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Blind tickets to solve the inefficiencies of subsidies for residents in air transport markets

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ABSTRACT

Subsidies for passengers living on islands or in remote regions are common in European air transport markets. However, the literature on subsidies for resident passengers highlights their inefficiencies since they may imply increases in fares and non-residents' exclusion. This paper analyses the optimality of blind tickets - cheap surprise flight tickets without knowing the final destination - to manage those inefficiencies. This pricing strategy allows airlines to discriminate between resident and non-resident passengers by creating two different markets - one transparent and the other opaque. While resident passengers may be better off because of additional discounts, non-residents, who were excluded from the market, are now able to fly by purchasing blind tickets. We prove that, unless the proportion of residents is very low, blind tickets always imply an increase in social welfare and that this increase does not depend on passengers' risk attitude. To illustrate this welfare improvement due to blind tickets under different market conditions, we include some numerical examples based on real data from Spain, where residents of the Canary Islands, Balearic Islands, and the autonomous cities of Ceuta and Melilla receive a 75 per cent discount on flight ticket fares.

1. Introduction

Air transport is essential for the economic and commercial development of countries. In some regions, air transport is the only available mode of transport for people because of isolation, distance and, in some cases, the lack of territorial integration (Jiménez et al., 2023a).

Governments may implement various policies to increase air connectivity in remote regions. In this paper, we focus on subsidies for resident passengers. Ecuador, Portugal, Italy, Scotland and Spain are examples of regions in which specific discounts are given to resident passengers. While in Scotland and Spain these discounts consist of an *ad valorem* subsidy, in Ecuador, France, Italy and Portugal they take the form of flat rates or maximum fares (Fageda et al., 2018).

Although discounts for resident passengers might be justified in order to guarantee territorial equity and cohesion, they can involve significant inefficiencies. Previous studies on the effects of resident passenger subsidies concludes that airlines may try to take advantage of the subsidy by increasing ticket prices. Consequently, residents may be unable to fully enjoy the subsidy, and non-residents and tourists may be unwilling to travel to these destinations (and if they do decide, they will spend less at destination).[1]

The main objective of this paper is to prove that the use of blind tickets, also known as opaque products, may solve such inefficiencies. Blind tickets consist of surprise tickets in which customers purchase flight tickets without knowing the final destination until the payment is made. All they know before paying is the set of possible destinations. We show that blind tickets allow the airline to create two different markets: the transparent market (for residents) and the opaque market (for non-residents). While resident passengers may be better off because of additional discounts, non-residents, who were excluded from the market, are now able to fly by purchasing blind tickets.

Eurowings, a European airline and a subsidiary of Lufthansa, is an example of an airline that offers blind tickets to different European cities. Consumers need to select their departure airport, travel dates, and a travel theme that encompasses various destinations. Depending on the chosen departure airport, Eurowings provides different categories such as "Pizza, Pasta & Amore," "Siesta & Fiesta," "Selfie Hotspots," "Adventure in the City," "Nordic Adventures," "Off to the Warm," "Happiness Comes in Waves," etc. Each category features a range of potential destinations, and consumers discover their specific travel

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[1] See, for instance, Jiménez et al. (2023b).

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destination only at the end of the booking process (Alonso and Socorro, 2024a, 2024b).[2]

Blind tickets suppose an innovative and original pricing strategy for consumers and firms. In the case of these tickets, over 87 per cent of reviews posted by purchasers, are positive. Additionally, independently of consumers' risk attitude, this pricing strategy: is always optimal for firms; might increase airline's profits by up to 30 per cent, and may enhance social welfare (Alonso and Socorro, 2024b).

This paper proposes an economic model to analyse the optimality of selling blind tickets in markets with subsidies for resident passengers. In particular, we consider two different routes operated by an airline with both resident and non-resident passengers. First, we assess the social implications of introducing an *ad valorem* subsidy only for residents. Second, we parse the optimality of introducing blind tickets in such markets. We demonstrate that blind tickets allow the airline to discriminate between resident and non-resident passengers, which is crucial to addressing some of the inefficiencies associated with such subsidies. Third, we use some numerical examples based on real data to illustrate the main results of the economic model and the effects on social welfare of introducing subsidies for residents and blind tickets. To the best of our knowledge, this paper is the first to provide an alternative pricing strategy that may coexist with those subsidies, mitigating their inefficiencies (without any additional public expenditure) and enhancing social welfare.

