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air transport markets  
by  
Jorge Valido<sup>\*</sup>, M. Pilar Socorro<sup>\*\*</sup>,  
Aday Hernández<sup>\*</sup> and Ofelia Betancor<sup>\*\*</sup>**

**Documento de Trabajo 2012-10**

CÁTEDRA Fedea-Abertis

September 2012

\* Universidad de Las Palmas de Gran Canaria.

\*\* Universidad de Las Palmas de Gran Canaria and Fundación de Estudios de Economía Aplicada (FEDEA).

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ISSN: 1696-750X

Jorge Juan, 46  
28001 Madrid -España  
Tel.: +34 914 359 020  
Fax: +34 915 779 575  
[infpub@fedea.es](mailto:infpub@fedea.es)

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N.I.F. G-78044393

# Subsidies for resident passengers in air transport markets<sup>§</sup>

Jorge Valido<sup>a,\*</sup>, M. Pilar Socorro<sup>a,b</sup>, Aday Hernández<sup>a</sup> and Ofelia Betancor<sup>a,b</sup>

<sup>a</sup>Universidad de Las Palmas de Gran Canaria. Departamento de Análisis Económico Aplicado, Campus de Tafira. 35017 Las Palmas de Gran Canaria, Spain

<sup>b</sup>Fundación de Estudios de Economía Aplicada (FEDEA). Jorge Juan 46, 28001 Madrid, Spain

November 2012

## Abstract

In this work, we analyse from a theoretical perspective the efficiency of an *ad valorem* and a lump sum subsidy for resident passengers. In particular, we consider passengers with high and low willingness to pay that may be residents in a given area (and therefore entitled to a subsidy). All passengers are served by a monopoly air carrier that wants to get as much of their willingness to pay as possible. We show that if the proportion of resident passengers is high enough, non-resident passengers may be expelled from the market. Taken into account this undesirable situation we compare *ad valorem* and lump sum subsidies. We conclude that if the proportion of passengers with high willingness to pay is low (high) enough applying a lump sum (*ad valorem*) subsidy for resident passengers is better in social terms. We apply these results to a specific case study in the Canary Islands where *ad valorem* subsidies for resident passengers have been extensively used. We conclude that in most routes the lump sum subsidy is undoubtedly better in social terms.

**Keywords:** resident passengers, lump-sum subsidy, *ad valorem* subsidy

**JEL Classification:** L12, L93, H25

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<sup>§</sup> This research was undertaken within the EVA-AIR project, which is funded by the Spanish Ministry of Economics and Competitiveness, research grant ECO 2012-39277. The responsibility for possible errors is solely ours.

\* Corresponding author. Tel.: +34-928-451836; Fax: +34-928-458183. E-mail address: jvalido@acciones.ulpgc.es.

## 1. Introduction

In Europe air transport markets are usually free. Any European airline may fly wherever it likes without further restrictions than the normal requirements regarding the availability of an operating licence and access to the airport infrastructure desired.

Free markets are by definition not subject to regulatory interventions, but only when justified by the existence of market failures or for equity reasons. In this paper we aim to analyse interventions in air transport markets that take the form of a subsidy on the ticket prices. These subsidies are an exemption within the general European legislation on state aid rules, aiming to protect passengers from peripheral areas on a territorial equity basis.<sup>1</sup> It is for example the case of passengers living in the Canary and Balearic Islands (Spain); Madeira and Azores (Portugal); Martinique, Reunion Islands, Guadeloupe and French Guyana (France). In all cases the type of subsidies varies from lump sum to *ad valorem* ones, with some variants in the administrative procedures. The goal of the intervention is to compensate passengers for the travel costs when air transport is an essential mode of transport that also ensures territorial continuity (Santana and Betancor, 2011).

In Spain, for example, these subsidies are granted to passengers living in the archipelagos of the Canaries and Balearic Islands<sup>2</sup> when travelling by air to mainland Spain and in interisland air routes. This subsidy currently corresponds to 50 percent of the air ticket price.<sup>3</sup> It is worth to mention that being a subsidy aimed for passengers it is finally paid directly to air carriers on a yearly basis.

Most academic papers concerned with subsidies in air transport markets focus on the analysis of subsidies in the context of public services obligations declarations (see for example Reynolds-Feighan, 1999; Williams, 2004 and 2005, or Nolan *et al.*, 2005). To our knowledge only Santana and Betancor (2011) and Calzada and Fageda (2012), attempt to empirically assess the effectiveness of this type of intervention.

The approach of our paper is theoretical, aiming to analyse the efficiency of subsidies for passengers in its various forms. We are not aware of similar papers in the same area.

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<sup>1</sup> Note that these subsidies are different than those granted to air carriers under a public service obligation declaration that are intended to compensate air carriers for the losses incurred during the provision of declared services.

<sup>2</sup> Also people living in the Spanish autonomous cities of Ceuta and Melilla in the north of Africa.

<sup>3</sup> Although there are some limitations on the type of fares. For instance business fares are just entitled to a limited amount of subsidy given by the subsidy that corresponds to the complete economy fare.

We develop a model in which there are two types of passengers with high and low willingness to pay for an air transport service. In addition both types of passengers may be resident in a given area and hence, entitled to a subsidy, or non-residents. All passengers are served by a monopoly air carrier that wants to get as much of their willingness to pay as possible. By doing so it risks leaving out of the market some type of passengers or leaving others with a surplus, which in turn would be dependent on the proportion of resident passengers.

This model allows to show that the establishment of passengers' subsidies based on the residential feature leads to a result that critically depends on the proportion of resident passengers. In particular, for a high enough proportion of resident passengers, non-resident passengers may be expelled from the market. Taken into account this undesirable situation we compare the possible effects of both, an *ad valorem* and a lump sum subsidy. We conclude that if the proportion of passengers with high willingness to pay is low (high) enough, applying a lump sum (*ad valorem*) resident subsidy is better in social terms. Finally, we apply our results to the case of the Canary Islands. Even though *ad valorem* subsidies for resident passengers have been extensively used in the Canary routes, we can never conclude that this kind of subsidy is the most efficient one. In most routes we can undoubtedly state that the lump sum subsidy would be socially better.

