Competition, vertical relationship and countervailing power: Empirical evidence from the UK airport industry[1]

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Abstract

In this paper, we study whether competition in the airport market and the vertical interactions between upstream airports and downstream airlines influence the airport pricing decisions. Using a panel of the twenty-four largest UK airports, as well as a refined definition of competition between airports, we find that lower concentration in an airport's catchment area, higher airlines countervailing power and more intense downstream competition, measured by lower degrees of product differentiation of airlines, are associated to lower aeronautical charges. We also find that stronger competition in the airport market and more intense competition between airlines are complements.

Keywords: airport, competition, countervailing power, vertical relations
JEL codes: L93, D43, R40.

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1. Introduction

Does competition in the airport market affect aeronautical charges? Does airlines countervailing power prevent airports to raise them? More generally, what is the role of the vertical interactions between airports and airlines in shaping airports pricing decisions? In this paper, we seek to answer these questions by empirically analysing, for the case of the UK airport sector, the relationship between aeronautical charges, the degree of competition faced by airports and various measures of airline countervailing power and degree of product differentiation in the airlines market.

These issues have been on top of recent policy debates after the major changes that have occurred in both the airport and airline markets during the last decades. Indeed, the trend towards privatization of airports, together with the liberalization of the airline market and the massive entry

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of low cost carriers, have significantly modified the market structure and the competitive environment faced by airports (Oum and Fu (2008)). In the UK such changes have led to the intervention of market regulators, as witnessed by the recent decisions of the UK Competition Commission to force BAA, the joint owner of some of the largest UK airports, to divest both Gatwick and Stansted and by the recent decision by the UK Civil Aviation Authority (CAA) to exclude Manchester from the list of regulated airports, because of the increased competition in the city area (Civil Aviation Authority, 2007).

The evolution of the industry has in turn spurred the attention of both academic and practitioners to the study of the economics of the airport sector and its relations with the airline market (Starkie, 2008). In this respect, the understanding and modelling of the market environment where airports operate is a complex task. Indeed, like any industry, the competition assessment in an airport market strongly depends on the definition of the relevant market. Unlike most industries, in the case of airports such a definition does not depend on the exclusive identification of either a relevant product/service or a relevant geographic dimension, but simultaneously on both (Civil Aviation Authority, 2011). For instance, two airports may be geographically very close (e.g., belong to the same metropolitan area) but nonetheless exert very little competitive pressure on each other if they serve different destinations; by the same token, two airports may be in rather distant geographical areas but may be competing to attract potential passengers from both areas if their respective set of destinations largely overlap (and ground access is relatively inexpensive).

Moreover, within a given market, the degree of market power of each incumbent airports depends on the ability of its customers (passengers, cargo shippers, airlines and, to a lesser extent, retailers) to switch between airports. The demand of these user groups is interdependent and generally pro-competitive: an airport may want to keep airline charges low to ensure an adequate flow of passengers and consequently a higher demand for retail space. Boosting traffic volumes is also a way for airports to defray their large share of fixed costs. The ensuing low entry costs may boost airlines' incentives to open and close routes. After the European liberalization of the Civil Aviation market, an increasing proportion of passengers can reach an intra-European destination departing from at least two reasonably attractive substitute airports (Copenhagen Economics, 2012).

Countervailing (buyer) power appears therefore to impose a strong competitive constraint on airports. First, airlines do not only open and close routes but, as part of their wider business model, establish hubs and bases; by doing so, they commit to direct a large level of traffic into a chosen airport. This intensifies airport competition since each airport has to be ready to defend its existing base and hub activities while, at the same time, trying to win additional airline capacity. Second, the enhanced choice available for European leisure travellers has likely intensified competition among airports close to holiday resorts in different countries: a Greek airport cannot increase its charges since holidaymakers and airlines can promptly switch their operations in Italy or Spain. A similar switching threat characterizes the market for short city breaks.

Haskel et al. (2013) is the first study to tackle some of these issues jointly in a formal theoretical set-up. Using a model of upstream airports and downstream airlines with varying countervailing power and pricing structures, the study suggests that: *i*) an increase in concentration in the airport market rises aeronautical charges and that higher countervailing power of airlines lowers them, although such reductions typically do not pass through to consumers; *ii)* higher competition among airlines, measured by the degree of substitutability of their products, is associated to lower aeronautical charges.

This paper tries to shed additional light on these issues by empirically analysing the relationship between airport charges, airlines countervailing power and airport competition using data from the 24 largest UK airports observed over the period 1996-2008. In particular, we address in a novel manner two main issues that are central in order to assess the competitive environment faced by airports.

First, although we adopt a standard approach to identify an airport catchment area, defined by a circle of 90 km around each airport, the structural measures of the airport relevant market are constructed by taking into account the extent to which airports in overlapping catchment areas offer services to the same destination areas (Brueckner et al., 2012, CAA, 2011; Scotti et al., 2012). To the best of our knowledge, this is the first paper that explores the impact of competition in the airport market on airports pricing decisions that goes beyond very crude proxies of competition such as the number of airports within a predetermined circle.

Second, we model the influence of the structure of the downstream airline market on airport charges by including not only a measure of airlines countervailing power, as in Bel and Fageda (2010) and Bilotkach et al. (2012), but also by taking into account the role played by the degree of route substitutability within each airport, which can be seen as an inverse proxy of the importance of airlines product differentiation, and therefore of the likely intensity of competition in the downstream airline market.

Our results, which broadly support the main predictions of the theoretical model of Haskel et al (2013), can be very briefly summarized as follows: *i)* stronger airlines' bargaining power, more intense competition in each airport catchment area and higher degrees of route substitutability are associated to lower airport charges; *ii)* variations in route substitutability affect aeronautical charges only when the upstream airport market is sufficiently competitive, which in turn suggests a form of complementarity between competition in the airport (upstream) and airlines (downstream) markets.