Our main results are fourfold. First, we demonstrate that resident passengers may benefit from blind tickets because of additional discounts on the current fares they pay. Second, blind tickets are a way of reintroducing those non-resident passengers who were excluded from the markets because of the higher prices. These latter passengers are now able to travel by purchasing blind tickets. Third, despite discounts, we prove that blind tickets may increase an airline's profits because of new non-resident passengers travelling to both destinations. Fourth, we show that, with the same public expenditure, this pricing strategy may enhance social welfare by mitigating the inefficiencies of subsidies to resident passengers. Therefore, in air transport markets with resident subsidies, blind tickets might be an optimal pricing strategy for residents, non-residents, firms, and policymakers.

The rest of the paper is organised as follows. Section 2 provides a brief literature review of both subsidies to resident passengers and blind tickets. In Section 3, we develop the theoretical model and display the main results. Section 4 illustrates the main results of the model through different numerical examples. Finally, all results and economic implications are discussed in Section 5.

2. Literature review

2.1. Previous research on air transport subsidies to resident passengers

Countries around the world have implemented different policies in order to increase air connectivity in remote regions. Fageda et al. (2018) provide a detailed explanation of these policies, which can be classified as route-based, passenger-based, airline-based and airport-based policies. The discount for resident passengers is an example of a passenger-based policy.

Subsidies for resident passengers can be provided either as an *ad valorem* subsidy (a percentage discount on the ticket price) or a specific subsidy (a fixed amount per trip regardless of the fare level). Examples of these types of subsidies are found in European countries like France, Greece, Italy, Portugal, and Spain. In Spain, the subsidy for residents is *ad valorem*, whereas in France and Italy, it takes the form of flat rates. In Portugal, the subsidy can be either a specific subsidy or a flat rate (de Rus and Socorro, 2022).

Prior empirical research has focused on the effects of residents' discounts on ticket prices. Calzada and Fageda (2012) show that discounted routes are more expensive and highly demanded than unsubsidised domestic routes. Fageda et al. (2016) also find that subsidised routes are more expensive than unsubsidised ones. Similarly, Fageda et al. (2019) show that resident passengers face lower frequencies.

From a theoretical perspective, Valido et al. (2014) analyse the effects on prices of an *ad valorem* and a specific subsidy given to resident passengers. They show that as long as an airline has market power and the proportion of residents is large enough, non-resident passengers may be excluded from the market. In addition, they demonstrate and illustrate that the willingness to pay of resident passengers determines the type of subsidy to be implemented. Further, de Rus and Socorro (2022) study the efficiency of both types of subsidies. They find that a fixed discount per trip (specific subsidy) is always superior to an *ad valorem* subsidy. Moreover, de Rus and Socorro (2022) prove that the degree of competition on a route, the proportion of residents and non-residents, and the shape of the demand function are crucial variables that affect the efficiency of such subsidies.

In the case of Spain, the percentage of the subsidy has moved in the last years from 50 to 75 per cent. Fageda et al. (2016) analyse the effect of this regulatory change on ticket prices. They do not find any price difference between both routes affected and unaffected by the discount. AIReF (2020) also assess the economic effects of the change in the subsidy using two databases, one with two million flights from July 2009 to June 2019 and another with over 100 million subsidised tickets from July 2009 to June 2019. To perform the analysis, AIReF (2020) divides the number of passenger trips into different quintiles, according to the proportion of resident passengers on each route. Contrary to Fageda et al. (2016), they find higher ticket prices for non-resident passengers on subsidised routes, with a positive relation between the proportion of resident passengers on a given route and the increase in prices.

Few recent studies have focused on the effect of such subsidies on the tourism industry. Jiménez et al. (2023a) analyse how changes in this policy affect residents' travel behaviour. Their results show that a subsidy increase produces a significant reduction in the length of stay and an increase in tourist expenditure, depending on the place of residence. Moreover, Jiménez et al. (2023b) propose a similar approach to assess non-residents' travel behaviour. Their results suggest that an increase in the percentage of the discount results in a decrease in non-resident tourist expenditure.