The structure of the paper is the following: after this introduction, section 2 develops the model setup and section 3 the benchmark case of no subsidies. Sections 4 and 5 expand the framework to include the analysis of an *ad valorem* and a lump sum subsidy, respectively. Both types of subsidies are compared in section 6. Our conclusions are presented in section 7.

## **2. The theoretical model**

We consider an air transport market operated just by one airline. Let us denote by  $N$  the number of passengers that may be willing to fly in this market. We assume that there are only two types of passengers that differ in their willingness to pay for an air transport service: type  $h$  passengers, that is, passengers with a high willingness to pay, and type  $l$  passengers, that is, passengers with a low willingness to pay. High willingness to pay passengers are present in the market in a proportion  $\alpha \in [0,1]$ . Necessarily, the

proportion of low willingness to pay passengers is given by  $(1-\alpha)$ . Let us denote by  $H$  and  $L$  the maximum willingness to pay by type  $h$  and type  $l$  passengers, respectively. By definition,  $H > L$ . We assume that both types of passengers share the same aircraft cabin and therefore, enjoy the same quality of the air service (i.e. there is a single class cabin).<sup>4</sup>

The utilities of both types of passengers are given by the following equations:

$$\begin{aligned} U^h &= H - p^h \\ U^l &= L - p^l, \end{aligned} \tag{1}$$

where  $p^h$  and  $p^l$  denotes the ticket price charged to type  $h$  and type  $l$  passengers, respectively.

Passengers of any type are divided into residents and non-residents in a proportion  $\delta$  and  $(1-\delta)$ , respectively, with  $0 \leq \delta \leq 1$ . Passengers with residence in a given geographical area are entitled to a special discount on the ticket price enjoying either an *ad valorem* subsidy denoted by  $\tau$  or a lump-sum subsidy denoted by  $S$ .

For the sake of simplicity we assume that the air carrier has a constant marginal cost per passenger equal to  $c$ .<sup>5</sup> In order to have the model well-defined we assume that  $H > L > c$ .

**Table 1. Summary of notation**

$N$	Total number of passengers
$h$	High willingness to pay passengers
$l$	Low willingness to pay passengers
$\alpha$	Proportion of high willingness to pay passengers
$1-\alpha$	Proportion of low willingness to pay passengers
$p$	The ticket price
$\delta$	Proportion of resident passengers
$1-\delta$	Proportion of non-resident passengers
$c$	Airline's constant marginal cost

<sup>4</sup> This setting may currently correspond to interisland air transport in the Canary Islands, where there is just one airline providing services with a single class cabin aircrafts.

<sup>5</sup> The literature on transport cost functions is quite extensive. In particular, Oum and Waters (1997) find many examples of constant returns to scale for the air transport industry in the case of airlines (seven out of ten studies).

$\tau$	<i>Ad valorem</i> subsidy for resident passengers
$S$	Lump sum subsidy for resident passengers

### 3. Benchmark case: No subsidies for resident passengers

The airline cannot perfectly distinguish the type of the passenger and thus, faces an adverse selection problem. Under perfect information conditions, the airline would charge a ticket price equal to the maximum willingness to pay for the air transport service (first degree price discrimination), but with asymmetric information it needs to rely on a second degree price discrimination system. In particular, in order to induce passengers to reveal their real type, the airline offers restricted and non-restricted tickets. Restricted tickets are cheaper ( $p^l$ ) than non-restricted tickets ( $p^h$ ), but also less convenient as they are subject to a set of limitations that make passengers to incur in an additional cost in case of choosing such a ticket.<sup>6</sup> This strategy allows the airline to differentiate between both types of passengers by inducing self-selection. Let us denote by  $c_h$  and  $c_l$  the additional cost faced by type  $h$  and type  $l$  passengers if they acquire a restricted ticket, with  $c_h > c_l$ . For the sake of simplicity and without loss of generality, we normalize  $c_l = 0$ . Moreover, we assume that  $H \geq L + c_h$ . The self-selection or incentive compatibility constraints are given by:

$$\begin{aligned} H - p^h &\geq H - p^l - c_h \\ L - p^l &\geq L - p^h. \end{aligned} \quad (2)$$

So the airline induces self-selection by charging the following prices for restricted and non-restricted tickets:

$$\begin{aligned} p_0^l &= L \\ p_0^h &= p_0^l + c_h = L + c_h, \end{aligned} \quad (3)$$

where the subscript “0” refers to the benchmark situation in which there is no subsidy.

**Lemma 1:** *If there are no subsidies for resident passengers, type  $l$  passengers are always charged their maximum willingness to pay. On the contrary, type  $h$  passengers*

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<sup>6</sup> For example, non refundable tickets need to be bought in advance, no changes are allowed, etc.

are charged a higher price than type  $l$  passengers but they keep a consumer surplus equal to  $H - L - c_h$ .

The optimal profits for the airline in the benchmark situation are given by the following expression:

$$\pi_0 = \alpha N(L + c_h) + (1 - \alpha)NL - Nc. \quad (4)$$

#### 4. An *ad-valorem* subsidy for resident passengers

Let us consider now the case in which the government subsidizes air travel for resident passengers. This subsidy takes an *ad-valorem* form, that is, it is established as a percentage of discount on the ticket price and it is equal to  $\tau$ , with  $\tau \in [0,1]$ . Let us denote by  $p_d^k$  the final price paid by a type  $k$  passenger, and by  $p_s^k$  the price charged by the airline to a type  $k$  passenger, with  $k = h, l$ . If the type  $k$  passenger is non-resident, no subsidy is applied and we have that  $p_d^k = p_s^k$ . On the contrary, if the type  $k$  passenger is resident, he will enjoy an *ad valorem* subsidy and  $p_d^k = p_s^k(1 - \tau)$ .

