FIGURE 10 ABOUT HERE]

[TABLE 6 ABOUT HERE]

[TABLE 7 ABOUT HERE]

4.2 Who is responsible for the de/concentration?

Airlines may take benefits from concentrating traffic in a small number of airports. Since the seminal word of Caves et al. (1984), density economies are considered

[20] Already since Open Skies bilateral agreements some US carriers, instead of concentrating the intercontinental traffic between its US hub and the EU hubs of its alliance partners, have been directly serving primary as well as secondary European destinations from its US hubs. This is the case for instance of Detla from Atlanta and New York.

unequivocal in the airline industry. Density economies imply the decrease in average costs from increasing traffic at the route level.[21] This comes from using bigger airplanes (that are more cost efficient) at higher load factors. Hence, network airlines may exploit density economies by focusing traffic in their hub airports, while low-cost carriers may prefer to focus their operations in a number of operating bases. Other cost advantage of the concentration strategy is to save fixed costs that come from operating in additional airports. Additionally, they may increase the number of frequencies from their hubs or bases so that they can increase the utilization of the planes and the crew. Concentrating the activity in a few airports, airlines may also prevent competition in routes from these airports.

However, such concentration strategy has also some disadvantages. First, it may provoke congestion in the selected airports (this is particularly true when we consider the large hubs of network airlines). Second, it lowers the quality of service in routes from airports that are not the main nodes of the network. Third, it may promote competition that other airlines may exert from nearby airports.

Given that airlines may find both advantages and disadvantages in concentrating traffic in a few airports, it is not obvious a priori the tendency towards concentration or dispersion of traffic by airlines even after the deregulation process.

Overall, the effect of low-cost carriers in intra-EU and intra-US seat capacity deconcentration is appreciable from the 2000 (Figure 4), when competition from low-cost carriers forced network airlines to create alliances to exploit the connecting traffic

[21] Scale economies have to do with the decrease in average costs from both increasing the traffic in the route and the number of routes served. It is less clear whether scale economies are significant in the airline industry.

from their hubs and leave point-to-point traffic in the domain of low-cost carriers.[22] This had a direct effect on extra-regional seat capacity distribution, which became highly concentrated (Figure 4) as a result of the airline network alliances, which essentially took the form of code share and common frequent-flier programs that resulted in scheduling rationalization and dog-bone networks. The concentration of flows into hub-to-hub traffic created density economies (Button, 2009).

5. Conclusions

Acknowledgments

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Appendix 1

[TABLE A.1 HERE]

Appendix 2

[TABLE A.2 HERE]

[22] We should not forget that the competition from low-cost carriers has contributed to recent bankruptcies of network carriers: Sabena (2001), US Airways (2002 and 2004), United (2002), Swissair (2002), Northwest (2005) and Delta (2005). Additionally, low-cost competition has also contributed to foster the merge of some of the major network carriers: American and TWA (2001), Air France and KLM (2004), Delta and Northwest (2008), Continental and United (2010), British Airways and Iberia (2010).

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Table 1. Summary of seat capacity inequality studies.

Authors	Years of analysis	Europe		United States		Global
		Intra-EU	Extra-EU	Intra-US	Extra-US	
Chou (1993a)	1978-1989	-	-	No evidence of concentration	-	-
Goetz and Sutton (1997)	1978-1993	-	-	Concentration	-	-
Bowen (2002)	1984-1996	-	-	-	-	Deconcentration (in absolut terms) Concentration (in relative terms)
Reynolds-Feighan (1998)	1960-1984	-	-	Concentration	-	-
Reynolds-Feighan (2001)	1969-1999	-	-	Concentration	-	-
O'Connor (2003)	1990-2000	-	-	-	-	Deconcentration
Reynolds-Feighan (2007)	1990-2002	-	-	Concentration (1990-1997) Deconcentration (1997-1998) Stability (1998-2002)	-	-
Burghouwt and Hakfoort (2001) Burghouwt et al. (2003) Burghouwt (2005)	1990-2003	Deconcentration	Concentration	-	-	-
Suau-Sanchez and Burghouwt (2010) (Only Spain)	2001-2008	Deconcentration	Depending on the destination market	-	-	-
Bel and Fageda (2010)	2004-2008	Deconcentration	Deconcentration	-	-	-
Huber (2009)	2005	Deconcentration	Concentration	Concentration	Concentration	-

Table 2. Airport groups and number of seats in the selected week of 2009.

Groups	Seats range per airport in the selected week, 2009	Total number of seats per group in the selected week, 2009	Number of airports in each group	Average number of seats per airport in the selected week, 2009
First tier	> 670,000	8,259,488	10	825,949
Second tier	380,000 – 670,000	9,790,657	20	489,533
Third tier	165,000 – 380,000	9,798,668	40	244,967
Fourth tier	48,000 – 165,000	8,158,075	90	90,645
Fifth tier	< 48,000	5,475,882	1,008	5,432
Total		*41,482,770*	*1,168*	*35,516*

Table 3. Intra-EU, share of different airport categories in the Gini inex. Source: OAG.

