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Carlos F. Alves
Cristina Barbot

CEF.UP, Faculdade de Economia, Universidade do Porto

U.PORTO
FEP FACULDADE DE ECONOMIA UNIVERSIDADE DO PORTO

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Carlos F. Alves

CEF.UP[•], Faculdade de Economia, Universidade do Porto

Email: calves@fep.up.pt

Address: Rua Dr. Roberto Frias 4200-464 Porto PORTUGAL

Phone number: +351225571219

Fax number: +351225505050

Cristina Barbot

CEF.UP[•], Faculdade de Economia, Universidade do Porto

Email: cbarbot@fep.up.pt

Address: Rua Dr. Roberto Frias 4200-464 Porto PORTUGAL

Phone number: +351225571218

Fax number: +351225505050

ABSTRACT

Using a theoretical model, we examine both the relationship between a downstream dominant firm's market share and an upstream monopoly's Lerner index and the relationship between upstream and downstream price elasticities of demand, in a regulated industry context. We undertake an empirical study that confirms our theoretical predictions, namely that the market share of a leader downstream firm is significant in explaining the upstream producers' Lerner indexes. Also in accordance with the results of the theoretical model, the Lerner index is negatively influenced by the competition that suppliers face and by the level of economies of density, amongst other variables.

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1. Introduction

A basic result of classical economics theory is that a monopolist's Lerner index equals the inverse of the price elasticity of demand. This means that the higher the consumers' reaction to changes in prices, the less the market power of the monopolist. This also means that the consumers, who, in a free market context are individually price-takers are the only limit that monopolists face to increase prices above their marginal costs. This result is valid under the conditions of a monopoly selling to a large number of consumers, and attempts to measure the monopolist's degree of market power.[1]

But pure monopoly situations where the players are a single producer and numerous price-taker consumers are scarce in the real world. Indeed, real market situations are more complex than the simple case for which the Lerner index is computed. Let us consider, for example, the case of network industries. With the privatization and liberalization of many network industries, a few firms entered the market, as happened in telecommunications, energy and transport operations, while the main network remains as a natural monopoly.Also, networks or main infrastructure suppliers sometimes have new competitors, as in the case of mobile telecommunications, ports and airports. These new firms cannot be considered as price takers. Rather, they face imperfect competition.

In particular, airports are often monopolies or oligopolies that sell their facilities to airlines which compete amongst themselves as oligopolists. Thus, the downstream airlines may have the capacity to limit the upstream airports' monopoly (or oligopoly) power and profits.

Literature on the influence of the buyers' market power on the upstream market power (measured by the Lerner index) is scarce and presents several limitations. The purpose of this paper is to go some way in filling this gap, both theoretically and empirically. We develop new theoretical relations between a downstream dominant firm's market share and an upstream monopoly's Lerner index and also between upstream and downstream price elasticities of demand.

Our empirical study is based on a sample of 106 large airports all over the world. As we deal with airport prices, it should be noted that these prices are usually regulated. The same applies to other industries, such as telecommunications or energy networks where the access price is regulated. These cases are similar because in fact airport charges are access prices, or prices

[1] Theoretical literature also adds a version of the Lerner index for a Cournot oligopoly, equal to the ratio of the firm's market share to the price elasticity of demand.

that other firms (airlines) pay to use the infrastructure. If regulation strictly followed theoretical findings, there would either be zero profits and positive Lerner indexes if the upstream firm is a natural monopoly, or positive profits and Lerner indexes equal to zero, if it is a non-natural monopolist.

However, our data reveals positive Lerner indexes and positive profits for 97 and 99 per cent of the airports, respectively. This means that there is a positive price cost margin, along with positive profits, even for regulated firms. We develop arguments to explain why this happens for regulated firms. One of these explanations is the “capture” of the regulator by the regulated firm. Our results support the idea that the higher the market share of the downstream buyer, the lesser the degree of “capture” of the regulator by the regulated airport.

Our empirical study finds that the market share of a leader downstream firm is significant in explaining the upstream producers’ Lerner indexes. In particular, an increase in that market share of 10 points decreases the absolute value of the Lerner index by 2.3 basis points, which means a decrease in the Lerner index above 2.3% if we take into consideration its theoretical maximum value (1.0) and a decrease of 5.5% if we take as reference a Lerner index equal to the median of our sample (0.41).

As expected, and given the results of the theoretical model, our empirical study also reveals that the Lerner index is negatively influenced by the competition that suppliers face, the proportion of aeronautical revenues and the number of passengers per square meter of terminal area (which tests economies of density). The Lerner index is lower in European airports and when the dominant airline is a low cost carrier. On the other hand, the variable used to test the impact of airports’ economies of scale in the long run (number of passengers) has a positive but insignificant effect on the index Lerner of the airports. Our estimates are consistent according the endogeneity test of Hausman.