In this context, the airline needs to decide the best strategy in terms of pricing. This optimal pricing decision, as we will show, will be conditional on the resident proportion  $\delta$ . We can distinguish four alternative pricing strategies.

**Strategy 1:** Set  $p_s^l = L / (1 - \tau)$  and  $p_s^h = L + c_h$ .

*Strategy 1* implies charging type  $l$  resident passengers a ticket price equal to their maximum willingness to pay increased by the amount of the subsidy. This leaves out of the market type  $l$  non-resident passengers. On the contrary, type  $h$  passengers are charged the same price as in the situation without subsidies. Thus, all type  $h$  passengers will buy the air transport ticket and type  $h$  resident passengers are left with an additional surplus given by the amount of the subsidy.

**Strategy 2:** Set  $p_s^l = L / (1 - \tau)$  and  $p_s^h = (L + c_h) / (1 - \tau)$ .

*Strategy 2* implies charging both, type  $l$  and type  $h$  resident passengers, a ticket price that is equal to their maximum willingness to pay increased by the amount of the subsidy. This leaves out of the market type  $l$  and type  $h$  non-resident passengers.

***Strategy 3:*** Set  $p_s^l = L$  and  $p_s^h = (L + c_h)$ .

*Strategy 3* implies charging both type  $l$  and type  $h$  passengers the same ticket prices as in the situation without subsidies. Thus, all passengers buy the air transport ticket and both, type  $l$  and type  $h$  resident passengers are left with an additional surplus given by the amount of the subsidy.

***Strategy 4:*** Set  $p_s^l = L$  and  $p_s^h = (L + c_h) / (1 - \tau)$ .

*Strategy 4* implies charging type  $l$  resident passengers the same price as in the situation without subsidies. Thus, all type  $l$  passengers will buy the air transport ticket and type  $l$  resident passengers are left with an additional surplus given by the amount of the subsidy. On the contrary, type  $h$  resident passengers are charged a ticket price that is equal to their maximum willingness to pay increased by the amount of the subsidy. This leaves out of the market type  $h$  non-resident passengers.

Notice that each strategy implies a trade-off between increasing the ticket price and losing the non-resident passengers demand. Let us denote by  $\pi_i^{AV}$  the airline profits obtained by applying strategy  $i$  when an *ad valorem* subsidy for resident passengers is introduced. The airline profits for each strategy are then given by the following expressions:

$$\pi_1^{AV} = N \left( \alpha(L + c_h) + (1 - \alpha)\delta \frac{L}{1 - \tau} \right) - (\alpha + (1 - \alpha)\delta) Nc. \quad (5)$$

$$\pi_2^{AV} = N \left( \alpha\delta \frac{L + c_h}{1 - \tau} + (1 - \alpha)\delta \frac{L}{1 - \tau} \right) - (\alpha\delta + (1 - \alpha)\delta) Nc. \quad (6)$$

$$\pi_3^{AV} = N(\alpha(L + c_h) + (1 - \alpha)L) - Nc. \quad (7)$$

$$\pi_4^{AV} = N \left( \alpha\delta \frac{L + c_h}{1 - \tau} + (1 - \alpha)L \right) - (\alpha\delta + (1 - \alpha)) Nc. \quad (8)$$



In order to find the optimal strategy we need to compare the profits given by expressions (5), (6), (7), and (8). Let us start by comparing profits by pairs. This comparison gives us the critical value of  $\delta_{ij}^{AV}$  that makes both profits equal, with  $i=1,\dots,4$  and  $j=1,\dots,4$ . Secondly we analyze which strategy is dominant and the condition for that to happen.

**Proposition 1:** If  $0 \leq \delta < \delta_{13}^{AV} = \delta_{24}^{AV}$  strategy 3 is strictly dominant. However, for intermediate values of  $\delta$  ( $\delta_{13}^{AV} = \delta_{24}^{AV} < \delta < \delta_{21}^{AV} = \delta_{43}^{AV}$ ), strategy 1 is strictly dominant. Finally, if  $\delta_{21}^{AV} = \delta_{43}^{AV} < \delta \leq 1$ , strategy 2 strictly dominates.

**Proof:** In order to know which profit is preferred, we compare strategies two by two, obtaining six critical values of  $\delta_{ij}^{AV}$ , that is,  $\delta_{21}^{AV}, \delta_{13}^{AV}, \delta_{14}^{AV}, \delta_{23}^{AV}, \delta_{24}^{AV}$ , and  $\delta_{43}^{AV}$ . The partial derivatives of profits with respect to  $\delta$  inform us on how profits behave when taking values of  $\delta$  that are different from the critical ones.

Let us compare profits by pairs, starting with strategy 1 and strategy 2, to obtain  $\delta_{21}^{AV}$  and following the same procedure for strategy 3 and strategy 4 that gives us  $\delta_{43}^{AV}$ . We are also interested in knowing how profits behave when  $\delta_{ij}^{AV}$  is different from the critical value. To do that we need to compute the partial derivatives of the previous comparison of profits with respect to  $\delta$ . Formally:

$$\pi_1^{AV} - \pi_2^{AV} = \pi_3^{AV} - \pi_4^{AV} = 0 \rightarrow \delta_{21}^{AV} = \delta_{43}^{AV} = \frac{(L-c+c_h)(1-\tau)}{L-c(1-\tau)+c_h}$$

$$\frac{\partial(\pi_1^{AV} - \pi_2^{AV})}{\partial \delta} = \frac{\partial(\pi_3^{AV} - \pi_4^{AV})}{\partial \delta} < 0 \text{ for all } \alpha, \tau \in (0,1)$$

We observe that  $\delta_{21}^{AV} = \delta_{43}^{AV}$ . Moreover, for  $\delta > \delta_{21}^{AV} = \delta_{43}^{AV}$ ,  $\pi_1^{AV} > \pi_2^{AV}$  and  $\pi_3^{AV} > \pi_4^{AV}$ , respectively.