	Within-group					Between-group	Overall (not corrected)
	1st tier	2nd tier	3rd tier	4th tier	5th tier		
1990	0.00030	0.00021	0.00316	0.01321	0.13056	0.85256	1
1995	0.00026	0.00030	0.00394	0.01515	0.11890	0.86145	1
1999	0.00012	0.00017	0.00262	0.01075	0.11631	0.87003	1
2001	0.00003	0.00015	0.00221	0.01027	0.11865	0.86869	1
2003	0.00003	0.00013	0.00186	0.01004	0.12128	0.86666	1
2005	0.00004	0.00010	0.00166	0.00981	0.12493	0.86345	1
2007	0.00006	0.00011	0.00157	0.00803	0.13165	0.85858	1
2009	0.00006	0.00008	0.00144	0.00770	0.13712	0.85360	1

Table 4. Intra-US, share of different airport categories in the Gini index. Source: OAG.

	Within-group					Between-group	Overall (not corrected)
	1st tier	2nd tier	3rd tier	4th tier	5th tier		
1990	0.0004	0.0006	0.0014	0.0026	0.1152	0.8798	1
1995	0.0004	0.0007	0.0015	0.0027	0.0933	0.9014	1
1999	0.0004	0.0007	0.0014	0.0027	0.0845	0.9102	1
2001	0.0003	0.0006	0.0012	0.0026	0.0906	0.9046	1
2003	0.0004	0.0008	0.0013	0.0026	0.0862	0.9087	1
2005	0.0003	0.0008	0.0012	0.0024	0.0895	0.9059	1
2007	0.0003	0.0008	0.0000	0.0018	0.0886	0.9084	1
2009	0.0003	0.0008	0.0010	0.0017	0.0822	0.9139	1

Table 5. Extra-EU, share of different airport categories in the Gini index. Source: OAG.

	Within-group					Between-group	Overall (not corrected)
	1st tier	**2nd tier**	**3rd tier**	**4th tier**	**5th tier**		
1990	0.008	0.006	0.033	0.015	0.016	0.922	1
1995	0.009	0.007	0.042	0.016	0.007	0.920	1
1999	0.007	0.005	0.030	0.012	0.007	0.939	1
2001	0.005	0.005	0.027	0.013	0.005	0.945	1
2003	0.006	0.004	0.024	0.012	0.005	0.948	1
2005	0.006	0.004	0.020	0.016	0.005	0.950	1
2007	0.004	0.003	0.017	0.020	0.006	0.949	1
2009	0.004	0.002	0.015	0.018	0.006	0.954	1

Table 6. Extra-US, share of different airport categories in the Gini index. Source: OAG.

	Within-group					Between-group	Overall (not corrected)
	1st tier	**2nd tier**	**3rd tier**	**4th tier**	**5th tier**		
1990	0.022	0.051	0.014	0.010	0.005	0.898	1
1995	0.021	0.064	0.021	0.006	0.000	0.888	1
1999	0.018	0.063	0.016	0.007	0.000	0.895	1
2001	0.008	0.026	0.011	0.011	0.013	0.931	1
2003	0.008	0.028	0.010	0.012	0.011	0.930	1
2005	0.007	0.023	0.012	0.010	0.013	0.935	1
2007	0.008	0.026	0.013	0.008	0.011	0.934	1
2009	0.009	0.032	0.015	0.006	0.009	0.928	1

Table 7. Distribution of seat capacity in the EU and US airport hierarchy, 1990-2009. Source: OAG.

Intra-EU seat capacity					
	1st tier	2nd tier	3rd tier	4th tier	5th tier
1990	18%	12%	25%	25%	20%
1995	17%	12%	28%	25%	19%
1999	16%	13%	30%	23%	18%
2001	16%	12%	30%	24%	18%
2003	15%	13%	28%	26%	18%
2005	14%	13%	28%	27%	19%
2007	13%	12%	27%	28%	19%
2009	12%	12%	26%	29%	20%

Intra-US seat capacity					
	1st tier	2nd tier	3rd tier	4th tier	5th tier
1990	22%	27%	20%	16%	15%
1995	22%	29%	20%	16%	12%
1999	22%	30%	21%	16%	11%
2001	18%	28%	23%	19%	12%
2003	18%	29%	23%	19%	12%
2005	19%	29%	22%	18%	12%
2007	19%	29%	23%	17%	12%
2009	19%	30%	23%	16%	11%

Extra-EU seat capacity					
	1st tier	2nd tier	3rd tier	4th tier	5th tier
1990	43%	20%	25%	7%	5%
1995	44%	19%	26%	8%	3%
1999	47%	20%	24%	6%	2%
2001	48%	21%	23%	6%	2%
2003	52%	19%	21%	6%	2%
2005	50%	19%	22%	7%	2%
2007	47%	19%	24%	8%	2%
2009	47%	19%	23%	9%	2%

Extra-US seat capacity					
	1st tier	2nd tier	3rd tier	4th tier	5th tier
1990	44%	38%	11%	6%	2%
1995	42%	43%	11%	3%	0%
1999	43%	44%	9%	3%	0%
2001	39%	41%	10%	6%	3%
2003	38%	43%	10%	6%	3%
2005	38%	42%	11%	6%	3%
2007	40%	42%	11%	4%	3%
2009	39%	43%	11%	4%	3%