The paper is structured as follows. Section 2 provides a theoretical background for our main hypothesis. Section 3 presents the empirical study. The main conclusions are summarized in Section 4.

2. Theoretical background

A small number of papers had shown evidence of a negative relationship between the buyers’ concentration ratio (BCR) and the upstream gross price cost margin (Lustgarten, 1975; McGuckin and Chen, 1976; LaFrance, 1979). Feinberg (1980), in a test for 295 industries in the United States, uses the ratio of upstream concentration coefficient for the first largest firms (CR4) to BRC, and correlates this ratio with the Lerner index, obtaining a positive correlation coefficient of 0.22. Moreover, this author finds a value of -0.28 for the correlation coefficient between the Lerner index and BCR.

Other tests on the relation between the Lerner index and the industry structure have been performed for the banking industry. Maudos and Solis (2010) find values for the Lerner Index and the Panzar and Rosse's H-Statistic that support the hypothesis of monopolistic competition in the Mexican banking industry. But the buyers' market concentration is absent from their study. Moreover, the banking industry is a rather free market and not regulated (in the Industrial Organization context).

Hervani (2005) measures the oligopsony market power for the old newspapers market in the United States and finds evidence of the existence of oligopsony elements in this industry. The author also finds a negative correlation between the oligopoly/oligopsony index and of its impact on upstream prices, which were found to be positive or negative, depending on the period and on the region.

Ellison and Snyder (2010), using data for antibiotics in the United States, conclude that large buyers may obtain discounts from sellers using their countervailing power. But this power can only be exerted when there is competition amongst sellers.

Our study clearly separates the upstream and the downstream market concentration by using different variables which prove to be significant and have the expected sign. Moreover, by separating variables, and not using a combined oligopoly/oligopsony index, we obtain the size of the impact of each market structure.

Also, our model specification is built on the assumption of a dominant firm in the downstream market (a Stackelberg leader), and measures the buyer's market power of this firm, disregarding concentration coefficients that have proved to be not comparable across industries and, generally, across observations[2]. Thus, neither CR4 nor the oligopoly/oligopsony ratio (which are based on concentration ratios) are adequate to measure downstream market power, and the share of the dominant firm is a better proxy for this purpose.

[2] It is a standard result of industrial Organization literature that industries may have an identical CR4 and a very different concentration pattern.

Several other empirical studies[3] supported evidence for two hypotheses concerning the limitation on sellers' market power imposed from the buyers' side, in a cross section analysis of industries: (i) upstream profit rates are negatively correlated with downstream concentration, and (ii) this effect is more relevant when the upstream industry has a high concentration ratio.

Our case falls into both of the above-mentioned hypotheses. The second one fits our empirical study, as airports often none or few competitors. The same is true for networks supplying access to firms that provide operations (telecommunications, energy, railways). Therefore, we are dealing with industries where the concentration is high on the sellers' side, but can also be high downstream.

Our paper also deals with upstream industries that are regulated or publicly-owned. Newmark (1988) finds evidence that the negative relation between price-cost margins and buyers' concentration (measured by the concentration ration for the first four firms) is no longer valid for firms under government control or regulation. However, there is an important specificity in Newarks' study. The author considers the proportion of sales under administrative control as the proxy for government control or regulation. This procedure seems adequate for the author's example (defense industries), or even for some agricultural products, but it is certainly not the case of networks, ports and airports. Rather, in these industries, sales are not administratively controlled, but prices (or other variables) are defined by regulators.

Our paper differs from Ellison and Snyder's (2010) in that we do not analyse price discrimination but downstream market power in a context of upstream regulated industries. Moreover, we do not find that competition amongst sellers is a necessary condition for downstream market power limits to sellers' profits.

In brief, our paper adds to the previous literature as it develops an empirical study with variables that separate the effects of upstream and downstream market power and are, in our view, better proxies for the upstream and downstream market power and allows for a dominant downstream firm. Moreover, our paper provides theoretical justifications of the main and control variables we use, which are important features that are not present in other studies, which are built on a rather *ad hoc* basis.

In the following section we provide a description of the markets we consider in our study and show some results that provide the theoretical support of our empirical analysis.

[3] See Ellison and Snyder (2010) for references.