Similarly, we get  $\delta_{13}^{AV} = \delta_{24}^{AV}$  and  $\pi_1^{AV} > \pi_3^{AV}$  and  $\pi_2^{AV} > \pi_4^{AV}$  for  $\delta > \delta_{13}^{AV} = \delta_{24}^{AV}$ .

$$\pi_1^{AV} - \pi_3^{AV} = \pi_2^{AV} - \pi_4^{AV} = 0 \rightarrow \delta_{13}^{AV} = \delta_{24}^{AV} = \frac{(L-c)(1-\tau)}{L-c(1-\tau)}$$

$$\frac{\partial(\pi_1^{AV} - \pi_3^{AV})}{\partial \delta} = \frac{\partial(\pi_2^{AV} - \pi_4^{AV})}{\partial \delta} > 0 \text{ for all } \alpha, \tau \in (0,1)$$

Moreover,  $\delta_{23}^{AV}$  and  $\pi_2^{AV} > \pi_3^{AV}$  for  $\delta > \delta_{23}^{AV}$ . Formally:

$$\pi_2^{AV} - \pi_3^{AV} = 0 \rightarrow \delta_{23}^{AV} = \frac{(L - c + \alpha c_h)(1 - \tau)}{L - c(1 - \tau) + \alpha c_h}$$

$$\frac{\partial(\pi_2^{AV} - \pi_3^{AV})}{\partial \delta} > 0 \text{ for all } \alpha, \tau \in (0, 1)$$

Finally, we also obtain the critical value of  $\delta_{ij}$  by comparing profits from *strategy 1* and *strategy 4*. To know how profits behave for values of  $\delta$  different from the critical value, we need an extra condition depending on the proportion of type *l* and type *h* passengers. Formally:

$$\pi_1^{AV} - \pi_4^{AV} = 0 \rightarrow \delta_{14}^{AV} = \frac{(1 - \tau)((L - c)(1 - 2\alpha) - \alpha c_h)}{(1 - 2\alpha)(L - c(1 - \tau)) - \alpha c_h}$$

$$\frac{\partial(\pi_1^{AV} - \pi_4^{AV})}{\partial \delta} > 0 \text{ if } \alpha < \frac{L - c(1 - \tau)}{2(L - c(1 - \tau)) + c_h}$$

$$\frac{\partial(\pi_1^{AV} - \pi_4^{AV})}{\partial \delta} < 0 \text{ if } \alpha > \frac{L - c(1 - \tau)}{2(L - c(1 - \tau)) + c_h}$$

Therefore,  $\pi_1^{AV} > \pi_4^{AV}$  if  $\alpha < \alpha^*$  and  $\pi_4^{AV} > \pi_1^{AV}$  if  $\alpha > \alpha^*$ , with

$$\alpha^* = \frac{L - c(1 - \tau)}{2(L - c(1 - \tau)) + c_h}$$

Consequently, if we rank the  $\delta_{ij}^{AV}$  values we will obtain the following:

$$\text{If } 0 < \alpha < \alpha^*, \delta_{14}^{AV} < \delta_{13}^{AV} = \delta_{24}^{AV} < \delta_{23}^{AV} < \delta_{21}^{AV} = \delta_{43}^{AV}$$

$$\text{If } 1 > \alpha > \alpha^*, \delta_{13}^{AV} = \delta_{24}^{AV} < \delta_{23}^{AV} < \delta_{21}^{AV} = \delta_{43}^{AV} < \delta_{14}^{AV}$$

To conclude, we can state that if  $0 \leq \delta < \delta_{13}^{AV} = \delta_{24}^{AV}$ , *strategy 3* is strictly dominant. However, for intermediate values of  $\delta$  ( $\delta_{13}^{AV} = \delta_{24}^{AV} < \delta < \delta_{21}^{AV} = \delta_{43}^{AV}$ ), *strategy 1* is strictly dominant. Finally, if  $\delta_{21}^{AV} = \delta_{43}^{AV} < \delta \leq 1$ , *strategy 2* strictly dominates.

This completes the proof. ■

In the space  $(\delta, \alpha)$  it is possible to identify ten different areas that we need to analyse in order to determine which strategy dominates in each region (see Figure 1). In regions I, II and III, *strategy 3* is preferred. In regions IV, V, VI and VII *strategy 1* is dominant,



not. In other words, if the airline does not provide services for type  $h$  non-resident passengers, neither it does for type  $l$  non-resident passengers. Thus, for  $\alpha \in (0,1)$ , strategy 4 is never optimal. This is formally stated in the following proposition.

**Proposition 2:** *If  $\alpha \in (0,1)$  strategy 4 is never a strictly dominant strategy. In the extreme cases where all passengers have a high willingness to pay, that is  $\alpha = 1$ , or a low willingness to pay, that is  $\alpha = 0$ , strategy 4 coincides with strategy 2 or strategy 3, respectively, and thus it may be chosen.*