Table A.1 List of alliance members by year

Year	Star	Oneworld	SkyTeam	Wings
2009	Air Canada, Air China, Air New Zealand, All Nippon Airways, Asiana Airlines, Austrian Airlines, BMI British Midland, BMI Regional, Egyptair Eurowings Luftverkehrs, LOT Polish Airlines, Lufthansa Cityline, Lufthansa German Airlines, SAS, Singapore Airlines, South African Airways, Spanair, SWISS, SWISS European Air, TAP Air Portugal, Thai Airways Intl, Turkish Airlines, United Airlines, US Airways	American Airlines, British Airways, Cathay Pacific Airways, Finnair, Iberia, Japan Airlines, Lan Airlines, Lan Argentina, Lan Peru, Lan Ecuador, MALEV Hungarian Airlines, Mexicana de Aviación, Qantas Airways, Royal Jordanian	Aeroflot Nord, Aeroflot Russian Airlines, Aeroflot-Don, Aeromexico, Air Europa, Air France, Alitalia, Alitalia Express, China Southern Continental Airlines, Czech Airlines, Delta Air Lines, Kenya Airways, KLM Cityhopper,, KLM-Royal Dutch Airlines, Korean Air, Northwest Airlines	-
2007	Air Canada, Air New Zealand, All Nippon Airways, Asiana Airlines, Austrian Airlines, BMI British Midland, BMI Regional, Eurowings Luftverkehrs, LOT Polish Airlines, Lufthansa Cityline, Lufthansa German Airlines, SAS, Singapore Airlines, South African Airways, Spanair, SWISS, SWISS European Air, TAP Air Portugal, Thai Airways Intl, United Airlines, US Airways	American Airlines, British Airways, Cathay Pacific Airways, Finnair, Iberia, Japan Airlines, Lan Airlines, Lan Argentina, Lan Peru, Lan Ecuador, MALEV Hungarian Airlines, Qantas Airways, Royal Jordanian	Aeroflot Nord, Aeroflot Russian Airlines, Aeroflot-Don, Aeromexico, Air France, Alitalia, Alitalia Express, Continental Airlines, Czech Airlines, Delta Air Lines, KLM Cityhopper,, KLM-Royal Dutch Airlines, Korean Air, Northwest Airlines	-
2005	Air Canada, Air New Zealand, All Nippon Airways, Asiana Airlines, Austrian Airlines, BMI British Midland, BMI Regional, Eurowings Luftverkehrs, LOT Polish Airlines, Lufthansa Cityline, Lufthansa German Airlines, SAS, Singapore Airline, South African Airways, Spanair, TAP Air Portugal, Thai Airways Intl, United Airlines, US Airways	American Airlines, British Airways, Cathay Pacific Airways, Finnair, Iberia, Lan Airlines, Lan Argentina, Lan Peru, LanEcuador, Qantas Airways	Aeromexico, Air France, Alitalia, Alitalia Express, Continental Airlines, Czech Airlines, Delta, KLM Cityhopper, KLM-Royal Dutch Airlines, Korean Air, Northwest Airlines	-
2003	Air Canada, Air New Zealand, All Nippon Airways, Asiana Airlines, Austrian Airlines, BMI British Midland, BMI Regional,	American Airlines, British Airways, Cathay Pacific Airways, Finnair, Iberia, Lan Airlines, Lan Peru, Lan Ecuador Lan Argentina,	Aeromexico, Air France, Czech Airlines, Delta, Korean Air	Alitalia, Alitalia Express, Continental Airlines, KLM Cityhopper, KLM-Royal Dutch Airlines, Northwest Airlines

	Eurowings Luftverkehrs, Lufthansa Cityline, Lufthansa German Airlines, SAS, Singapore Airlines, South African Airways, Spanair, Thai Airways Intl, United Airlines	Qantas Airways		
2001	Air Canada, Air New Zealand, All Nippon Airways, Austrian Airlines, BMI British Midland, BMI Regional, Eurowings Luftverkehrs, Lufthansa Cityline, Lufthansa German Airlines, SAS, Singapore Airlines, South African Airways, Thai Airways Intl, United Airlines	American Airlines, British Airways, Cathay Pacific Airways, Finnair, Iberia, Lan Airlines, Qantas Airways, Lan Peru, LanEcuador, LAN Argentina	Aeromexico, Air France, Czech Airlines, Delta, Korean Air	Alitalia, Alitalia Express, Continental Airlines, KLM Cityhopper, KLM-Royal Dutch Airlines, Northwest Airlines
1999	Air Canada, Air New Zealand, All Nippon Airways, Lufthansa Cityline, Lufthansa German Airlines, SAS, Thai Airways Intl, United Airlines	American Airlines, British Airways, Cathay Pacific, Finnair, Iberia	-	Alitalia, Alitalia Express, Continental Airlines, KLM Cityhopper, KLM-Royal Dutch Airlines, Northwest Airlines
1995	-	-	-	KLM Cityhopper, KLM-Royal Dutch Airlines, Northwest Airlines
1991	-	-	-	KLM Cityhopper, KLM-Royal Dutch Airlines, Northwest Airlines