2.2. Previous research on blind tickets

In the airline industry, blind tickets, opaque products, opaque selling or surprise goods consist of receiving one flight ticket from a set of multiple destinations (Fay and Xie, 2010; Huang and Yu, 2014; Gönsch, 2020; Klingemann, 2020). Jiang (2007) study the optimality of these products in the field of air transport and tourism by considering a monopolist airline that offers two flights with distinct departure times, morning and night. Fay and Xie (2008) extend this model by including heterogeneity, demand uncertainty and capacity restrictions, while Huang and Yu (2014) evaluate the effects of bound rationality. Similarly, other authors assess the effects of considering different transportation costs and consumer valuations (Balestrieri et al., 2021; Elmachtoub and Hamilton, 2021).

Most research has focused on studying the optimality of blind tickets as a pricing strategy to deal with 'distressed inventory' or end-of-season products (Gallego et al., 2004; Li et al., 2020; Alonso and Socorro, 2024a). Jerath et al. (2010), for example, investigate the case of two competing firms that offer a similar product and an intermediary that sells all distressed inventory through blind tickets. Specifically, they examine a dynamic setting in which firms compete in a first period while the intermediary sells blind tickets in a second.

Anderson and Xie (2012) study the optimality of an opaque bidding challenge, where consumers propose the price that they are willing to

[2] More information at https://blindbooking.eurowings.com/#opq_retrieve.

pay for the opaque product. In this context, Post (2010) proposes the optimal price of opaque products depending on the level of opaqueness, while Ko and Song (2020) develop an algorithm for a variety of opaque products.

Fay and Xie (2008) suggest in their pioneer research that the main extensions of opaque products must be in line with consumers' risk attitudes. Alonso and Socorro (2024a) develop a theoretical model with two destinations as a simplified representation of the case of Eurowings, a European airline that offers blind tickets to different destinations and operates as a monopolist on most direct routes. Alonso and Socorro (2024a) study the optimality of blind tickets considering consumers' risk aversion and a pricing strategy managed directly by the airline. Additionally, Alonso and Socorro (2024b) assess their optimality as a pricing strategy to deal with unsold tickets in the case of risk-averse individuals with heterogeneous preferences. In particular, they analyse airline profitability, as well as the profit/losses derived from ignoring risk aversion.

Various empirical studies evaluate the main differences between regular and opaque prices (Granados et al., 2008), and the profitability of opaque flight tickets in the case of Germanwings (Post and Spann, 2012; Lee et al., 2012). Alonso and Socorro (2024b) study the demand of opaque products in air transport markets, evaluating customers' perceptions through a 'sentiment analysis'. With over 87 % positive reviews, the results indicate that consumers are very satisfied with these products. Moreover, purchasers highlight in their reviews that it is an optimal pricing strategy for travelling cheaply to low-demand destinations.[3]

Theoretical papers suggest that the optimality of opaque products relies on heterogeneous consumers (Jiang, 2007; Feng et al., 2021), bounded rationality (Huang and Yu, 2014), non-refundable and non-transferable tickets (Fay, 2008), the level of opaqueness (Anderson and Xie, 2014; Li et al., 2020) consumers' risk attitudes (Alonso and Socorro, 2024a, 2024b), and additional fees for reducing uncertainty. While implementing blind tickets may increase a firm's profit by up to 30 per cent, avoiding risk aversion may suppose a loss in profit of up to 25 per cent (Alonso and Socorro, 2024b). In the case of an intermediary, prices, brand loyalty and revenue share determine their optimality (Li et al., 2020; Feng et al., 2021). These results are reinforced by empirical studies (see, for example, Tan (1999), Anderson and Xie (2012), Green and Lomanno (2012), Yang et al. (2019) or Sasanuma et al. (2022)).

3. Theoretical model

Consider an airline that operates as a monopolist in two possible direct routes: from city C to destination A and from city C to destination B.[4] In this market, there exist N passengers willing to travel from city C to destination A, and N passengers willing to travel from city C to destination B. Some of those N passengers willing to travel from city C to destination A or B, respectively, have their home residence in such destinations (that is, they are resident passengers). The proportion of residents willing to fly from city C to destination A (B) is equal to θ_A (θ_B), with $0 \leq \theta_A \leq 1$ ($0 \leq \theta_B \leq 1$). Notice that one passenger can only be resident in one of the destinations, never in both destinations.