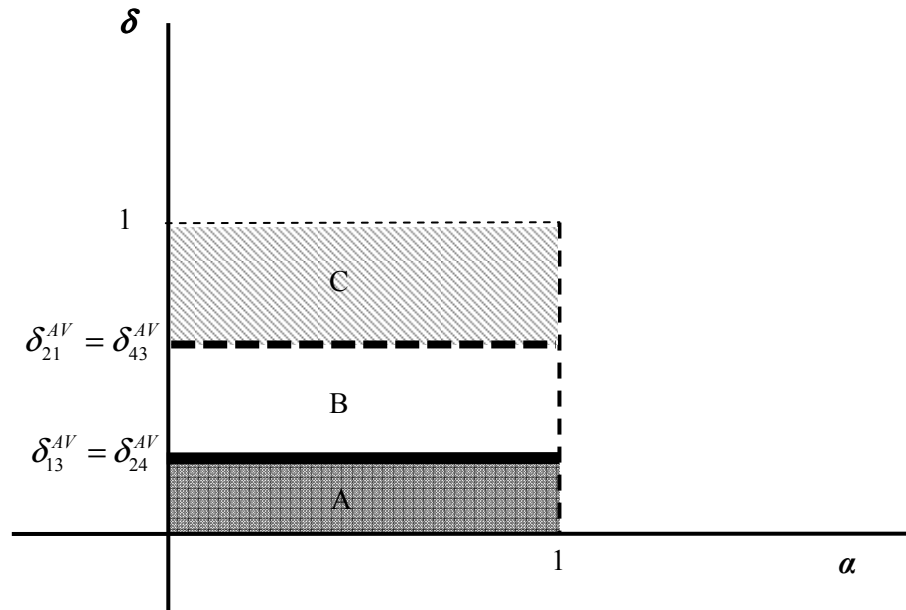
**Proof:** On the one hand, if  $\alpha = 0$ , we can see that  $\pi_3^{AV}$  is equal to  $\pi_4^{AV}$ , that is, strategy 3 and strategy 4 are equivalent. In addition  $\pi_1^{AV}$  and  $\pi_2^{AV}$  are also identical what implies that strategy 1 and strategy 2 are also equivalent. On the other hand, if  $\alpha = 1$ ,  $\pi_1^{AV}$  is equal to  $\pi_3^{AV}$ , and  $\pi_2^{AV}$  is equal to  $\pi_4^{AV}$ . This means that strategy 1 and strategy 3 are equivalent. On the other hand, strategy 2 and strategy 4 are equivalent too. For all these reasons:

- If  $\alpha = 0$  and:
  - $0 \leq \delta < \delta_{14}^{AV} = \delta_{24}^{AV} = \delta_{13}^{AV} = \delta_{23}^{AV}$ , strategy 3 and strategy 4 are strictly dominant.
  - $\delta = \delta_{14}^{AV} = \delta_{24}^{AV} = \delta_{13}^{AV} = \delta_{23}^{AV}$ , all strategies are equivalent.
  - $\delta_{14}^{AV} = \delta_{24}^{AV} = \delta_{13}^{AV} = \delta_{23}^{AV} < \delta \leq 1$ , strategy 1 and strategy 2 are strictly dominant.
- If  $\alpha = 1$  and:
  - $0 \leq \delta < \delta_{14}^{AV} = \delta_{12}^{AV} = \delta_{34}^{AV} = \delta_{23}^{AV}$ , strategy 1 and strategy 3 are strictly dominant.
  - $\delta = \delta_{14}^{AV} = \delta_{12}^{AV} = \delta_{34}^{AV} = \delta_{23}^{AV}$ , all strategies are equivalent.
  - $\delta_{14}^{AV} = \delta_{12}^{AV} = \delta_{34}^{AV} = \delta_{23}^{AV} < \delta \leq 1$ , strategy 2 and strategy 4 are strictly dominant.

This completes the proof. ■

Figure 2 reproduces Figure 1 highlighting the three relevant regions. Region A represents the space where strategy 3 is dominant, region B represents the space for strategy 1 and region C indicates the region where strategy 2 dominates.

**Figure 2. Dominant strategies for different values of  $(\delta, \alpha)$  with an *ad valorem* subsidy for resident passengers**



**Corollary 2:** Depending on the value of  $\delta$  (proportion of resident passengers), when an *ad valorem* subsidy for resident passengers is introduced we will end up in one of the following regions:

- Region A which corresponds to a situation in which ticket prices remain as in the situation without subsidies.
- Region B which corresponds to a situation in which the ticket price for type *l* passengers is increased by the amount of the subsidy and type *h* passengers are charged the same price as in the situation without subsidies. This leaves out of the market type *l* non-resident passengers.
- Region C which corresponds to a situation in which all ticket prices are increased by the amount of the subsidy. This leaves out of the market all non-resident passengers.

If we assume that the aim of the subsidy is to guarantee that resident passengers are able to buy cheaper tickets but without damaging non-resident passengers, being in region A would be the most desirable situation. In this area all passengers travel after the introduction of the subsidy. Following the same reasoning region C represents the less desirable situation in which the airline captures all resident passengers' surplus and non-

resident passengers are driven out of the market. This is formally stated in the following corollary.

**Corollary 3:** *Region A is the most desirable situation and region C is the worst situation in social terms.*

### 5. A lump-sum subsidy for resident passengers

Let us consider now that the subsidy takes a lump-sum form instead of an *ad-valorem* one. The government sets a fixed amount of subsidy per resident passenger ( $S$ ) independently of the ticket price. Recall that  $p_d^k$  denotes the final price paid by a type  $k$  passenger, and  $p_s^k$  the price charged by the airline to a type  $k$  passenger, with  $k = h, l$ . If the type  $k$  passenger is non-resident, no subsidy is applied and we have that  $p_d^k = p_s^k$ . On the contrary, if the type  $k$  passenger is resident, he will enjoy a lump-sum subsidy and  $p_d^k = p_s^k - S$ .

Again, the airline needs to decide its best strategy in terms of pricing, which will be conditional on the resident proportion  $\delta$ . Thus, the airline has four different price possibilities to consider:

**Strategy 1':** Set  $p_s^l = L + S$  and  $p_s^h = L + c_h$ .

**Strategy 2':** Set  $p_s^l = L + S$  and  $p_s^h = L + c_h + S$ .

**Strategy 3':** Set  $p_s^l = L$  and  $p_s^h = L + c_h$ .

**Strategy 4':** Set  $p_s^l = L$  and  $p_s^h = L + c_h + S$ .

The intuitions behind *strategies 1', 2', 3' and 4'* are similar to those already explained in the previous section.