Table A.2 List of low-cost carriers by year

Year	Low-cost carriers
2009	AirBerlin, Ryanair, Transavia, Virgin Express, easyJet, Wizz Air, Vueling, Niki, Jet2, Germanwings, BMIbaby, Southwest, Frontier, jetBlue, Virgin America, AirTran, Allegiant Air, Spirit Airlines, Sun Country Airlines, USA 3000, Belleair, InterSky, Jetairfly, TUIfly, Wizz Air Bulgaria, Smart Wings, Cimber Sterling, Astra Airlines, Iceland Express, AerArann, AirOne, Blue-express, Wind Jet, airBaltic, Star1, Norwegian Air Shuttle, Blue Air, Avianova, Sky Express, AnadoluJet, Corendon, Onur Air, SunExpress, Pegasus, SkyEurope, CentralWings, MyAir.com, Volareweb.com
2007	AirBerlin, Ryanair, Transavia, easyJet, Wizz Air, Vueling, Clickair, Niki, Jet2, Germanwings, BMIbaby, Southwest, Frontier, jetBlue, Virgin America, AirTran, Allegiant Air, Spirit Airlines, Sun Country Airlines, USA 3000, Belleair, InterSky, Jetairfly, TUIfly, Smart Wings, Cimber Sterling, Astra Airlines, Iceland Express, AerArann, AirOne, Blue-express, Wind Jet, airBaltic, Norwegian Air Shuttle, Blue Air, Sky Express, Corendon, Onur Air, SunExpress, Pegasus, Sterling, DBA, Alpi Eagles, Fly Nordic, FlyMe, SkyEurope, CentralWings, MyAir.com, Skybus, Sky Value
2005	AirBerlin, Ryanair, Transavia, easyJet, Wizz Air, Vueling, Niki, Jet2, Germanwings, BMIbaby, Southwest, Frontier, jetBlue, Virgin America, AirTran, Allegiant Air, Spirit Airlines, Sun Country Airlines, USA 3000, Belleair, InterSky, Jetairfly, Hapag-Lloyd Express, Smart Wings, Cimber Sterling, Iceland Express, AerArann, AirOne, Blue-express, Wind Jet, airBaltic, Norwegian Air Shuttle, Blue Air, Corendon, Onur Air, SunExpress, Pegasus, Sterling, DBA, Alpi Eagles, Maersk Air, Fly Nordic, FlyMe, SkyEurope, CentralWings, MyAir.com, Independence air
2003	AirBerlin, Ryanair, Transavia, easyJet, Wizz Air, Niki, Jet2, Germanwings, BMIbaby, Southwest, Frontier, jetBlue, AirTran, Allegiant Air, Spirit Airlines, Sun Country Airlines, USA 3000, InterSky, Jetairfly, Hapag-Lloyd Express, Cimber Sterling, Iceland Express, AerArann, AirOne, Wind Jet, airBaltic, Norwegian Air Shuttle, Onur Air, SunExpress, Pegasus, Sterling, DBA, Alpi Eagles, Maersk Air, Air Scotland, Fly Nordic, SkyEurope, AirPolonia, Vbird, Flying Finn, Independence air
2001	AirBerlin, Ryanair, Transavia, easyJet, Southwest, Frontier, jetBlue, AirTran, Allegiant Air, Spirit Airlines, Sun Country Airlines, USA 3000, InterSky, Cimber Sterling, AerArann, AirOne, airBaltic, Norwegian Air Shuttle, Onur Air, SunExpress, Pegasus, Sterling, DBA, Alpi Eagles, Maersk Air, Fly Nordic, SkyEurope, AirPolonia, Vanguard, National Airlines, Independence air
1999	AirBerlin, Ryanair, Transavia, easyJet, Southwest, Frontier, jetBlue, AirTran, Allegiant Air, Spirit Airlines, Sun Country Airlines, Cimber Sterling, AerArann, AirOne, airBaltic, Norwegian Air Shuttle, Onur Air, SunExpress, Pegasus, Sterling, DBA, Alpi Eagles, Maersk Air, Debonair, National Airlines, Kiwi International, Independence air
1995	AirBerlin, Ryanair, easyJet, Southwest, Frontier, Spirit Airlines, Sun Country Airlines, Cimber Sterling, AerArann, AirOne, airBaltic, Norwegian Air Shuttle, Onur Air, SunExpress, Pegasus, Valuejet, Sterling, DBA, Alpi Eagles, Maersk Air, Debonair, Kiwi International, Independence air
1991	AirBerlin, Ryanair, easyJet, Southwest, Spirit Airlines, Sun Country Airlines, Cimber Sterling, AerArann, Onur Air, SunExpress, Pegasus, Sterling, Alpi Eagles, Maersk Air, Debonair, Kiwi International, Independence air

Figure 1. Airport classification map, 5th tier airports are not shown.

Figure 2. Lorenz curve for Europe, years 1990, 2001 and 2009. Source: OAG.