The reminder of the paper is organized as follows: Section 2 presents a brief survey of the literature on airport competition and pricing, while Section 3 describes the data sources. Section 4 discusses the econometric strategy and comments the results, while Section 5 concludes.

2. Literature Review

As Haskel et al (2013) underline, most of the theoretical literature on airport pricing does not deal with the role played by the airports-airlines interactions,[2] which are closely affected by the characteristics of both upstream (airports) and downstream (airlines) markets.[3]

Some previous works have addressed these issues separately. Oum and Fu (2008) investigate the effect of competition among independent airports, while Starkie (2002) considers whether the

[2] A few empirical works study the impact of market structure on airport efficiency and productivity. For example, Bottasso et al (2013), Pels et al (2009), Choo and Oum (2013) analyse the importance of the presence of low cost carriers for airports efficiency and productivity; in turn, Scotti et al (2012) investigate the relationship between airports competition and efficiency. More in general, there is a vast empirical literature that has sought to analyse the cost structure of the airport industry as well as the determinants of airport efficiency and productivity; for recent examples of this strand of the literature, see Bottasso and Conti (2012) and Yan and Oum (2014).

[3] A related strand of theoretical literature is that on congestion pricing and airport capacity financing, which is reviewed in Haskel et al. (2013).

countervailing power of airlines might mitigate airports market power[4]. The only study that tackles these issues jointly within a formal theoretical model is Haskel et al (2013), whose set-up accounts for different levels of concentration in the upstream (airports) and downstream (airlines) markets and for demand substitutability both within airport and between airports. Upstream market structure and competitive pressure among airports are proxied by the extent of common ownership and by the degree of substitutability among airports. The degree of routes substitutability within the same airport represents a measure of the intensity of competition in the airlines market, while downstream concentration is considered as a proxy for airlines countervailing power. The main predictions of the model by Haskel et al (2013) that are relevant for this work can be summarized as follows: a) an increase in competition among independent airports reduces aeronautical charges and this effect is stronger when downstream competition, as proxied by routes substitutability, is higher; b) when airports are under separate ownership, higher airlines countervailing power always reduces aeronautical charges; c) an increase in routes substitutability always reduces aeronautical charges and this effect increases with the intensity of upstream competition.

Some of the implications of the model proposed by Haskel et al (2013) have been analyzed by the applied literature, although the empirical evidence is rather limited. Van Dender (2007) considers a sample of 55 US airports observed over the period 1998-2002 and shows that the degree of competitive pressure among airports, measured by the number of nearby airports located within 100 km, has a significant negative effect on aeronautical charges. Because this result is obtained without controlling for airports fixed effects, its robustness warrants further econometric analysis. The author also finds that airlines' concentration at each airport, a proxy for buyers' countervailing power, is positively correlated to charges, but its parameter is weakly significant even after controlling for airports fixed effects. Factors determining airport charges have also been analyzed by Bel and Fageda (2010) on a cross section of 100 large European airports observed in 2007. Their estimates suggest that competition from nearby airports (managed by a different operator) located within 100 km and greater airlines' bargaining power, identified by the airport's Herfindal index of concentration based on the number of flights offered by its airlines, tend to reduce aeronautical charges; these results are however strongly dependent on the sample composition and hold only for those airports that do not adhere to a price fixing system and are not located on islands (45 airports). The study by Bilotkach et al (2012), who analyze a panel of 61 European airports observed over the period 1990-2007 points to the opposite conclusion that the presence of nearby airports located within 90 km around the airport does not affect aeronautical charges. More recently, Choo (2014) analyzes 59 major United States airports observed during the period 2002-2012. In line with previous works, the competitive pressure in the upstream market is modelled using the number of airports with more than 100,000 passengers, within a catchment area of 100 km and managed by a different operator, while the market share of the dominant airline in an airport is expected to capture the airlines' bargaining power. Estimates show that both variables do not significantly affect aeronautical charges.

As the review of the aforementioned studies makes it clear, the existing empirical evidence acknowledges the role played by airlines' countervailing power and competition in the airport market as possible competitive restraints on airport pricing decisions, but has produced partly

[4] The same authors underline the role played by the complementarity between the demand of aviation and commercial services in reducing the incentives for airports to increase aeronautical charges.

conflicting results, possibly due to differences in terms of samples (US versus EU), time period and estimation strategy. Most importantly, the previous literature presents two important limitations that this study seeks to address. First, it has (implicitly) assumed the exogeneity of competition in the airport market; second, it has failed to take into account another important dimension of the vertical structure of the sector, namely, the role played by the intensity of downstream competition as identified by the degree of overlapping in routes served by nearby airports.

3. Data

The dataset used in this study is a balanced panel of the 24 largest UK airports observed over the period 1996-2008 (see Table 1). It comes from two main sources: the CAA dataset and the statistical series "The UK Airport Industry" published by the Centre for the Study of Regulated Industry at the University of Bath.

As far as the ownership definition is concerned, we consider an airport as "public" (*pub*) if the majority of ownership belongs directly or indirectly to one or more municipalities, as "mixed" (*mix*) whenever private investors retain the majority control but more than 20% of ownership is held by a local council or whenever the airport is under public ownership but the management is fully delegated to private investors and as "private" (*priv*) if the airport does not belong to either groups. Table 1 reports ownership status and its changes in the 24 analyzed airports: as of 1996, 11 airports in our sample were publicly owned against 13 under private ownership; in turn, in 2008, only 5 airports were public owned, against 14 and 5 under private and mix ownership, respectively. Furthermore, it is noteworthy that not all ownership changes result in a privatization: Bournemouth and East Midlands airports became publicly owned in 2001.