(i) The Model Architecture

In our model we consider two markets that are vertically related. In the downstream market, a small number of firms operate, buying some input from the upstream supplier, at price P. A natural monopoly operates in the upstream market. In the downstream market there are $n+1$ firms playing a Stackelberg game. For simplicity we assume that all the $n+1$ firms have a constant and identical marginal cost which is the price, P, they pay the upstream monopoly for the input. Also, for the sake of simplicity, we suppose that the production function is $q_i=X_i$ ($i=1,2,\ldots,n+1$),where X denotes the input quantity. A standard result of the equal marginal costs assumption is that all the followers will produce the same quantity q_j ($j=1,2,\ldots,n$) while the leader will produce q_D, $q_D>q_j$.

The input X is produced by a regulated natural monopoly. A well known result in literature is that the price the regulator imposes on this firm is superior to marginal cost, allowing for a positive Lerner index. Let the monopoly have a cost function with the form $c(q) = cq+F$, where c is its constant marginal cost and F is its fixed cost and q the total amount of the input bought by the downstream firms.

In the downstream market, for any follower, for instance, for firm i, profits are represented by $\pi_i = p(q_D + q_i + (n-1)q_j))q_i - Pq_i$. In the third stage of the game, the followers maximise their profits, and, as they produce the same quantity, any of the followers' best reply function has the expression: $q_i = q_i(q_D)$.

In the second stage, the leader maximizes its profits, $\pi_D(q_D + nq_i(q_D), P)$. Solving the leader's first order condition, we get the derived demand of the upstream firm $q(P)$. The upstream monopoly is regulated with a price cap, P, $P< P_m$, where P_m stands for the profit maximising price. In the first stage, the regulator announces the value of P, and the total quantity, q, is subsequently determined.

(ii) The impact of downstream leader's market share

Within these conditions we may state the following proposition:

Proposition 1: The upstream firm's profit depends negatively on the downstream leader's market share.

Proof: The leader's first order condition is:

$$\left(\frac{\partial p}{\partial q_D} + n\frac{\partial p}{\partial q_i}\frac{\partial q_i}{\partial q_D}\right)q_D + p\big(q_D + nq_i(q_D)\big) - P = 0 \quad (1)$$

Let s_D be the leader's market share. Considering that $\frac{\partial p}{\partial q_D} = \frac{\partial p}{\partial q_i} = \frac{\partial p}{\partial q}$,

equation *(1)* may be changed into:

$$s_D = \frac{p(q) - P}{p(q)} \frac{e}{(1 + n\frac{\partial q_i}{\partial q_D})}$$

where *e* stands for the absolute value of the price elasticity of demand, and $s_D = s_D\ (P)$.

Then:

$$\frac{\partial s_D}{\partial P} = -\frac{e}{p(1+n\frac{\partial q_i}{\partial q_D})}$$

From the leader's best reply function:

$$\frac{\partial p}{\partial q_D}\left(1 + n\frac{\partial p}{\partial q_i}\right) q_D = P - p$$

So that P-p is negative, as $\frac{\partial p}{\partial q_D} < 0$, it must happen that $0 < n\frac{\partial q_i}{\partial q_D}$<-1.

As, in absolute values, $n\frac{\partial q_i}{\partial q_D}$<1, $\frac{\partial s_D}{\partial P} < 0$. Also, we may consider $P(s_D)$, the inverse function of $s_D\ (P)$, with $\frac{\partial P}{\partial s_D} < 0$.

The airport's profit is $\pi_A = (P-c)(q_D+nq_i(q_D))-F$, where F is a fixed cost. As $P<P_m$, $\frac{\partial \pi A}{\partial P} > 0$.

Let $\pi_A = \pi_A(P(s_D))$. Then, $\frac{\partial \pi A}{\partial s_D} = \frac{\partial \pi A}{\partial P}\frac{\partial P}{\partial s_D}$<0.

Therefore the downstream market power negatively influences the upstream firm's profits. Also, the price cost margin, $\frac{P-c}{P}$, depends positively on P, and, as $\frac{\partial P}{\partial s_D} < 0$, ,negatively on s_D.

<u>(iii) Other Results</u>

In order to give some theoretical support to the control variables used in our empirical study and to their expected signs, we now establish other theoretical results. Propositions 2 and 3 refer to conditions for variables used as proxies for quantities and for the price elasticity of demand. Other variables, like the upstream market structure and the origin of revenues, need less explanation, as either they are commonly accepted by literature or they have been shown elsewhere as related to the Lerner index, or to some variables on which this index depends.