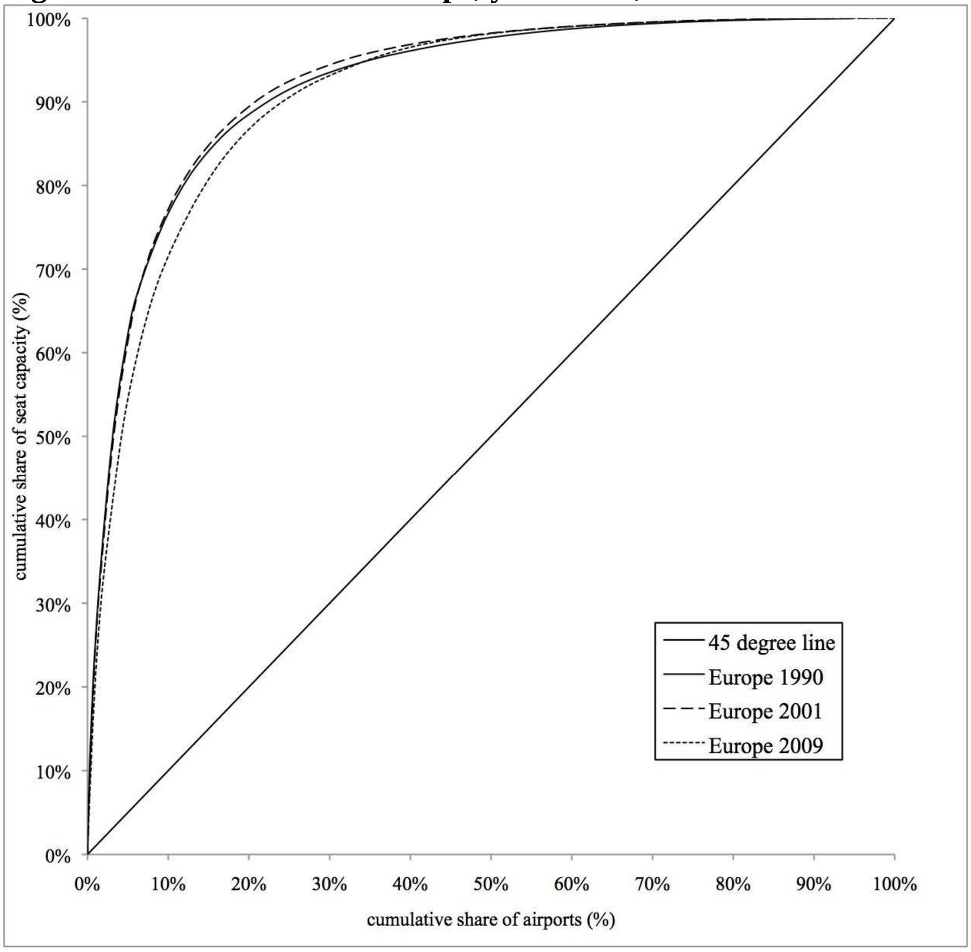


Figure 3. Lorenz curve for US, years 1990, 2001 and 2009. Source: OAG.

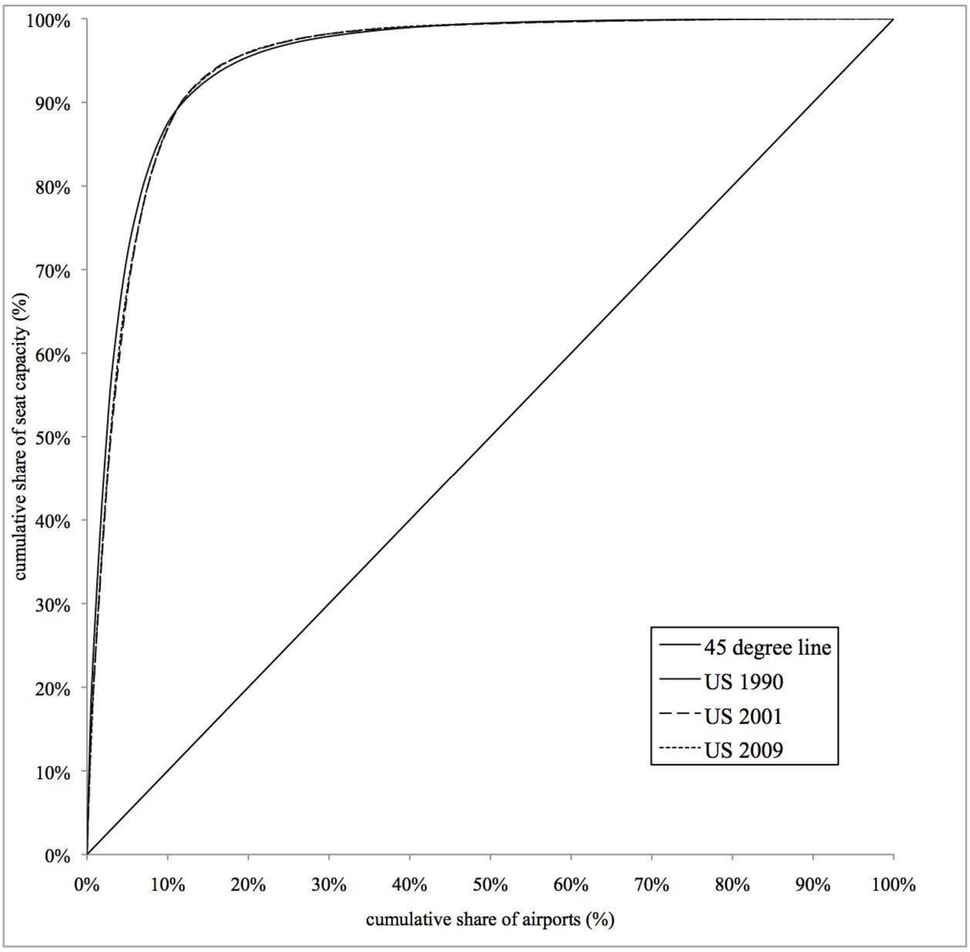
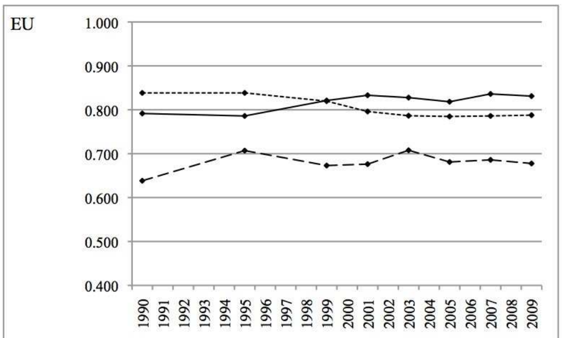
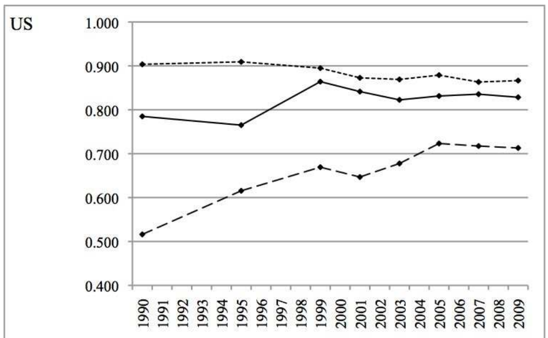