The airline operates both routes, from city C to destination A and from city C to destination B, with direct flights. However, residents need to arrive at their homes and, thus, they may consider different alternatives. First, they may travel from city C to the other destination on a direct flight, and then use an alternative transport mode to return to their homes. This journey on an alternative transport mode involves a transportation cost for the resident passenger. Let us denote this transportation cost by t, which includes both the ticket price of the alternative transport mode and time costs (that is, the monetary value of access and egress time, waiting time, and in-vehicle time). Second, they may travel to their homes considering other non-direct routes, different from that described above. We refer to these other non-direct alternatives as an outside option. Fig. 1 summarises the network structure with all possible alternatives.

Let us denote by H and L the willingness to pay for travel to destinations A and B. While resident passengers have a high willingness to pay, H, for travelling to their home destinations, non-residents have a low willingness to pay for both destinations. Additionally, let a represent the surplus of resident passengers from purchasing the outside option, this is, the difference between their willingness to pay and the price of the outside option.

The utility functions for both residents and non-resident passengers are as follows:

$$U_A^R = (I + H - P_A)^\alpha, U_A^{NR} = (I + L - P_A)^\beta. \tag{1}$$

$$U_B^R = (I + H - P_B)^\alpha, U_B^{NR} = (I + L - P_B)^\beta, \tag{2}$$

Where I represents the level of income, P_A and P_B are the prices charged on destinations A and B, and α and β are positive parameters. Similarly, the utility for resident passengers of purchasing the outside option is:

$$U_A^R = U_B^R = a^\alpha. \tag{3}$$

For the sake of simplicity, let us assume that the airline has a constant marginal cost per passenger equal to 0. We also consider that the difference between non-residents' willingness to pay, L, and the price of the outside option is negative. Thus, non-residents have no incentives to purchase the outside option: they only consider flying to destination A, flying to destination B, or not flying at all. Moreover, we assume that the surplus of purchasing the outside option, a, is lower than $H - L$.

Table 1 summarises the main notation of the paper.

3.1. Benchmark case: a market without subsidies

In this case, the airline may charge two different prices according to consumers' willingness to pay. First, it may charge a price equal to $H - a$ so that resident passengers are indifferent between purchasing the direct flight and the outside option. Second, according to non-resident passengers, both destinations may be offered at L. Notice that if the airline implements the first price, $H - a$, it may only sell tickets to resident passengers. Otherwise, it may sell tickets to all passengers.

Regarding destination A, if the airline implements a price equal to

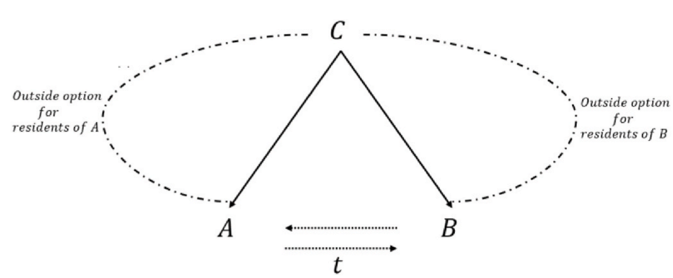

Fig. 1. Network structure.

[3] See also, Shapiro and Shi (2008), Fay and Xie (2010), Alegre et al. (2012), Sheridan et al. (2013), Courty and Liu (2013), Lee and Jang (2013), Chen and Yuan (2014), Chen and Bell (2017), Huang et al. (2018), Chen et al. (2024), and Xu et al. (2024) for other theoretical and empirical studies of opaque products.

[4] We consider a monopolist airline for two reasons: first, in this paper, we are interested in analysing the importance of blind tickets to solve the inefficiencies associated with *ad valorem* subsidies for resident passengers. Previous research has highlighted that this policy results in significant inefficiencies when airlines have market power (see de Rus and Socorro, 2022). Second, although competition on many air transport routes might be intense, the routes usually offered through blind tickets are characterised by low competition. In this sense, Alonso and Socorro (2024)stress that over 24 per cent of the routes offered through blind tickets by Eurowings are operated only by Eurowings, and more than 70 per cent of them are covered by a maximum of two airlines.

Table 1
Summary of notation.