There is some empirical literature that suggests that profits and productivity may depend on the firm's size. Vasigh and Hamzaee (1998) have found a positive and significant correlation between airports' operating revenues and size. Oum et al. (2003) found that the productivity of airports is positively correlated with size, thus suggesting the existence of economies of scale, and negatively correlated with the percentage of international traffic and with the share of aeronautical revenues. Oum et al. (2004) confirm the same relationship both for capital productivity and total factor productivity. But neither productivity nor operating revenues reflect real market power.

We need to show that the quantity a firm produces negatively influences the Lerner index. We do that in the context of a natural monopoly.

Proposition 2: For a regulated natural monopoly, in the short run the Lerner index decreases with the quantity.

Proof: Let $\pi_A = (P-c)(q(P))-F$. The regulator maximizes the monopoly's profit, subject to the constraint $\pi_A = 0$. The lagrangean is:

$\mathcal{L} = CS + (P-c)q(P)-F+\lambda((P-c)q(P)-F)$ where CS is the consumer surplus, and $\frac{\partial CS}{\partial P} = -q$.

One of the first order conditions, $\frac{\partial \mathcal{L}}{\partial P} = 0$, may be written as $L = \frac{1+\lambda}{e}$, where L is the Lerner index, $L = \frac{P-c}{P}$, e is the price elasticity of demand and λ the Lagrange multiplier. The other first order condition is $\frac{\partial \mathcal{L}}{\partial \lambda} = 0$, or $P - c = \frac{F}{q}$. As L increases with P-c, it also increases with $\frac{F}{q}$ and decreases with q.

Notice that this conclusion is valid for a fixed amount of capital. As airports seldom change their capacity, it seems more appropriate to analyze these economies of density than long run effects.

An inverse measure of $\frac{F}{q}$ may be any variable that assesses the ratio of the number of passengers by any measure of capacity and the Lerner index should depend negatively on this variable.

The Lerner index also depends on the price elasticity of demand and on the firm's market share. The higher this market share is, the higher the Lerner index will be[4]. It is sometimes

[4] In an oligopoly, with n identical firms, the Lerner index of any firm is equal to the ratio of the firms share to the price elasticity of demand. This is a well-known result.

difficult to compute the price elasticity of demand. In the case of our empirical study, there are no estimates for the price elasticities of airports, but only for the price elasticities of airlines. However we can find the relationship between the price elasticities of demand of an upstream and a downstream firm. For the sake of simplicity, we suppose there is only one firm in any of two vertically related markets.

Suppose the downstream firm charges consumers the price *p*, and sells the quantity *q*, with a downward sloping demand *p(q)*, and has a constant marginal cost, *c*. Additionally, it pays a price *P* to an upstream firm, for every unit of the input, *X*. Assume also that the production function is such that one unit of output uses one unit of the input *X*. Under these assumptions, we may establish the following proposition.

Proposition 3: When the downstream demand is linear or concave, the upstream firm's Lerner index depends negatively on the downstream firm's price elasticity.

Proof: Let *E* and *e* be, respectively, the upstream's and the downstream's price elasticity of demand.

The downstream firm's profits are $\pi_d = p(q)q-(P+c)q$. The inverse of its demand elasticity may be written as $\frac{1}{e} = \frac{p'(q)q}{p(q)}$ and, as the downstream firm is a monopolist, $\frac{1}{e} = \frac{p(q)-c}{p(q)}$. The first order condition of profit maximization is: $p'(q)q+p(q)-(c+P)=0$, which yields the upstream firm's derived demand: $P = p'(q)q+p(q)-c$.

The upstream firm's inverse demand elasticity is $\frac{1}{E} = \frac{dP}{dq}\frac{q}{P} = \frac{p''(q)q+2p'(q)q}{p'(q)q+p(q)-c}$. Then, and dividing by *p(q)*: $E = \frac{\frac{p'(q)q}{p(q)}+\frac{p(q)-c}{p(q)}}{\frac{p''(q)q+2p'(q)q}{p(q)}}$ and $E = \frac{\frac{2}{e}}{\frac{p''(q)q^2}{p(q)}+\frac{2}{e}} = \frac{2}{2+\frac{p''(q)q^2}{p(q)}e}$. Let $A = \frac{p''(q)q^2}{p(q)}$. The derivative of *E* with respect to *e*, $\frac{\partial E}{\partial e} = -2\frac{A}{(Ae+2)^2}$ has the sign of -*A*. then:

1) If $p''(q)<0$, or if the demand function is strictly concave, *E* grows with *e*, and *E>e*.
2) If the demand function is linear, *E=e*.
3) If the demand function is strictly convex, *E<e*, and *E* decreases with *e*.

Thus, in the first two cases, the upstream firm's Lerner index depends negatively on the downstream firm's price elasticity.