Figure 4. Evolution of the corrected Gini Index by airline type, 1990-2009. Source: OAG.



	1990	1995	1999	2001	2003	2005	2007	2009
Network	0.792	0.786	0.821	0.833	0.828	0.818	0.836	0.831
Low-Cost	0.638	0.707	0.673	0.676	0.708	0.681	0.686	0.678
Other	0.838	0.838	0.820	0.796	0.786	0.785	0.786	0.788



	1990	1995	1999	2001	2003	2005	2007	2009
Network	0.785	0.765	0.864	0.841	0.823	0.831	0.836	0.828
Low-Cost	0.516	0.615	0.669	0.647	0.678	0.723	0.717	0.713
Other	0.904	0.909	0.895	0.873	0.869	0.879	0.863	0.867

Figure 5. Spatial forms of airline networks.

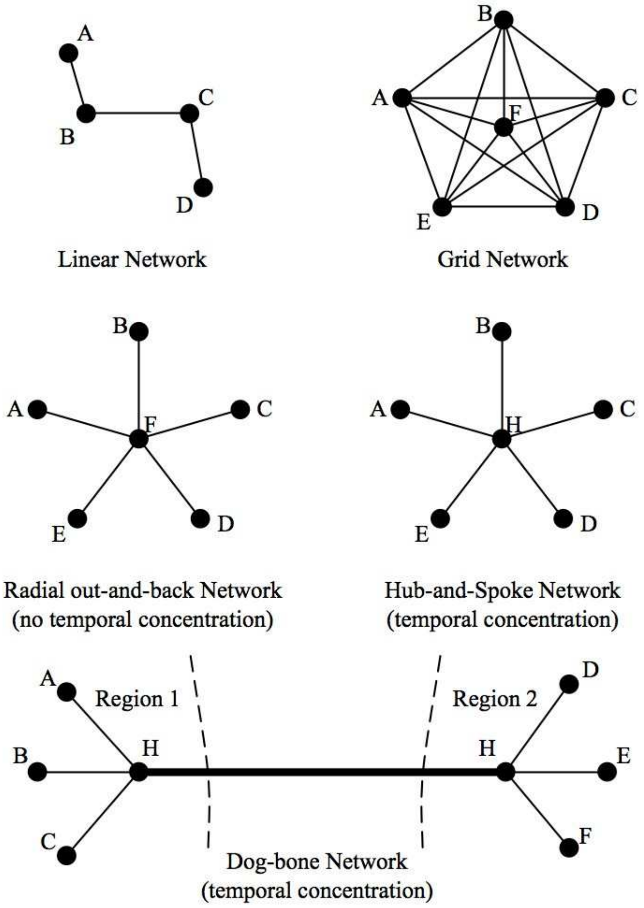
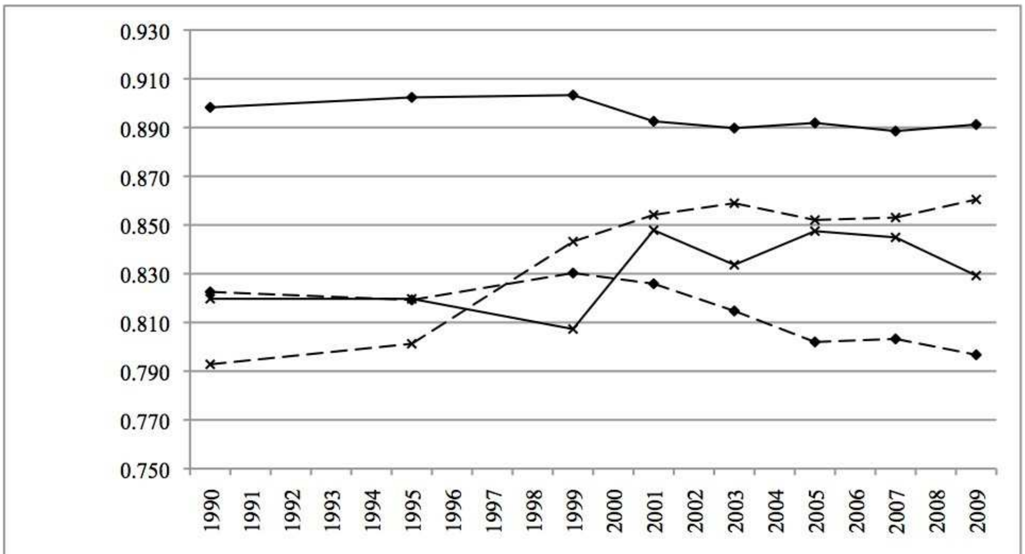
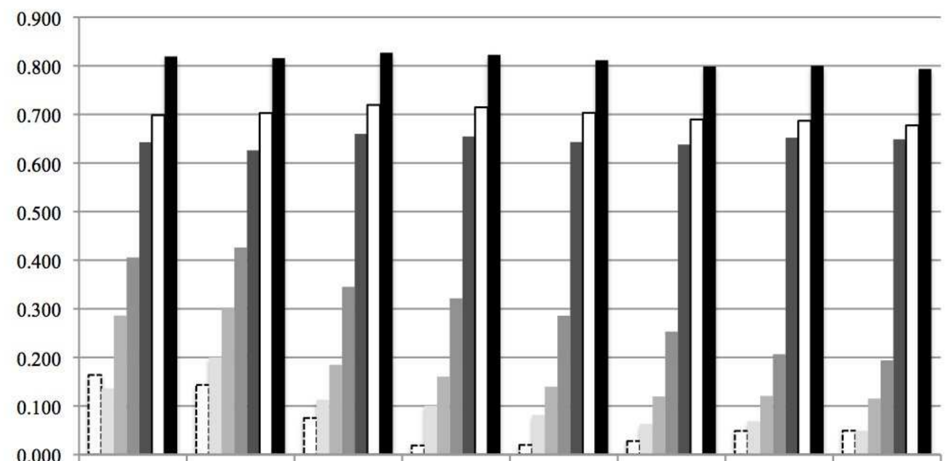