The dependent variable in our econometric analysis corresponds to the airport's charges revenues (*charges*) per *atm* (Airport Transport Movements), i.e. the number of flights that carry cargo mail or passengers. It is obtained from the statistical series "The UK Airport Industry", which also contains data on the percentage of passengers traffic (*pax* per *wlu*), i.e. the number of passengers traffic over the WLU (Work Load Units, defined by 100 kg of cargo or 1 passenger), and the percentage of international passengers traffic (*international pax*). Table 3 points towards a positive trend for the aviation market that has been taking place since the airline market deregulation: passengers and cargo movements have been increasing over the last years, as well as airports' revenues and international passengers.

Using the GIS software, we first define each airport's catchment areas by drawing a circle with a radius of 90 Km around each of the 24 airports (Scotti et al., 2012); the resulting catchment areas are shown in Figure 1. Then, we identify all the Local Authorities[5] and NUTS3[6] included in each

[5] "Local authority (LA) is a generic term for any level of local government in the UK. In geographic terms LAs therefore include English counties, non-metropolitan districts, metropolitan districts, unitary authorities and London boroughs; Welsh unitary authorities; Scottish council areas; and Northern Irish district council areas." Office for National Statistics, available at:
http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/glossary/glossary-l.html.

[6] "The Nomenclature of Units for Territorial Statistics (NUTS) is a hierarchical classification of spatial units that provides a breakdown of the European Union's territory for the purposes of producing comparable regional statistics." Office for National Statistics, available at:
http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/glossary/glossary-n.html.

area in order to identify the overlapping areas where airports compete with each other. Figure 1 shows how airports in southern UK have more overlapping catchment areas than those in the north; residents in southern UK thus potentially enjoy a wider choice of airports: the ensuing higher degree of substitutability is likely to enhance the competitive pressures for southern airports.

Figure 1. UK Airports' catchment areas

The explanatory variables in our econometric model are grouped as follows. Regional characteristics, obtained using data from the UK Office of National Statistics, are captured by *population density* and *Gdp growth* of every catchment area; in particular, we use data on the population density at local authorities level, while for GDP we have data only at NUTS3 level.[7] Note that we impute all the NUTS3 areas that have at least one half of their surface included in the catchment area. From table 2 and table 3 we can notice that, as expected, both *population density* and *Gdp* are increasing over the period analyzed.

The airport competition indexes are derived by refining the idea that two airports compete with each other when their catchment areas somehow overlap. This is not necessarily the case because, even if they had different ownership, in the most extreme case the two airports could be considered as local monopolists if they were serving totally different final destinations. Therefore, in order to measure the intensity of competition between airports, it is essential to extend the pure geographical classification of overlap between catchment areas to include a measure of the extent to which the destinations they serve overlap.

The CAA dataset provides monthly data on traffic for all routes (i.e., airport-pairs) served by all airlines that operated from all the UK airports during the period 1996-2012. More precisely, for each combination of company, route, and departure period (i.e. monthly/year), the CAA provides the number of monthly passengers and flights that we then aggregate by year. The analysis distinguishes between the standard concept of route, defined as airport pairs, and *superoute*s, identified by airline services departing from one UK airport and arriving in one of the airports that are considered to operate in the same geographical market by the CAA (i.e. the flight Heathrow-Milano Linate is considered to be in the same *superoute* as Heathrow-Milano Malpensa) and *vice versa*. To further clarify, Figure 2, Panel A, shows six different routes while Figure 2, Panel B, describes three possible *superoutes*.

Through the construction of the *superoute* we try to capture the intensity of competition among airports in a way that jointly takes into account the extent to which airports share both the same catchment area and similar sets of products.[8] Figure 2, Panel C, for example, shows that even if all the three UK airports had flights to Milan, London Stansted would not be competing with Southampton because their catchment areas do not overlap, while London Gatwick would with both Southampton and London Stansted airport.

[7] We have computed these variables at the catchment area level by summing over local authorities included in the catchment area.

[8] Pavlyuk (2009) states that an airport's catchment area should be built taking into account the nearest airports but also their flights availability and that those areas can vary for different destinations

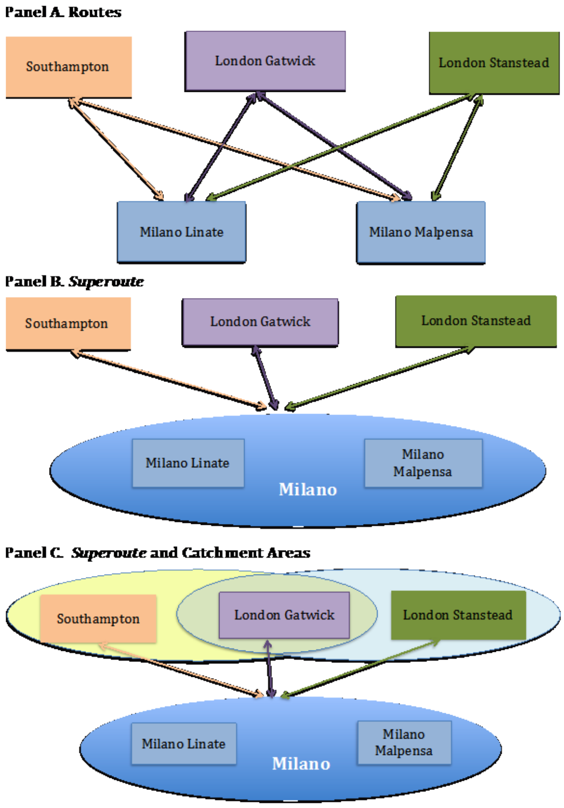

Figure 2. Routes, *superoutes* and catchment areas.