Notation	Definition
H	High willingness to pay for a destination
L	Low willingness to pay for a destination
N	Number of individuals willing to travel to each destination
θ_A	Proportion of resident passengers for destination A
θ_B	Proportion of resident passengers for destination B
I	Individual's income
P_A	Ticket price of destination A
P_B	Ticket price of destination B
P_{BT}	Ticket price of blind tickets
α	Parameter that represents residents' risk attitude
β	Parameter that represents non-residents' risk attitude
a	Surplus of the outside option. Difference between residents' willingness to pay and price of the outside option
t	Transportation cost between destinations A and B (this includes price and time costs).
τ	Positive parameter that shows the a*d valorem* subsidy of resident passengers
x	Discount applied to resident passengers so that they do not have incentives to purchase blind tickets
U_A^R	Utility that resident passengers of destination A get when purchasing destination A
U_A^{NR}	Utility that non-resident passengers get when purchasing destination A
U_B^R	Utility that resident passengers of destination B get when purchasing destination B
U_B^{NR}	Utility that non-resident passengers get when purchasing destination B
$CS_{RES.\ A}$	Consumer surplus for residents of destination A
$CS_{RES.\ B}$	Consumer surplus for residents of destination B
$CS_{NON\text{-}RES.}$	Consumer surplus for non-residents
PS	Producer surplus
GS	Government surplus
SW	Social welfare

$H - a$, it may only sell $N\theta_A$ tickets and its profits are equal to $N\theta_A(H-a)$. If the price set is equal to L, then the airline sells N tickets of destination A, and its profits are equal to NL. Therefore, if $\theta_A > \frac{L}{H-a}$, it is optimal for the airline to charge the high price, this is, to sell tickets of destination A at a price equal to $H - a$.

Regarding destination B, if the airline implements a price equal to $H - a$, it only sells $N\theta_B$ tickets and its profits are equal to $N\theta_B(H-a)$. If the price set is equal to L, then the airline sells N tickets of destination B, and its profits are equal to NL. Therefore, if $\theta_B > \frac{L}{H-a}$, it is optimal for the airline to sell the tickets of destination B at a price equal to $H - a$.

Proposition 1. *In the benchmark case, if the proportion of resident passengers in any destination is larger than* $\frac{L}{H-a}$*, the optimal price in this destination is* $H-a$*. Otherwise, the optimal price is* L*.*

Table 2 shows optimal prices and profits for different cases, depending on the proportion of residents willing to travel in both routes.

In *Case 1*, only resident passengers of both destinations purchase flight tickets. Thus, $N(1-\theta_A)$ tickets of destination A and $N(1-\theta_B)$ tickets of destination B remain unsold. In *Case 2*, the airline sells all tickets of destination B, while there exist $N(1-\theta_A)$ unsold tickets of destination A. In *Case 3*, all seats of destination A are sold, while $N(1-\theta_B)$ tickets of destination B remain unsold. Only in *Case 4* does the airline serve all customers.

Note that, while all cases ensure that resident passengers are accommodated, it is only in *Case 4* where the airline also accommodates non-resident passengers. In *Cases 1*, *2*, and *3*, the airline does not serve at least some, or even all, non-residents, despite their positive willingness to pay for travelling to both destinations.

Table 3 shows the social welfare (SW) of each case. Producer surplus (PS) coincides with the airline's profits. Consumer surplus (CS) is the difference between consumers' willingness to pay and the price they are charged.

While residents are always better off in *Case 4*, the optimality for the airline depends on the ratio of residents and non-resident passengers.

Table 2
Optimal prices, quantities and profits in a benchmark case depending on the proportion of resident and non-resident passengers.

		Prices	Tickets sold on each route	Profits
Case 1: $\theta_A, \theta_B > \frac{L}{H-a}$	Dest. A	$P_A = H - a$	$N\theta_A(H-a)$	$N(\theta_A + \theta_B)(H-a)$
	Dest. B	$P_B = H - a$	$N\theta_B(H-a)$	
Case 2: $\theta_A > \frac{L}{H-a}$, $\theta_B < \frac{L}{H-a}$	Dest. A	$P_A = H - a$	$N\theta_A(H-a)$	$N\theta_A(H-a) + NL$
	Dest. B	$P_B = L$	NL	
Case 3: $\theta_A < \frac{L}{H-a}$, $\theta_B > \frac{L}{H-a}$	Dest. A	$P_A = L$	NL	$NL + N\theta_B(H-a)$
	Dest. B	$P_B = H - a$	$N\theta_B(H-a)$	
Case 4: $\theta_A, \theta_B < \frac{L}{H-a}$	Dest. A	$P_A = L$	NL	$2NL$
	Dest. B	$P_B = L$	NL	

Table 3
Social welfare analysis in the benchmark case.