Figure 6. Evolution of the corrected Gini Index by region, 1990-2009. Source: OAG.



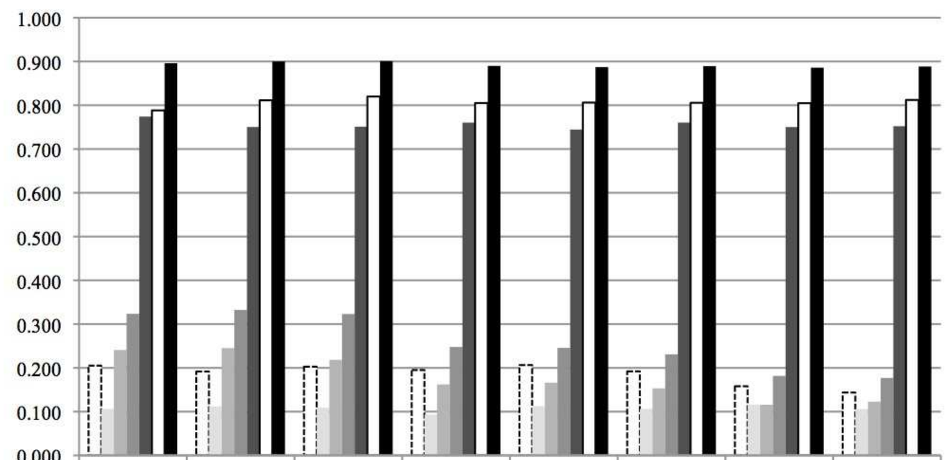
	1990	1995	1999	2001	2003	2005	2007	2009
Intra-US	0.898	0.902	0.903	0.893	0.890	0.892	0.889	0.891
Intra-EU	0.823	0.819	0.830	0.826	0.815	0.802	0.803	0.797
Extra-US	0.820	0.820	0.807	0.848	0.834	0.847	0.845	0.829
Extra-EU	0.793	0.801	0.843	0.854	0.859	0.852	0.853	0.860

Figure 7. Intra-EU, within-group and between-groups Gini index. Source: OAG.



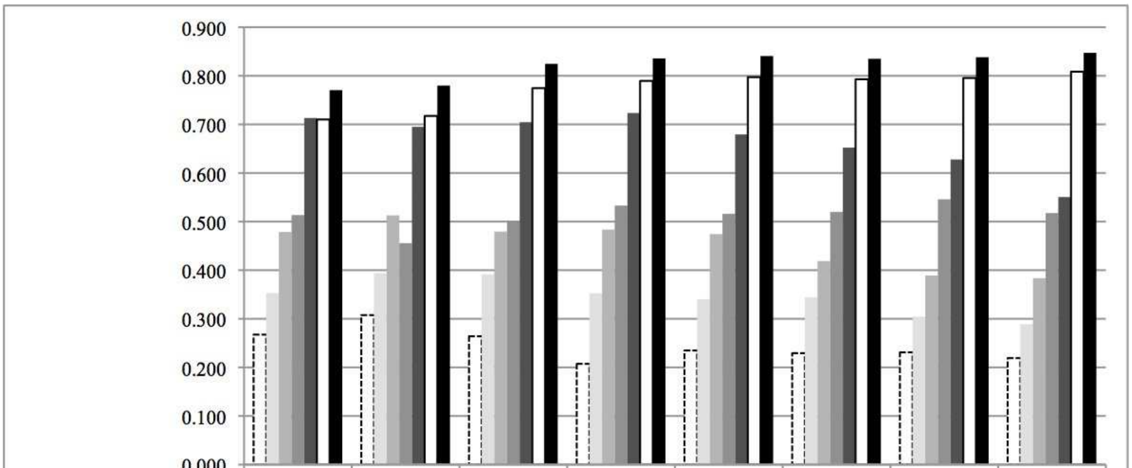
	1990	1995	1999	2001	2003	2005	2007	2009
Within-group 1st tier	0.164	0.143	0.075	0.019	0.020	0.028	0.049	0.049
Within-group 2nd tier	0.136	0.200	0.113	0.100	0.082	0.063	0.068	0.049
Within-group 3rd tier	0.286	0.302	0.185	0.160	0.140	0.120	0.121	0.115
Within-group 4th tier	0.406	0.426	0.345	0.322	0.286	0.253	0.207	0.194
Within-group 5th tier	0.643	0.626	0.660	0.655	0.643	0.638	0.652	0.649
Between group	0.698	0.703	0.719	0.715	0.703	0.690	0.687	0.677
Overall (not corrected)	0.819	0.816	0.827	0.823	0.811	0.799	0.800	0.794