It is not possible to find a measure of airlines' price elasticity of demand for every observation in our data. Literature on air transport has found that price elasticity of demand is higher for business than for leisure passengers[5]. But data on these two types of passengers is not available either. Based on surveys of air travel elasticity studies for several countries, Gillen et al. (2003) find that long-haul international passengers, both “business” and “leisure”, have a lower elasticity than the short-haul and domestic passengers of both demand segments. IATA (2008) also reports that, according to a review of research, long-haul international demand has a lower elasticity. This is confirmed by either route level, national level and supranational level studies. According to the above references, it seems appropriate to consider the percentage of international passengers as a proxy for elasticity.

The variables on which the Lerner index may depend, and for which we find appropriate proxies in the next section (the downstream leader’s market share, the upstream firm market share, the price elasticity of demand, and the quantity) are valid for any industry. We will now refer to three control variables that are specific to the case of airports.

The first one is related to the origin of the airports’ revenues. Zhang and Zhang (1997) found that when marginal cost pricing is imposed on concession revenues social welfare is lower. Thus (and considering a dual till regime) a higher share of concession revenues (or lower share of aeronautical revenues) should have a positive effect on the Lerner index.

The second one is related to the fact that literature has shown that low cost carriers (LCCs) often dominate secondary airports (some of which are in our data base), and try to negotiate in order to obtain lower aeronautical fares. This also applies to other airports where LCCs have large market shares[6]. Thus, airports dominated by a LCC should have lower Lerner indexes.

The third one is ownership. It is expected that airports that are publicly-owned have lower Lerner indexes.

3. Empirical study

3.1. Dataset and regulation

Our data was collected from ATRS (2009) and is for 2007, for all observations. Additionally, we use IATA (2010), an airport locator which yields the distance between two airports. According to IATA’s geographical classification, 26% of the airports in the sample are located in Asia & Pacific, 44% in the United States and Canada and 30% in Europe.

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[5] For a complete study on business and leisure travelers’ elasticities, see Oum et al. (1992).
[6] See Barbot (2006).

Airports (like other upstream firms) are often regulated and it is therefore important to justify the use of the Lerner index in a sample of regulated firms. If regulation in practice might strictly follow theoretical findings, either there would be zero profits and positive Lerner indexes, if the upstream firm is a natural monopolist, or positive profits but Lerner indexes equal to zero, if it is a non-natural monopolist. If the regulator strictly behaves as stated by theory, for each firm either the Lerner indexes or the profits should be zero. However, our data shows the existence of positive Lerner indexes (in 97 per cent of the observations) and of positive profits (in 99 per cent of the observations)[7]. There are some reasons which explain why regulation in practice can lead to this empirical evidence. These arguments that can be grouped in three types:

(i) The regulator's aims: If theory dictates that prices should equal average and marginal cost, for natural and non-natural monopolies respectively, in practice the aim may not be achieved by the regulator, for several reasons.

Firstly, it is difficult to know if a firm is a natural monopoly. Sometimes they are taken as such on common sense beliefs, such as that all networks or all large firms are natural monopolies. The detection of natural monopolies needs to be based on solid analysis of cost functions, which are sometimes difficult to build. Thus the regulator may be using a simple Ramsey price for a non-natural monopoly, as she supposes (but is not sure) that she is dealing with this kind of monopoly.

Secondly, some of these large upstream firms are not exactly regulated, as they are publicly owned and governments establish a reasonable price, but not effective regulation. In these cases the process of regulation is not well defined. As an example, in our sample, 65 per cent of the airports are wholly owned by public entities.

Thirdly, regulators may be myopic and ignore a good number of competitive conditions within which the firm operates and which influence their prices. Parallel or downstream competition, or even competition from other markets of imperfect substitutes or of complements, is often ignored by regulators. It has been shown that the Ramsey rule changes when there is competition even from different firms operating in different markets (Prieger, 1995).

[7] There should be more positive Lerner indexes than net profits. The discrepancy is due to the difference in the number of observations for each variable.

(ii) Regulation process: To the well known argument of information asymmetry between the regulator and the regulated firm, which is present in the COS (cost of service) regulation, but also in price capping, and which leads to higher price cost margins, we add a few issues that can lead to positive price cost margins and profits.

The process of regulation is unclear when it comes to the initial price. As De Fraja and Iozzi (2000) point out, the determination of price that should be set in the first regulation period, has received little, if any, attention from literature, which has concentrated more in the adjustment mechanism of capped prices. This is not surprising as it is difficult to know marginal costs. In general, it is the initial price that is used, and that is subject to a posterior adjustment mechanism. In practice, price may not be equal or even close to marginal cost.