The Civil Aviation Authority (2011) states that an airport can increase the likelihood of an undertaking holding market power when it has a high market share relative to its competitors; on the other hand, market shares are less reliable where there is a high degree of product differentiation. For these reasons, we calculate a Herfindhal Index for each airport, as explained below, in order to take into account this potential market power. More specifically, following Haskel et al. (2013), we build the following set of variables, in order to measure the airport's market power:

Upstream competition (i.e. airports' substitutability). This is measured by the *Herfindhal* Index of airport *i*. We first derive a measure of the market power of airport *i* in its catchment area over a single *superoute r*: this is calculated as the sum of the squared market shares of airports in the same catchment area over a single *superoute r* (MS_{ir}). However, when airports operating in the same catchment area belong to the same ownership group they may not be competing with each other. Therefore if, in the catchment area of airport i there are other airports belonging to the same ownership group, we consider their joint market shares:

$$HHI_{ir} = \sum_{i=1}^{N} MS_{ir}^2 = \sum_{i=1}^{N} \left(\frac{Pax\ of\ airport\ i\ over\ superoute\ r}{Pax\ of\ catchment\ area\ over\ r} \right)^2 \quad (1)$$

where N is the number of airports in the catchment area of airport i^9.

Next, in order to have a single Herfindhal index for each airport we aggregate HHI_{ir} over all *superoutes*. Each HHI_{ir} is weighted by the relative importance of the *superoute* for airport *i*, as measured by the ratio between the number of passengers that travel from airport *i* over *superoute r* (Pax_{ir}) and the total number of passengers that travel from airport *i* (Pax_i).[10] The idea is that even if an airport has a big market power over a *superoute*, this could contribute very little to an airport *i's* overall market power if that *superoute* represents only a tiny fraction of total passengers for that airport. Hence, the aggregate index of competition for airport *i* is defined as:

$$HHI_i = \sum_{r=1}^{R} \frac{Pax_{ir}}{Pax_i} HHI_{ir} \qquad (2)$$

where *R* is the number of *superoutes* available at airport *i.*

Our Herfindal measure ranges from 0 to 1, where 0 indicates that an airport faces many competitors, while 1 indicates that airports is a local monopolist; thus, the greater the value of HHI of an airport, the bigger its market power.

Airlines countervailing power. This has been measured by three different variables:

- Low Cost Market Share in airport *i* at year *t* (*Low Cost*); we identify as low cost airlines those that are member of the ELFAA and that have at least a market share greater than 30% in at least one year and in at least one airport: Ryanair, EasyJet, Flybe (as in Bottasso et al,. 2013) and Jet2.[11] The variable represents the sum of these airlines' market shares in airport *i* in a particular year.
- Airline countervailing power (at airport level); this is measured by the largest airline market share in airport *i* at year *t* (*Countervailing PW_a)*: the airlines market shares are calculated as the ratio between the number of passengers that travel with one airline from airport *i* and the total number of passenger that travel from the same airport *i* (with all airlines), in year *t*. This variable will be used in order to investigate whether an airport is dominated by a single airline.
- Airline countervailing power (at airport catchment area level); this is measured by the largest airline market share in the catchment area of airport *i* at year *t* (*Countervailing PW_ca*): the airlines market shares are calculated as the ratio between the number of passengers that travel with one airline from the catchment area of airport *i* and the total number of passengers that travel from the same catchment area (with all airlines in all its airports), at time *t*.

Route substitutability. This is measured by the variable *Route stb*, a proxy that uses the HHI index of routes defined at the country level (in terms of route destinations): it is defined as the sum of the squared market share of each country *c* served by airport *i* at time *t*:

$$RS_i = \sum_{c=1}^{C} MS_{ci}^2 = \sum_{c=1}^{C} \left(\frac{\#\,fligths\ to\ country\ c\ from\ airport\ i}{\#\,flights\ from\ airport\ i} \right)^2 \qquad (3)$$

[9] If an airport in the catchment area of airport *i* does not serve superoute *r*, we impute a market share of zero.

[10] In doing this, we follow Scotti et al. (2012), which, however, used the number of available seats instead of the number of passengers

[11] ELFAA is the European Low Fare Airline Association; information on its members are available at http://www.elfaa.com/members.htm

where *C* is the number of countries that are served by an airport.
Route stb ranges from 0 to 1, where a value close to 0 means that the airport is serving several countries, while 1 indicates that the airport is serving only one country. The interpretation of such a variable in terms of route substitutability is based on two considerations, one pertaining to the degree of airline' geographical specialization, the other to the decision-making process of potential travellers. First, if several countries are served, then it is more likely that an airline flying to country C may not face competition from another airline, which specializes in countries other than C. That is, each airline enjoys a higher degree of market power, which the airport can extract by charging higher landing fees. However, if only a limited number of countries are connected to a specific airport, the products sold by airlines are more likely to be poorly differentiated, competition is tougher and profit margins (as well as landing fees) lower. Second, as Gaggero and Piga (2012) highlight, a growing proportion of travelers make their purchasing decision relatively close to the departure date; such a decision is often driven by the possibility to visit a new destination, something that is more likely if an airport serves a wider set of destination countries. Because, among the available choice set of final destination, a traveler will choose the one with the lowest fare, we therefore expect that the higher *Route stb*, the lower the landing fees**..**
Table 4 shows that from 1996 to 2008 airports face a decrease in their market power (the *Herfindhal* index is smaller in 2008); in addition, the presence of Low Cost airlines in the analyzed airports is increasing as well as the market share of a single airline. The countervailing power of carriers has been, therefore, increasing over the years. Finally, the route substitutability index is declining over time. Overall, our descriptive evidence seems to indicate that, following the liberalization, airports have had to face an increasingly tougher competitive environment.
Other control variables are also derived from "the UK Airport Industry"statistical series; in particular we calculate the share of commercial revenues (*other revenues*), i.e. revenues not deriving from aeronautical charges, in terms of total revenues, and the operational costs index, in terms of WLU (*unit opex*); in particular, costs are the sum of labour and other operating expenditure items, deflated with the weighted average of the Construction Output Price Index (COPI, as a proxy for the price of materials), a price index for water, gas and electricity (as a proxy for the price of energy used by airports) and the Retail Price Index (RPI, as a proxy for the price of other services paid by airports). In addition, we calculate a measure of *aircraft size* as the ratio of *atm* and total number of passengers.
Finally, we collect data directly from airports accounts in order to calculate the runaways kms of airports located in the same catchment area but not belonging to the same ownership group, also divided by atm (*other airports capacity*).