Let us denote by  $\pi_i^{LS}$  the airline profits obtained by applying strategy  $i$  when a lump sum subsidy for resident passengers is introduced. The airline profits functions for each strategy are given by:

$$\pi_1^{LS} = N(\alpha(L + c_h) + (1 - \alpha)\delta(L + S)) - (\alpha + (1 - \alpha)\delta)Nc. \quad (9)$$

$$\pi_2^{LS} = N(\alpha\delta(L + c_h + S) + (1 - \alpha)(L + S)) - (\alpha\delta + (1 - \alpha)\delta)Nc. \quad (10)$$

$$\pi_3^{LS} = N(\alpha(L + c_h) + (1 - \alpha)L) - Nc \quad (11)$$

$$\pi_4^{LS} = N(\alpha\delta(L + c_h + S) + (1 - \alpha)L) - (\alpha\delta + (1 - \alpha))Nc. \quad (12)$$

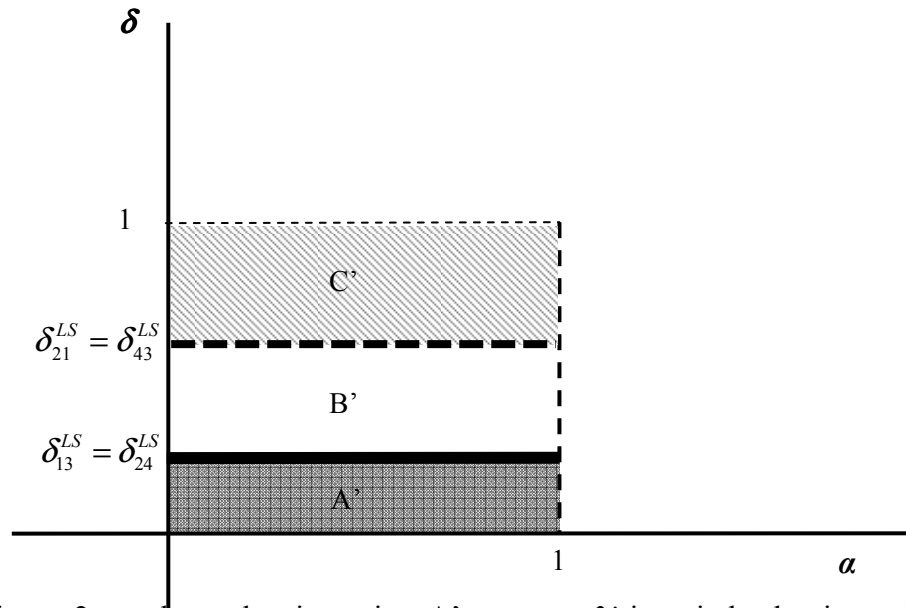
We follow the same procedure as in the previous section. Therefore we compare profits by pairs in order to obtain the critical values of  $\delta_{ij}^{LS}$ . This allows us to find which strategy is dominant and under what conditions this dominance takes place.

**Proposition 3:** If  $0 \leq \delta < \delta_{13}^{LS} = \delta_{24}^{LS}$  strategy 3' is strictly dominant. However, for intermediate values of  $\delta$  ( $\delta_{13}^{LS} = \delta_{24}^{LS} < \delta < \delta_{21}^{LS} = \delta_{43}^{LS}$ ), strategy 1' is strictly dominant. Finally, if  $\delta_{21}^{LS} = \delta_{43}^{LS} < \delta \leq 1$ , strategy 2' strictly dominates.

**Proof:** The proof of this proposition is similar to the one of Proposition 1 ■

Our ranking between profits and strategies do not vary with respect to the previous section. That is, our results are qualitatively identical but the magnitude and the critical values are numerically different. We illustrate the situation now in Figure 3.

**Figure 3. Dominant strategies for different values of  $(\delta, \alpha)$  with a lump sum subsidy for resident passengers**



Similarly to Figure 2, we have that in region A' *strategy 3'* is strictly dominant (all passengers are served); in region B *strategy 1'* is strictly dominant (only type *l* resident passengers and all type *h* passengers are served); while in region C' *strategy 2'* is strictly dominant (only resident passengers are served). Once again, region A' corresponds to a situation in which prices remain as in the case without subsidies and, thus, is the best situation in social terms. On the contrary, region C' corresponds to a situation in which all prices are increased and all non-resident passengers are expelled from the market. This latter situation is the worst situation in social terms. This is formally stated in the following corollary.

**Corollary 4:** *Region A' is the most desirable situation and region C' is the worst situation in social terms.*

## 6. Comparison between *ad valorem* and lump sum subsidies for resident passengers

### 6.1. *Ad valorem* vs. lump-sum subsidies: the critical values



We wish to compare now the two proposed subsidy mechanisms and to show under what conditions one is preferred to the other. A natural way of approaching this problem is to compare the areas depicted in Figures 2 and 3, taking into account that the greater regions A and A' and the lower regions C and C' are, the better in social terms.

Let us consider the same public expenditure for an *ad valorem* and lump sum subsidy for resident passengers, that is,  $S = (1 - \alpha)\tau L + \alpha\tau(L + c_h)$ . With such a lump sum subsidy, type *l* (type *h*) resident passengers are receiving a higher (lower) subsidy than with an *ad valorem* subsidy,  $\tau L < S < \tau(L + c_h)$ . Keeping constant the government expenditure, a lump-sum subsidy would be socially preferred to an *ad-valorem* subsidy if region A' is greater or equal than region A and region C' is smaller or equal than region C. This comparison will strongly depend on the value of  $\alpha$ , that is, on the proportion of high willingness to pay passengers.

**Proposition 4:** *There is a critical threshold  $\bar{\alpha} = (\tau L) / (c_h(1 - \tau))$  such that, for every  $\delta$ , if  $\alpha \leq \bar{\alpha}$ , a lump-sum subsidy for resident passengers is socially preferred to an *ad valorem* one.*

**Proof:** We can obtain the condition that makes region A' greater or equal than region A.

By solving  $\delta_{13}^{AD} \leq \delta_{13}^{LS}$  we get that  $S \leq \frac{\tau L}{1 - \tau}$ . This lump-sum subsidy also implies that region C' is lower than C ( $\delta_{12}^{AD} > \delta_{12}^{LS}$ ), since this holds if  $S < \frac{\tau(L + c_h)}{1 - \tau}$ .