Regulation is a process that takes time and includes the consultation of stakeholders. Some of the stakeholders have market power, like dominant airlines in regulated airports or telephone operators that buy access to networks. The more market power these stakeholders have, the stronger their lobby to lower the regulated price.

(iii) Post regulation choice: After a price cap has been set, the regulated firm may set a price that is nearer or further from the cap, depending on some factors, such as competition and downstream market power[8], among others[9].

3.2 Regression Analysis

We tested the two following equations:[10]

$$L = C+\beta_1 CR1+\beta_2 PAX+\beta_3 WAR+\beta_4 INT+\beta_5 PTER+\beta_6 LCC+ \beta_7 OWN+\beta_8 EUR+\mu \quad [1]$$

and

$$L = C+\beta_1 CR1^2+\beta_2 PAX+\beta_3 WAR+\beta_4 INT+\beta_5 PTER+\beta_6 LCC+ \beta_7 OWN+\beta_8 EUR+\mu \ [2]$$

The second specification intends to investigate if the influence of the downstream leader's market share is better captured in a non-linear form, by using the square of the dominant airline's share (CR1). Our point is that Lerner indexes may decrease more when the dominant airline has larger markets shares.

[8] As an example, Competition Commission (2008) states that in the years before 2007/2008, BAA priced to the maximum allowed at Heathrow and Gatwick, but below the maximum at Stansted.

[9] Other factors are related to our control variables and are explained in the next section.

[10] However, as explained in the text other variants were regressed. Results of one of them are also reported in Table 1. Others are not reported to save space. However results are available upon request.

As dependent variable we used the Lerner index (L), computed as the ratio of the price minus marginal cost to the price.[11] For the price, we used the aeronautical revenues per passenger, and for marginal cost we used variable costs per passenger. As independent variables we used the following (the rationales and expected signs of which are based on the theoretical model):

CR1: the share of the dominant airline (which, in our sample, ranges between 0.115 and 0.855, with a median of 0,375). The expected sign is negative;

CONC: a dummy that takes the value of "1" if there is another airport less than a hundred kilometers from a certain airport, and "0" otherwise. It intends to capture competition in the upstream market and its expected sign is negative (more competition decreases the Lerner index);

PAX: number of passengers (in millions). This variable is used to test the impact of economies of scale in the long run. According to our theoretical model, the expected sign is negative.

WAR: the proportion of aeronautical revenues. The expected sign is negative;

INT: The share of international passengers. This variable is a proxy for the airlines' price elasticity of demand. The expected sign is positive;

PTER: number of passengers per square meter of terminal area. This variable tests the existence of economies of density. The expected sign is negative;

LCC: a dummy that assumes the value of "1" if the dominant airline is a LCC, and of "0" otherwise. The expected sign is negative;

OWN: a dummy that takes the value of "1" if the majority of the airport's capital is state-owned, LCC, and of "0" otherwise. The expected sign is negative;

EUR: a dummy that is equal to "1" if the airport is located in Europe and "0" otherwise.

The results confirm that the share of the dominant airline has a negative influence on the Lerner index. Equation (1) in Table 1 shows that CR1 is significant at 5%, and that an increase in this market share of 10 percentual points decreases the Lerner index by 2.3 basis points, which means a decrease above 2.3% if we take into consideration that the theoretical

[11] As robustness test we also use the operating margin as dependent variable. The essence of our conclusions, namely regarding the negative impact of CR1 and $CR1^2$, remains the same.

maximum value for the Lerner index is 1.0 and a decrease of 5.5% if you take as a starting point a Lerner index equal the median of our sample (0.41).

- Insert Table 1 -

The variable CR1 acquires a higher significance if it takes a square form, instead of a linear one. Equation [2] shows that $CR1^2$ is significant also at 5% (however, the p-value of CR1 coefficient is 4.8% and the p-value for the $CR1^2$ coefficient is 2.5%).[12] Thus higher values of CR1 have a greater impact on decreasing L than small ones. We thus confirm that, as expected, and given the results of our theoretical model, a high market power of a leader downstream firm reduces the upstream firm's market power.

With regard to our control variables, the results show that CONC is always significant at 1%, meaning that the presence of a competitor decreases the Lerner index, as expected. WAR is significant at 5% and has a negative coefficient. Thus, the higher the share of aeronautical revenues, the lower the airports' Lerner index. Airports with higher shares of concession revenues have higher market power. LCC is significant at 5% (p-value is 3.1%), which confirms the negative impact of the dominance of a low cost carrier on the airports' Lerner index. In fact, our results point to the fact that when the dominant carrier is a LCC, the airport's market power is lower by about 0.085, which means *ceteris paribus* a decrease of 8.5% in the airport margin (price minus marginal cost) relatively to the price when compared to the situation of dominance of full service carriers.