4. Empirical strategy and results

4.1 Empirical strategy

Our empirical strategy consists of the estimation of various versions of the following equation:

$$lnCh_{it} = \alpha + \beta_1 HHI_{it} + \beta_2 CP_{it} + \beta_3 LC_{it} + \beta_4 RS_{it} + X^{'}\gamma + \lambda_{jt} + \mu_i + \epsilon_{it} \quad (4)$$

where *Ch* is the level of aeronautical charges (*Charges*), *HHI* is the Hirschman-Herfindhal index of concentration in the catchment area of airport *i*, and represents an inverse proxy for the degree of competition in the upstream airport market (*Herfindhal Airp*); *LC* is the passengers share of the largest low cost airline (*Low cos*t); *CP* is the other variable which captures the countervailing power of airlines: it is either represented by the market share of the largest airline in airport *i (Countervailing* PW_a*)* or in its wider catchment area (*Countervailing* PW_{ca}); *RS* is the degree or route substitutability in airport *i (Route stb)* and proxies the degree of downstream competition. Moreover, *X* represents a set of control variables: in particular, in all model specifications we include two ownership dummies (for public and mixed airports, respectively, with private airports being the omitted category), the airport's proportion of international passengers, the fraction of work load units related to passenger traffic and population density in each airport's catchment area.[12]

As far as λ_{jt} is concerned, it represents a set of region by year fixed effects that account for time-varying unobserved heterogeneity in the NUTS2 region *j* where the airports operate. In particular, they may control for local shocks (e.g. regional business cycles), as well as for different degrees of development in the economic and competitive environment they face, due for example to changes in the intensity of intermodal competition, such as the spreading of high speed rail connections. Finally, μ_i is a set of airport fixed effects that capture unobserved time-invariant heterogeneity, potentially correlated with covariates (e.g. the fact that four airports have been subject to price regulation), and ϵ_{it} is an error term.

4.2 Empirical results

Empirical results are shown in Table 5. In columns 1-3 we report fixed effects (FE) results of different specifications of equation (4). In particular, in the first column we measure airlines' countervailing power by means of the market share of the largest airline in airport *i*, while in column 2 the same measure of airline bargaining power is defined at the airport catchment area level. In turn, in column 3 we extend the baseline specification of column 1 by including a measure of route substitutability.

In all specifications, greater airlines countervailing power is negatively correlated to aeronautical charges. In particular, when airlines countervailing power is measured at airport level, one standard deviation increase (which corresponds to moving from the 25^{th} to the 66^{th} percentile of *Countervailing* PW_a) in the largest airline market share is associated to a reduction of about 15% in aeronautical charges. In turn, when countervailing power is measured at the airport catchment area level, such variation leads to a decline in charges of about 8%.

Estimates suggest that the presence of low cost airlines in an airport does not have any statistically significant impact on the level of airport charges.

In column 3 we consider the role played by route substitutability and we find that it tends to be negatively correlated with aeronautical charges, as predicted by Haskel et al (2013): higher route substitutability is probably associated to more intensive downstream competition (between airlines) and lower profits for airlines, which in turn drive down charges. Indeed, when an airport is connected to a lower number of countries, the degree of airlines' product differentiation falls

[12] See Bel and Fageda (2010) and Choo (2014).

and competitive pressure increases. Parameter estimates imply that a one standard deviation increase in *Route stb* entails a fall in aeronautical charges by about 20%.

Interestingly, the effect of upstream concentration, as measured by the *HHI* index of airport market shares, is negative in all specifications, although never statistically significant. However, it has long been recognized in industrial economics that measures of industry concentration in reduced-form regressions are clearly endogenous, and *OLS* might therefore provide biased and inconsistent estimates. For instance, there could be omitted time varying variables at the level of airport catchment area that drive both concentration and aeronautical charges; moreover, there could be feedback effects from changes in concentration in an airport's catchment area to fluctuations in aeronautical tariffs charged by the various airport(s) in that catchment area. Therefore, we re-estimate previous specifications allowing our index of airport concentration to be endogenous.

In particular, for each airport we compute the lag of the ratio between Km of runaways and *atm* of the other airports in the catchment area (*other airports capacity*), which can proxy for the availability of spare capacity of the airport's rivals in its catchment area. We include it in our estimates as an instrument for our index of upstream airport concentration and we assume that higher values of other airports' spare capacity could reduce, other things equal, the incentives to collude for the other airports in that catchment area. By competing more aggressively, airports could expand their average market shares and, if they had low market shares to start with, *HHI* should go down (the variance of the market shares goes down and the index is an increasing function of the variance of the market shares). Therefore, we expect, in the first stage regression, the existence of a negative correlation between the Herfindhal index and *other airports capacity.* Of course, for an instrument to be valid, it needs to correlated with the endogenous variable (i.e. it is important that the model is actually identified and that there is not a weak instrument problem) and uncorrelated with the error term, i.e., in this empirical application it has to influence aeronautical charges indirectly by changing concentration in each airport's catchment area.