Since  $S = (1 - \alpha)\tau L + \alpha\tau(L + c_h)$ , we need  $(1 - \alpha)\tau L + \alpha\tau(L + c_h) \leq \frac{\tau L}{1 - \tau}$ , that is,  $\alpha \leq \bar{\alpha} = (\tau L) / (c_h(1 - \tau))$ . This completes the proof. ■

Proposition 4 states that if the proportion of high willingness to pay passengers in the market is low enough, for a given public expenditure, a lump-sum subsidy for resident passengers is less likely to distort the economy and, thus, it is socially better than an *ad valorem* one.

**Proposition 5:** *There is a critical threshold  $\bar{\alpha} = (\tau L + c_h) / (c_h(1 - \tau))$  such that, for every  $\delta$ , if  $\alpha \geq \bar{\alpha}$  an ad valorem subsidy for resident passengers is socially preferred to a lump-sum one.*

**Proof:** We can obtain the condition that makes region C' greater or equal than region C.

By solving  $\delta_{12}^{AD} \leq \delta_{12}^{LS}$  we get that  $S \geq \frac{\tau(L + c_h)}{1 - \tau}$ . This lump-sum subsidy also implies

that region A' is lower than region A ( $\delta_{13}^{AD} > \delta_{13}^{LS}$ ), since this holds if  $S > \frac{\tau L}{1 - \tau}$ .

Since  $S = (1 - \alpha)\tau L + \alpha\tau(L + c_h)$ , we need  $(1 - \alpha)\tau L + \alpha\tau(L + c_h) \geq \frac{\tau(L + c_h)}{1 - \tau}$ , that is,

$\alpha \geq \bar{\alpha} = \tau(L + c_h) / (c_h(1 - \tau))$ . This completes the proof. ■

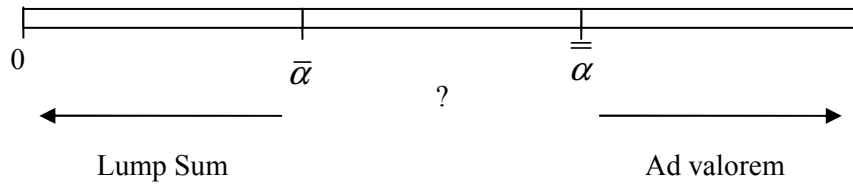
Proposition 5 states that if the proportion of high willingness to pay passengers in the market is high enough, for a given public expenditure, by applying an *ad valorem* subsidy for resident passengers the society is more likely to end up in the most desirable situation (region A), and less likely to end up in the worst situation (region C). Thus, an *ad valorem* subsidy for resident passengers is better from a social point of view than a lump sum one. Notice that for intermediate values of  $\alpha$  we cannot undoubtedly conclude which subsidizing system is better in social terms. The reason is that for intermediate values of  $\alpha$  region A may be greater than region A', but also region C may be greater than region C' and hence, the optimality of one policy over the other will depend on the value of  $\delta$ , that is, on the specific region that we are considering.

Finally, we would like to highlight that, though the value of  $\alpha$  must belong to the close interval  $[0,1]$ , the critical values of  $\bar{\alpha}$  and  $\bar{\alpha}$  are always positive but not necessarily lower than one. Thus, if  $\bar{\alpha} > 1$  every  $\alpha$  will be lower or equal than  $\bar{\alpha}$  and a lump sum subsidy for resident passengers will be always socially better than an *ad valorem* one. This is formally stated in the following corollary.

**Corollary 5:** *If  $\bar{\alpha} > 1$  a lump sum subsidy for resident passengers is always socially preferred to an ad valorem one.*

In summary, if  $\alpha$  is lower than or equal to  $\bar{\alpha}$ , a lump sum subsidy for resident passengers will be socially better. In contrast, if  $\alpha$  is greater than or equal to  $\underline{\alpha}$ , an *ad valorem* subsidy for resident passengers is preferred. Finally, for intermediates values of  $\alpha$  we cannot undoubtedly conclude anything about the optimal policy. We can summarise these results in Figure 4.

**Figure 4. Critical values of  $\alpha$**



Notice that both thresholds,  $\bar{\alpha}$  and  $\underline{\alpha}$ , depend on the low and high willingness to pay ticket prices in the absence of subsidies ( $p_0^l = L$  and  $p_0^h = L + c_h$ ) and on the inconvenience costs faced by type  $h$  passengers when buying a restricted-ticket ( $c_h$ ). That is, the lower the difference between the restricted and non-restricted ticket prices, the greater the value of the thresholds. For this reason, the lower the difference between the restricted and non-restricted ticket prices is, or the lower  $\alpha$  is, the more likely is to stay in the area in which the lump sum subsidy is preferred, and the less likely is to stay in the area in which the *ad valorem* subsidy is preferred. In other words, the closer is  $S$  to the value  $\tau L$  (the *ad valorem* subsidy for type  $l$  passengers), the more likely is that the lump sum subsidy dominates the *ad valorem* one. Moreover, both thresholds are strictly increasing with  $\tau$  and the ticket prices.

### 6.2. An empirical application: The case of the Canary Islands

In order to illustrate the relevance of our theoretical findings we make use of the case of interisland air transport in the Canary Islands. Hence, we proceed by estimating with

real data the critical values of  $\alpha$  that make one type of subsidy socially preferred to the other for the same government expenditure.

As we have already mentioned,<sup>7</sup> our theoretical model fits quite well within the current situation of interisland air transport in the Canary Islands. At the moment there is just one air carrier (Binter Canarias) that provides these services. The type of aircraft flown is unique (ATR 72) and all passengers share the same cabin class. In addition, the pricing structure is pretty simple what facilitates our estimation of critical values of  $\alpha$ .

At the moment passengers with residence in the islands are entitled to a 50 per cent subsidy on the ticket price. Nevertheless this subsidy has evolved along time, since a 10 per cent (in application from 1994 to 2001), to a 33 per cent (in application from 2001 to 2004), to a 38 per cent (in application from 2005 to 2007), and to the current 50 per cent (in application from 2007 to nowadays). In order to enjoy the subsidy passengers needs to facilitate the relevant data to the airline, which in turn, will get the money corresponding to this subsidy directly from the government on a yearly basis. At the moment this issue is under review, and we would expect a change in the scheme in the coming future.