	Case 1	Case 2	Case 3	Case 4
PS	$N(\theta_A + \theta_B)(H-a)$	$N\theta_A(H-a) + NL$	$NL + N\theta_B(H-a)$	$2NL$
CS $_{\text{RES. A}}$	N $\theta_A a$	$N\theta_A a$	$N\theta_A(H-L)$	$N\theta_A(H-L)$
CS $_{\text{RES. B}}$	$N\theta_B a$	$N\theta_B(H-L)$	$N\theta_B a$	$N\theta_B(H-L)$
CS $_{\text{NON-RES.}}$	0	0	0	0
SW	$N(\theta_A + \theta_B)H$	$N\theta_A H + NL + N\theta_B(H-L)$	$N\theta_B H + NL + N\theta_A(H-L)$	$2NL + N(\theta_A + \theta_B)(H-L)$

Notice that the consumer surplus for non-resident passengers is always 0, for two possible reasons: First, it might be the case that they do not buy any ticket, as happens, for instance, in *Case 1*. Second, it might be the case that they buy a flight ticket, but they are charged their maximum willingness to pay, as is the case, for example, in *Case 4*.

3.2. An ad valorem subsidy for resident passengers

Let us now consider the case in which the government introduces a discount for residents. It consists of an *ad valorem* subsidy, denoted by τ, with $\tau \in (0,1)$, which represents the percentage deducted from the flight ticket price paid by residents.

In this case, the airline may consider two different prices. First, the airline may set a price equal to $\frac{H-a}{1-\tau}$. With this price, the airline increases its profits with respect to the benchmark case. Non-resident passengers do not purchase flight tickets, while resident passengers end up paying the same price as before the subsidy. Second, the airline may fix a price equal to L. With this price resident passengers benefit since they only pay $L(1-\tau)$. Non-resident passengers purchase tickets, and the level of profits remains equal to the benchmark case. In this case, the subsidy is fully effective since residents enjoy the whole subsidy and the ticket price for non-residents doesn't change.

Regarding destination A, if the airline charges a price equal to $\frac{H-a}{1-\tau}$, only resident passengers purchase, and its profits are equal to $N\theta_A\frac{H-a}{1-\tau}$. On the contrary, if the price is equal to L, both resident and non-resident passengers buy flight tickets, and the airline's profits are equal to NL. Thus, as long as $\theta_A > \frac{L(1-\tau)}{H-a}$, it is optimal for the airline to set the highest price, $\frac{H-a}{1-\tau}$.

In the case of destination B, if the airline charges the highest price,

$\frac{H-a}{1-\tau}$, only resident passengers purchase tickets. However, if the price is equal to L, then all passengers purchase flight tickets. Thus, as long as $\theta_B > \frac{L(1-\tau)}{H-a}$, it is optimal for the airline to implement the highest price.

Notice that if the price of destination A (B) is equal to L, resident passengers of destination B (A) may not have incentives to purchase tickets of destination A (B), since they would not benefit from the subsidy and they would have to pay an additional cost for returning home (the transportation cost).

Proposition 2. *When the government introduces an ad valorem subsidy for resident passengers, if the proportion of resident passengers at any destination is larger than* $\frac{L(1-\tau)}{H-a}$*, the optimal price in this destination is* $\frac{H-a}{1-\tau}$*. Otherwise, the optimal price is L.*

Table 4 shows the optimal prices, number of sold tickets and profits depending on the ratio of resident passengers on both routes.

While in *Case 4*, the airline obtains the same profits as in the benchmark case, in the remaining cases (i.e., *Case 1*, *Case 2* and *Case 3*) profits are always larger. Table 5 shows the social welfare analysis when the government introduces an *ad valorem* subsidy only for residents. Notice that now we also need to take into consideration the government surplus.