Instrumental variables estimates reported in column 4 suggest that the degree of concentration in the upstream airport market has a positive and statistically significant impact on aeronautical charges. The order of magnitude of the related coefficient implies that a one standard deviation reduction in our index of concentration in the upstream airport market (which corresponds to moving from the 50^{th} to the 25^{th} percentile) would be associated to a fall in aeronautical charges of about 45%.

As far as the relevance of the chosen instrument is concerned, first stage results, displayed at the bottom of Table 5, confirm that the chosen instrument has a negative and statistically significant impact on upstream concentration. Moreover, the Kleibergen-Paap rk LM statistics (not shown) rejects the null hypothesis of underidentification at conventional confidence levels, and the Kleibergen-Paap rk Wald *F* statistics does not seem to suggest the existence of major weak instruments problems that might bias *IV* estimates in small samples (Staiger and Stock, 1997).[13]

[13] According to Stock et al (2002), one possible definition of the weak instrument problem is that instruments are weak if the α level Wald test based on IV statistics has an actual size that exceeds a certain threshold, such as 10% or 20%. The tabulated maximum critical values in the case of one endogenous regressor and one instrument, for an actual size of 20% (instead of the nominal 5%) is 6.66, which is very similar to the Kleibergen-Paap rk Wald F statistics of 6.61 as shown in column 4. This suggests that the maximum size distortion in this application is no larger than 15%: we interpret this result as evidence that our IV estimates are probably not affected by serious weak instrument problems.

Moreover, Angrist and Pischke (2009) note that just identified *IV* models, like the one in column 4, are median-unbiased and "therefore unlikely to be subject to a weak instrument critique".

In order to further investigate the robustness of our *IV* results, we report in column 5 estimates of an overidentified regression where we add the rate of growth of GDP in each airport's catchment area as an additional instrument. We estimate this specification with limited information maximum likelihood (*LIML*) which is well known to provide parameter estimates that are less biased than *IV* in small samples. We justify the relevance of this instrument by noting that in booms collusive agreements become less sustainable and concentration might fall if small airports with spare capacity manage to expand their market shares. Empirical results confirm our previous findings; moreover, the Hansen test of overidentifying restrictions leads us not to reject the null hypothesis of instrument validity.

In columns 6-7 we show that *IV* results are robust to the alternative measure of airlines countervailing power (column 6) and to the inclusion of an additional set of control variables (column 7), such as the log of the number of passengers (*Pax*), the log of average aircraft size (*Aircraft_size*), the share of non-aeronautical revenues (*oth_revenue*) and the log of unit operating costs (*Unit_opex*) (Choo, 2014).

It is worth noting that such control variables are likely to suffer from endogeneity problems, which might also generate biased estimates for the other model parameters. Since we do not have serious candidates for instruments, we prefer to avoid the "bad control problem" (Angrist and Piscke, 2009) and we add such controls just in the specification reported in column 7. The inclusion of the above control variables (lagged one year to attenuate endogeneity concerns) does not affect in any way our main results; moreover, we can note that airports with higher unit costs tend to charge higher aeronautical charges, confirming the results in Choo (2014), while the effects of the other regressors are imprecisely estimated.

As far as the other control variables is concerned, the only covariate showing a systematically statistically significant relationship with aeronautical charges is the dummy for public airports which suggests that aeronautical tariffs for publicly owned airports are on average between 30-40% higher than their private counterparts.

As we discussed in section 2, the model by Haskel et al (2013) predicts that the negative impact on aeronautical charges exerted by higher levels of routes substitutability is stronger in the case of a more competitive upstream market. In order to analyze this issue in the specification reported in column 8 we add an interaction term between *HHI* and *Route stb.* We deal with the endogeneity of the two variables including airport concentration (having one single instrument) by following Wooldridge (2010) and we estimate the equation with the Control Function (*CF*) approach that, in small samples, is more likely to provide precise estimates than traditional *IV*.

The control function approach is implemented by first regressing our airport concentration index on the other regressors plus the excluded instrument (*other airports capacity*) and its interaction with route substitutability. The residuals from the first step regression are included in the main equation: the presence of the residual should allow correcting for any possible bias generated by endogeneity issues and the significance of the residuals provides a direct test of endogeneity.[14]

Estimates suggest that the impact of a variation in route substitutability affects aeronautical charges only when the upstream airport market is sufficiently competitive, i.e. for levels of the

[14] However, because the residuals variable is a generated regressor, conventional standard errors are invalid and therefore we have reported bootstrapped standard errors (column 8).

Herfindhal index below the sample median. A one standard deviation increase in route substitutability reduces aeronautical charges by about 40% when concentration in the airport market is around the 25th percentile (i.e. a value of 0.55), while the impact amounts to a 20% reduction when it is at the sample median (0.72) and becomes not statistically significant for higher levels of concentration.

In turn, stronger competition in the airport market drives down charges particularly if route substitutability is high. Indeed, when the level of route substitutability is below the sample median (i.e. the products offered by airlines are very differentiated), a reduction in upstream concentration has a negative but not statistically significant impact on charges. However, a one standard deviation fall in *HHI* reduces charges by about 30% when route substitutability is at the sample median and by about 45% when it is at the 75th percentile.