In order to check the possible values of the thresholds we have calculated them for the cases of some interregional flights between islands. We select the main routes in terms of number of passengers (See Table 2).

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<sup>7</sup> See footnote 4.

**Table 2. Main inter islands routes in the Canary Islands**

<b>Routes</b>	<b>Passengers (2011)</b>
Tenerife North - Gran Canaria	698.457
Tenerife North - La Palma	616.552
Gran Canaria - Fuerteventura	599.049
Gran Canaria - Lanzarote	590.899
Tenerife North - Lanzarote	286.454
Tenerife North - Fuerteventura	193.789
Tenerife North - El Hierro	139.536
Gran Canaria - La Palma	115.074

Source: AENA.

Price data are taken from the company website for a one way ticket with two months in advance of the flight. We consider that the value for  $c_h$  is given by the difference between the cheapest and the more expensive ticket. We also need to take into account that  $\tau = 0.5$ .  $\tau^*$  represents the value of  $\tau$  for which  $\bar{\alpha} = 1$ , and hence the *ad valorem* subsidy for resident passengers may be socially better than a lump sum subsidy. The results are presented in Table 3.

**Table 3. Threshold values for main inter islands routes in the Canary Islands**

	$p_0^l = L$	$p_0^h = L + c_h$	$c_h$	$\bar{\alpha}$	$\bar{\alpha}$	$\tau^*$
Tenerife North - Gran Canaria	41	77	36	1,14	2,14	0,32
Tenerife North - La Palma	41	81	40	1,03	2,03	0,33
Gran Canaria - Fuerteventura	43	87	44	0,98	1,98	0,34
Gran Canaria - Lanzarote	50	100	50	1,00	2,00	0,33
Tenerife North - Lanzarote	60	130	70	0,86	1,86	0,35
Tenerife North - Fuerteventura	61	123	62	0,97	1,97	0,34
Tenerife North - El Hierro	48	87	39	1,23	2,23	0,31
Gran Canaria - La Palma	58	122	64	0,91	1,91	0,34

Note: Prices are in euros for a one way ticket. Data was collected on the 2<sup>nd</sup> of November 2012.

We can see that in most routes the value of  $\bar{\alpha}$  is greater than one. Thus in those routes, for any value of  $\alpha$ , a lump sum subsidy for resident passengers is socially preferred. Moreover, in all the routes for which the value of  $\bar{\alpha}$  is lower than one,  $\bar{\bar{\alpha}}$  is around two. Thus, we can never conclude that the *ad valorem* subsidy is the preferred one.

We can compute the value of  $\tau$  that makes  $\bar{\bar{\alpha}}=1$ , that is,  $\tau^*$ . We find that for any  $\tau$  higher or equal than 33 per cent on average an *ad valorem* subsidy for resident passengers (which is indeed the policy that has been applied in the Canary Islands since 2001) is never socially preferred to a lump sum subsidy. For  $\tau$  lower than 33 per cent on average, the *ad valorem* subsidy will be only socially better than a lump sum subsidy if the proportion of high willingness to pay passengers,  $\alpha$ , is high enough.

## 7. Conclusions

In this work we have developed a theoretical model that aims to analyse the efficiency of passengers' subsidies in European air transport markets. These subsidies are not frequent, and when applied they are intended to protect the interest of passengers from outermost regions within the EU, being based on a residential feature.

Our model distinguishes between two types of passengers: passengers with a high and with a low willingness to pay. The proportion of both types of passengers and the proportion of resident passengers in each group appear to be playing a very important role in the market.

On the one hand, depending on the proportion of resident passengers, it may even happen that non-resident passengers would be expelled from the market. If the objective of the policy is the protection of peripheral resident passengers without damaging the interest of non-resident passengers, this is an undesirable equilibrium.

On the other hand, we have also compared our results for two variants of subsidies: an *ad valorem* and a lump sum one. In both cases the danger of leaving non-resident passengers out of the market arises. In turn, both type of subsidies would be more or less damaging for non-resident passengers depending on the proportion of high and low willingness to pay passengers. We use the Canary Islands case in order to illustrate how our findings can be empirically applied. We find that for these routes we can never conclude that the *ad valorem* subsidy is the preferred one.

Finally, we would like to highlight that in this paper we are not justifying the use of subsidies for resident passengers but only discussing their possible effects and the best way of applying such subsidies (either with an *ad valorem* or a lump sum subsidy). It remains to be shown whether a passenger subsidy based on other criteria (e.g. route criterion) should be socially better than subsidies for resident passengers. This is an issue that deserves another research.

## 8. References

Calzada, J. and X. Fageda, (2012). “Discount and Public Service Obligation in the Airline Market: Lesson from Spain”. *Review of Industrial Organization*, 40 (4), pp. 291-312

Nolan, J., Ritchie, P. and Rowcroft, J. (2005), “Small market air service and regional policy”, *Journal of Transport Economics and Policy*, 39, 363-378.

Oum, T.H., Waters, W.G.I.I., (1997). Recent developments in cost function research in transportation. In: De Rus, G., Nash, C. (Eds.), *Recent Developments in Transport Economics*. Ashgate Publishing, Aldershot, Hampshire, pp. 33–73.

Reynolds-Feighan, A. (1999): “Subsidisation policies in the provision of air services to small communities – European and US approaches”. *1st Forum on Air Transport in Europe’s Remote Regions*. Conference Proceedings. Nairn (United Kingdom).

Santana, M. and Betancor, O. (2011). “Subsidies to air transport passengers: efficiency of the European policy practice”. Paper presented at the 7<sup>th</sup> International Forum on Air Transport in Remoter Regions. Newquay (United Kingdom).

Williams, G. and Pagliari, R. (2004). A comparative analysis of the application and use of public service obligations in air transport within the EU. *Transport Policy*, 11, 55-66.

Williams, G., (2005). European experience with direct subsidization of air services. *Public Money & Management*, June 2005, 155-161.

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