The variable PTER is significant at 10% and its coefficient has a negative sign. This confirms our theoretical point (see Section 2). Indeed, in airports, as may happen in other networks, economies of density exist, but not economies of scale. In fact, the variable PAX is not significant.

INT is not significant. We expected that airlines would be more willing to support higher margins in the airports with more international passengers than in airports that are more dedicated to domestic flights. However, this variable is not significant. Given that, theoretically, long and short-haul passengers can have different willingness to pay, we keep

[12] Confirming this, if we use as regressor log (CR1), the p-value is slightly lower (4.87%) than when we use CR1.

this variable in our regressions. However, if we exclude it other explanatory variables remain significant (see regression [3]).

Finally, variable OWN is significant (its p-value is around 7%), and has a negative sign, revealing that, *ceteris paribus*, airports owned by the state have lower Lerner indexes in 0.09 than the others. This difference represents 22.2% of the median Lerner index.

In sum, our model seems to behave quite well, as most variables are significant and have the expected sign. The empirical results clearly show that market concentration of downstream buyers' squeezes the upstream suppliers' market power.

3.3. Causality tests

We concluded that a larger share of the dominant airline negatively influences airports' market power (Lerner indexes). Though regulators set price caps or other forms of price regulation, there is a margin of choice for the airports, and, within this margin, downstream market power tends to lower the airports' price margins. Also, dominant airlines lobbying during the process of regulation leads to lower airport prices and so to lower Lerner indexes.

But it might be worth questioning if the Lerner indexes of airports influence the dominant airline's market share. In other words, the question is: if regulators, while influenced by airlines' lobbying, do not also influence their dominance at a particular airport. For instance, if the regulator sets a low cap, will this lead to higher dominant airlines' market shares?

This is the same as asking which direction causality works. We showed that CR1 influences L. But does L influence CR1? *A priori* there are no factors that unambiguously support this influence. We could think that airlines might switch from an airport that has a higher price to another that has a lower price. But dominant airlines use "their" airports as hubs and have often made specific investments there, and so switching on account of lower airports' margins would have high transaction costs[13]. Our causality test intends to detect if switching is current, or if, on the contrary, it is difficult because of transaction costs and specific investments and, consequently, airlines prefer to lobby for lower prices with regulators and airports.

We performed the Hausman test to check for causality. The Hausman test is appropriate for cross section data, where Granger causality tests cannot be applied.

[13] Though transaction costs may also be small whenever an airline has a minimum of specific investments in an airport, as happens with some low cost carriers.

To carry out the Hausman test we ran two OLS regressions. In the first step regressions, we regressed the suspect variable (CR1 or $CR1^2$) on a set of instrumental variables that are not correlated with the error term of the respective equation ([1], [2] or [3]) and which we present in the Table 1. In the set of explanatory variables (as CONC, PAX, WAR, LCC, INT, EUR, PTER and OWN), we also include the average revenue per passenger (ARPP).[14] All variables have reduced correlation with the errors of the original equations.[15]

In the second step regressions, we re-estimate the regressions [1], [2] and [3] including the residuals from the first regression as additional regressors. The results are in Table 2.[16]

- Insert Table 2 -

For all equations [1], [2] and [3], the coefficients on the first stage residuals do not differ significantly from zero. Thus, we conclude that our estimates in Table 1 are all consistent.

4. Conclusions

This papers deals with the limitation of upstream market power by a downstream market leader. Studies on this subject are scarce and limited. The purpose of this paper is twofold. First we build up a theoretically framework to understand the relationship between the upstream market power and the downstream leader's market share, applicable for regulated firms. Second, we develop and empirical study (using a large sample of airports), the hypotheses of which are based on our theoretical work.

According to the results of our theoretical model, we find that the market share of a leader downstream firm is significant in explaining the upstream producers' Lerner indexes. Thus, our results support the idea that the higher the market share of the downstream buyer, the smaller the degree of "capture" of the regulator by the regulated upstream firm. Also in accordance with the results of the theoretical model, we find a positive influence on upstream market power of economies of density, of public ownership, of upstream competition, of the

[14] If this variable is not included, and thus we only include as regressors the other original independent variables, the conclusions remain unchangeable

[15] For equation [1], for example, the correlation with the errors ranges between -0.30 (ARPP) and 0.15 (LCC).