We believe it is worth to discuss our main results by comparing them with those reported by the few papers existing in the literature. As far as the role played by competition among airports is concerned, all previous studies proxy the degree of competitive pressure in the airport market with the number of airports located within 100 km around the airport and are unable to find robust effects on aeronautical charges (Bel and Fageda, 2010; Bilotkach et al, 2012; Choo, 2014; Van Dender, 2007). Indeed, Van Dender (2007) does find a significant negative effect but without controlling for airports fixed effects, while Bel and Fageda (2010) report a negative effect, but only after excluding from the sample airports located on islands or that adhere to a price-fixing system. All these studies do not check and possibly correct for the endogeneity problem. When we do so, our analysis suggest a rather strong negative relationship between the competitive pressure faced by an airport and its aeronautical charges. Our different result may also be due to the more refined way we adopt to measure market concentration, which explicitly takes into account the degree of overlap between the routes served by nearby airports.

Previous evidence on the effect of airlines' countervailing power, as measured with the HHI of concentration of airlines flying from the same airport, is mixed. Van Dender (2007) finds that higher concentration among airlines is positively correlated with charges, although the result is not robust to the inclusion of airports fixed effects, while Bel and Fageda (2010) suggest that higher airlines' countervailing power is associated with lower aeronautical charges, although only for a sub sample of airports. Moreover, Choo (2014) does not find any significant effect. On the contrary, our results indicate a large impact of countervailing power, which is robust to different ways to measure it and to different estimation methods.

Finally, to the best of our knowledge, our study is the first applied work that takes into account the role of route substitutability in aeronautical charges determination in accordance to the theoretical model proposed by Haskel et al (2013).

5. Conclusions

The main aim of this paper is to provide an empirical evaluation of the determinants of airport charges in the UK airport sector over the period 1996-2008. In particular, we have focused our analysis on the role that the vertical and horizontal structures of the sector have on airports' charging behavior by jointly considering the impact of the degree of competition within the airport sector (proxied by the Hirschmann-Herfindhal index of concentration in each airport's catchment area), the countervailing power of airlines (proxied by the marker share of the largest airline in each airport or in its catchment area) as well as the degree of competition in the downstream airlines market (proxied by the degree of route substitutability in each airport).

Our results are in line with the predictions of the theoretical model by Haskel et al (2013): indeed, we find that stronger airlines' countervailing power and more intense competition in each airport catchment area significantly reduce airport charges. Moreover, higher levels of route substitutability in each airport tends to be associated to lower aeronautical charges especially when the upstream airport market is sufficiently competitive. In turn, the negative effect on charges associated to lower concentration in the airport market is stronger in the case of airports characterized by higher degrees of route substitutability (higher downstream competition): these results suggest a sort of complementarity between competition in the airport (upstream) and airlines (downstream) markets.

These findings can have important policy implications. First, airport markets with high levels of concentration are in general associated to higher aeronautical charges: this lends some support to those who argue that joint ownership of airports with overlapping catchment areas, as in the case of the metropolitan areas of New York, Paris, Rome or Milan, among the others, should be discouraged, ceteris paribus. Second, airlines countervailing power might indeed be a powerful restraint on airports pricing power and, as a result, it should be taken into consideration by regulators and antitrust authorities in competition investigations. Nevertheless, it should also be remembered, as noted by Haskel et al. (2013), that the lower aeronautical charges associated to stronger airlines countervailing power might not be transferred to consumers, who may not necessarily benefit from the airlines' strong bargaining power towards airports. The investigation of such issues is left for future research.

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Appendix

Table 1. Ownership pattern

Airport	Ownership
Heathrow	Private
Gatwick	Private
Stanstead	Private
Southend	Private
Southampton	Private
Glasgow	Private
Edinburgh	Private
Aberdeen	Private
Manchester	Public
Bournemouth	Private (1996-2000); Public (2001-2008)
Humberside	Public
Nottingham-East Midlands	Private (1996-2000); Public (2001-2008)
Birmingham	Public (1996); Mix (1997-2008)
Newcastle	Public (1996-2000); Mix (2001-2008)
Cardiff	Private
Luton	Public (1996-1997); Private (1998-1999); Mix (1997-2008)
Blackpool	Public (1996-2003); Mix (2004-2008)
Bristol	Public (1996-1997); Mix (1998-2000); Private (2001-2008)
Durham	Public (1996-2002); Private (2003-2008)
Exeter	Public (1996-2007); Private (2008)
Leeds-Bradford	Public
Liverpool	Private
London City	Private
Norwich	Public (1996-2003); Mix (2004-2008)

Table 2. Summary statistics

Variable	Obs	Mean	Std. Dev	Min	Max
Population density	312	361.247	202.167	52.07	774.157
Gdp	288	1.031	0.021	0.969	1.086
Low Cost	312	0.261	0.279	0	0.945
Countervailing PW_a	312	0.387	0.172	0.125	0.910
Countervailing PW_{ca}	312	0.238	0.113	0	0.675
Herfindhal	312	0.717	0.174	0.389	1
Route stb	312	0.287	0.183	0.054	0.890
WLU (,000)	311	8,812	16,500	4	83,000
Atm (,000)	311	80.137	99.797	1.528	475.700
Charges	310	0.569	0.606	0.072	10.045
Pax per WLU (%)	311	0.916	0.122	0.205	1
International pax (%) (%)	311	0.401	0.243	0	0.967
Other airports capacity	312	0.459	0.478	0	2.591
Pax	312	7829420	14000000	3457	69500000
Other revenue	309	0.48	0.132	0	0.91
Unit opex	311	0.0287	0.095	0.0024	0.9241
Aircraft size	3.11	0.0385	0.0965	0.0068	0.7667

NOTE- Table A-2 uses data from "The UK Airport Industry", the CAA dataset and from the Office for National Statistics, for 24 airports over the period 1996-2008.