Figure 8. Intra-US, within group and between-groups Gini index. Source: OAG.



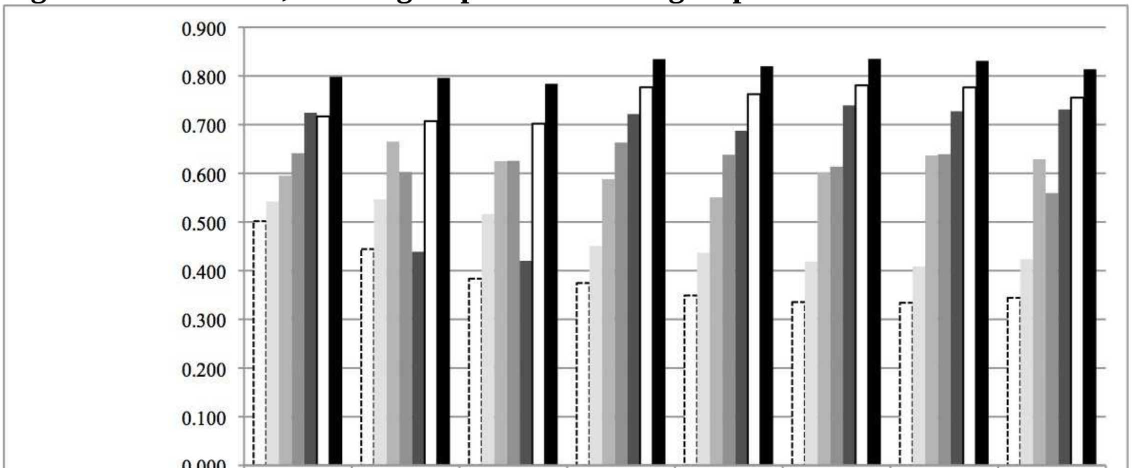
	1990	1995	1999	2001	2003	2005	2007	2009
Within-group 1st tier	0.205	0.192	0.203	0.195	0.206	0.192	0.158	0.144
Within-group 2nd tier	0.106	0.112	0.109	0.093	0.112	0.106	0.116	0.106
Within-group 3rd tier	0.241	0.245	0.218	0.162	0.166	0.153	0.116	0.123
Within-group 4th tier	0.324	0.332	0.323	0.248	0.246	0.231	0.182	0.177
Within-group 5th tier	0.774	0.750	0.751	0.760	0.744	0.760	0.750	0.752
Between group	0.788	0.811	0.820	0.805	0.806	0.806	0.805	0.812
Overall (not corrected)	0.896	0.900	0.901	0.890	0.887	0.889	0.886	0.889

Figure 9. Extra-EU, within-group and between-groups Gini index. Source: OAG.



	1990	1995	1999	2001	2003	2005	2007	2009
Within-group 1st tier	0.267	0.308	0.264	0.207	0.235	0.229	0.231	0.219
Within-group 2nd tier	0.353	0.394	0.392	0.352	0.340	0.344	0.304	0.289
Within-group 3rd tier	0.479	0.513	0.479	0.483	0.474	0.419	0.389	0.384
Within-group 4th tier	0.513	0.456	0.502	0.533	0.516	0.520	0.546	0.518
Within-group 5th tier	0.713	0.695	0.704	0.723	0.679	0.652	0.628	0.551
Between group	0.710	0.717	0.775	0.790	0.797	0.793	0.795	0.808
Overall (not corrected)	0.770	0.780	0.825	0.836	0.841	0.835	0.838	0.847

Figure 10. Extra-EU, within-group and between-groups Gini index. Source: OAG.



	1990	1995	1999	2001	2003	2005	2007	2009
Within-group 1st tier	0.502	0.444	0.384	0.375	0.349	0.335	0.334	0.344
Within-group 2nd tier	0.542	0.546	0.516	0.451	0.437	0.419	0.409	0.423
Within-group 3rd tier	0.595	0.665	0.625	0.588	0.551	0.602	0.637	0.629
Within-group 4th tier	0.641	0.603	0.626	0.663	0.638	0.614	0.639	0.559
Within-group 5th tier	0.724	0.439	0.420	0.722	0.687	0.740	0.727	0.731
Between group	0.717	0.707	0.702	0.777	0.763	0.781	0.776	0.755
Overall (not corrected)	0.798	0.796	0.784	0.835	0.820	0.835	0.831	0.814