[16] To save space, we only include the results for the additional regressor (i.e., the residuals from the first regressions), since only this variable is relevant to achieve the Hausman test's conclusions. However, the coefficients and p-values for other regressors are available upon request.

percentage of the main (aeronautical) revenues) and of the dominance of low cost carriers. These are the factors that may depress airports' market power.

Theoretically, we must admit that upstream firms' regulators could influence airlines' dominance at each airport, through their decisions on airport prices. If this happens, a downstream leader's market share should be endogenously determined together with the upstream producer's Lerner index. However, applying the Hausman test, we find no evidence of endogeneity. Thus we can conclude that our results support the idea that dominant airlines successfully exercise lobbying to influence the regulators, but the regulator's decisions on prices do not influence airlines' dominance at each airport. These findings underline the strategic importance of the lobbying process of the downstream buyers (that are not directly regulated) in influencing the market power of their (regulated) upstream suppliers, and in avoiding the consequences of upstream regulators' decisions on their own quantities and market share.

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TABLE 1 - OLS REGRESSIONS

	[1]	[2]	[3]
C	0.844 ***	0.802 ***	0.877 ***
CR1	-0.227 **		-0.238 **
$CR1^2$		-0.269 **	
CONC	-0.130 ***	-0.128 ***	-0.129 ***
PAX	1.310 *	1.411 *	1.466 *
WAR	-0.350 **	-0.355 **	-0.345 **
INT	0.084	0.079	
PTER	-0.353 **	-0.358 **	-0.395 **
LCC	-0.085 **	-0.085 **	-0.096 ***
OWN	-0.091 **	-0.089 **	-0.102 **
EUR	-0.116 **	-0.115 *	-0.072 **
N	106	106	106
R-squared	0.287	0.291	0.279

Notes: (i) The dependent variable is the Lerner index (L) of the upstream airport; (ii) ***, ** and * show statistical significance at 1%, 5% and 10%, (one-sided tests).

TABLE 2 – HAUSMAN TEST'S SECOND STAGE REGRESSIONS

	Regression [1]		Regression [2]		Regression [3]	
	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
First Stage Residual	0.021	0.252	0.000	0.790	0.000	0.962
N	106				106	
R-squared	0.297		0.288		0.279	

Notes: (i) The dependent variable is the Lerner index (L) of the upstream airport; (ii) Besides the First Stage Residuals also included as regressors were all independent variables included in the corresponding regression of the Table 1, ie, CR1 (regressions [1] and [3]), CR12 (regressions [2]), INT (regressions [1] and [2]) and CONC, PAX, WAR, PTER, LCC, OWN and EUR (all regressions); (iii) p-values refer to two-sided tests.

Appendix: List of Airports

Albuquerque	Kansas City
Aukland	Orlando
Albany	Chicago Midwest
Amsterdam	Melbourne
Stockholm Arlanda	Memphis
Athens	Macau
Atlanta	Miami
Austin	Milwaukee General Mitchell
Barcelona	Malta
Bangkok	Minneapolis St Paul
Nashville	New Orleans Louis Armstrong
Brisbane	Munich
Bombay	Tokyo Narita
Boston	Oakland
Brussels	Ontario
Baltimore	Chicago O'Hare
Bai Yun	Oslo
Paris CDG	Palm Beach
Jakarta	Portland
Cleveland	Beijing
Charlotte Douglas	Penang
Cairns	Perth
Copenhagen	Philadelphia
Cincinnati North Kentucky	Phoenix
Washington Ronald Reagan	Pittsburg
Dehli	Shanghai Pudong
Denver	Raleigh-Durham
Dallas Fort Worth	Richmond
Detroit	Riga
Dublin	Reno
Dusseldorf	San Diego
Edinburgh	San Antonio
Newark	Louisville
Rome Fiumicino	Seattle
Fort lauderdale	Seoul Gimpo
Frankfurt	San Francisco
Geneva	Shanghai Hongqiao
Helsinki	Singapore

Hong Kong	**San Jose**
Honolulu	**Salt Lake City**
Washington Dulles	**Sacramento**
Houston-Bush	**John Wayne Orange County**
Seoul Incheon	**Saint Louis Lambert**
Indianapolis	**London Stansted**
Istanbul	**Sydney**
Jacksonville	**Shenzhen Baoan**
New York JFK	**Tallinn**
Kansai	**Tampa**
Kuala Lumpur	**Taipei**
Las Vegas	**Berlin Tegel**
Los Angeles	**Vienna**
New York La Guardia	**Ottawa**
London Gatwick	**Montreal**
London Heathrow	**Vancouver**
Lisbon	**Calgary**
Madrid	**Zurich**
Manchester	

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Faculdade de Economia da Universidade do Porto
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