Table 3. Summary statistics

Year	Population density	Gdp	Atm (,000)	Charges (by *atm*)	Pax per wlu (%)	International pax (%)	Other airports capacity
1996	349.881	-	68.812	0.518	0.892	0.290	0.452
1997	351.186	1.063	66.875	0.511	0.902	0.302	0.447
1998	352.522	1.041	70.589	0.517	0.903	0.312	0.432
1999	354.453	1.034	73.626	0.531	0.906	0.326	0.399
2000	356.153	1.041	76.528	0.557	0.895	0.334	0.473
2001	358.019	1.033	76.753	0.585	0.892	0.329	0.693
2002	360.530	1.028	78.244	0.560	0.904	0.356	0.619
2003	362.221	1.035	81.969	0.552	0.924	0.400	0.518
2004	364.150	1.030	83.525	0.589	0.935	0.418	0.551
2005	367.210	1.018	89.285	0.555	0.940	0.470	0.448
2006	369.954	1.025	94.305	0.487	0.933	0.531	0.308
2007	373.241	1.035	93.606	0.467	0.932	0.560	0.286
2008	376.692	0.986	87.993	0.984	0.950	0.585	0.344

NOTE- Table A-3 uses data from “The UK Airport Industry”, the CAA dataset and from the Office for National Statistics, for 24 airports over the period 1996-2008.

Table 4. Summary statistics-Competition indexes

year	Low Cost	Countervailing PW_a	Countervailing PW_{ca}	Herfindhal	Route Stb
1996	0.105	0.382	0.277	0.744	0.325
1997	0.123	0.379	0.282	0.736	0.319
1998	0.144	0.366	0.273	0.735	0.312
1999	0.163	0.360	0.263	0.719	0.303
2000	0.166	0.365	0.255	0.721	0.284
2001	0.167	0.358	0.259	0.726	0.275
2002	0.224	0.360	0.249	0.733	0.282
2003	0.338	0.403	0.231	0.720	0.291
2004	0.368	0.420	0.216	0.712	0.284
2005	0.383	0.398	0.204	0.696	0.268
2006	0.374	0.407	0.196	0.698	0.269
2007	0.401	0.412	0.196	0.692	0.261
2008	0.432	0.422	0.199	0.689	0.262

NOTE- Table A-3 uses data from “The UK Airport Industry”, the CAA dataset and from the Office for National Statistics, for 24 airports over the period 1996-2008.

Table 5. Empirical Results

Dep var. Ch (ln)	FE	FE	FE	FE-IV	FE-LIML	FE-IV	FE-IV	FE-CF
	1	2	3	4	5	6	7	8
Herfindal	-0.187	-0.214	-0.233	2.778	2.746	2.863	2.899	0.106
	(0.503)	(0.434)	(0.465)	(1.605)*	(1.412)*	(1.407)**	(1.694)*	(1.351)
Countervailing PW_a	-0.999	.	-0.845	-0.986	-0.985	.	-0.953	-0.791
	(0.529)*		(0.379)**	(0.467)**	(o.464)**		(0.437)**	(0.476)*
Countervailing PW_{ca}	.	-0.680	.	.	.	-1.283	.	.
		(0.289)**				(0.588)**		
Low Cost	0.257	-0.187	0.210	0.461	0.459	0.044	0.683	0.527
	(0.267)	(0.242)	(0.236)	(0.306)	(0.294)	(0.215)	(0.322)**	(0.400)
Route Stb	.	.	-1.161	-1.036	-1.036	-1.370	-0.791	-6.09
			(0.500)**	(0.361)***	(0.359)***	(0.379)***	(0.384)**	(3.213)*
Pub	0.313	0.282	0.332	0.319	0.319	0.306	0.354	0.317
	(0.104)***	(0.085)***	(0.101)***	(0.129)**	(0.129)**	(0.104)***	(0.087)***	(0.188)*
Mix	0.225	0.217	0.248	0.110	0.111	0.088	0.162	0.123
	(0.122)*	(0.112)*	(0.115)**	(0.135)	(0.0128)	(0.117)	(0.094)*	(0.171)
International Pax	0.230	-0.124	0.138	0.260	0.257	-0.013	0.402	0.104
	(0.451)	(0.434)	(0.311)	(0.513)	(0.498)	(0.423)	(0.484)	(0.398)
Pax per wlu	-0.145	-0.062	-0.086	-0.374	-0.368	-0.359	-0.711	-0.383
	(0.302)	(0.315)	(0.194)	(0.379)	(0.344)	(0.337)	(0.468)	(0.471)
Population density	0.006	0.008	0.008	0.008	0.008	0.008	0.008	0.006
	(0.005)	(0.005)*	(0.005)*	(0.006)	(0.006)	(0.006)	(0.006)	(0.011)
Pax (ln)	.	.	.	.	.	.	0.210	.
							(0.141)	
Other revenue	.	.	.	.	.	.	-0.495	.
							(0.570)	
Unit opex (ln)	.	.	.	.	.	.	0.489	.
							(0.139)***	
Aircraft size (ln)	.	.	.	.	.	.	0.037	.
							(0.188)	
Herfindal x Route Stb	.	.	.	.	.	.	.	6.802
								(3.704)*
First step resid	.	.	.	.	.	.	.	-3.909
								(1.971)**
Other airports capacity				-0.056	-0.057	-0.056	-0.048	
				(0.0217)**	(0.021)**	(0.0216)**	(0.0163)***	
GDP growth				.	-0.414	.	.	
					(0.205)*			
KP rk Wald				6.61	5.56	6.80	8.87	
Hansen					0.94			
Observations	310	310	310	286	286	286	284	286

* *p*<0.1; ** *p*<0.05; *** *p*<0.01. KP rk is the Kleibergen-Paap rk Wald statistics; Hansen is the p value of the Hansen test for over identification restrictions. Clustered (at airport level) robust S.E. in parenthesis. Bootstrapped S.E. in column 8. All regressions include a set of airport fixed effects and a full set of region-by-year fixed effects.