According to the benchmark case and the case in which the government introduces an *ad valorem* subsidy for resident passengers, there exist different thresholds for the percentage of residents for destinations A and B, $\frac{L(1-\tau)}{H-a}$ and $\frac{L}{H-a}$, from which the airline may implement the highest prices. Fig. 2 shows these thresholds.

As shown in Fig. 2, if the proportion of resident passengers is lower than $\frac{L(1-\tau)}{H-a}$, with or without the *ad valorem* subsidy, passengers are charged the lowest price, L. Moreover, if the proportion of residents is larger than $\frac{L}{H-a}$, in both cases consumers pay the highest tariff. However, as long as $\theta_A, \theta_B \in \left(\frac{L(1-\tau)}{H-a}, \frac{L}{H-a}\right)$, prices differ in the benchmark case and in the case of the *ad valorem* subsidy for residents. While in the benchmark case tickets are sold at the lower prices, in the case of the *ad valorem* subsidy, they are sold at the maximum price. Thus, the introduction of the subsidy for residents results in higher fares and the exclusion of non-resident passengers. This situation corresponds to *Scenario 5* in Table 7. Even though the change in consumer surplus for non-resident passengers is zero, when there is no subsidy, these passengers travel to destinations A and B, while they do not travel when the subsidy for residents is introduced. Although the change in producer surplus might be positive or negative, under these conditions, the changes in the residents, government and social surpluses are negative. Thus, as long as $\theta_A, \theta_B \in \left(\frac{L(1-\tau)}{H-a}, \frac{L}{H-a}\right)$, the introduction of a subsidy for residents produces some inefficiencies. Previous research has achieved similar results, but it is worth studying how to manage these inefficiencies and achieve a socially desirable equilibrium.

Table 4
Optimal prices, quantities and profits when the government introduces an *ad valorem* subsidy only for residents.

		Prices	Tickets sold on each route	Profits
Case 1: $\boldsymbol{\theta_A, \theta_B > \frac{L(1-\tau)}{H-a}}$	Dest. A	$P_A = \frac{H-a}{1-\tau}$	$N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A + \theta_B)\left(\frac{H-a}{1-\tau}\right)$
	Dest. B	$P_B = \frac{H-a}{1-\tau}$	$N\theta_B\left(\frac{H-a}{1-\tau}\right)$	
Case 2: $\boldsymbol{\theta_A > \frac{L(1-\tau)}{H-a}}$ $\boldsymbol{\theta_B < \frac{L(1-\tau)}{H-a}}$	Dest. A	$P_A = \frac{H-a}{1-\tau}$	$N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N\theta_A\left(\frac{H-a}{1-\tau}\right) + NL$
	Dest. B	$P_B = L$	NL	
Case 3: $\boldsymbol{\theta_A < \frac{L(1-\tau)}{H-a}}$ $\boldsymbol{\theta_B > \frac{L(1-\tau)}{H-a}}$	Dest. A	$P_A = L$	NL	$NL + N\theta_B\left(\frac{H-a}{1-\tau}\right)$
	Dest. B	$P_B = \frac{H-a}{1-\tau}$	$N\theta_B\left(\frac{H-a}{1-\tau}\right)$	
Case 4: $\boldsymbol{\theta_A, \theta_B < \frac{L(1-\tau)}{H-a}}$	Dest. A	$P_A = L$	NL	$2NL$
	Dest. B	$P_B = L$	NL	

Depending on the proportion of residents and non-residents, we can distinguish nine different scenarios, as shown in Fig. 3.

In Table 6, we provide the economic and social implications of implementing the *ad valorem* subsidy only for residents with respect to the benchmark case for each possible scenario.

In all scenarios, the introduction of the *ad valorem* subsidy for residents improves airline's profitability. However, in social terms, regardless of the proportion of residents and non-residents, the *ad valorem* subsidy never leads to an increase in social welfare. Resident passengers only benefit from the subsidy, paying lower fares, when the proportion of residents on both routes is low enough (*Scenario 1*). In *Scenario 3* and *Scenario 7*, residents of one of the routes benefit from the subsidy, while the others remain at the same level of welfare as before the subsidy. Additionally, in both scenarios non-residents only travel to one of the destinations without the subsidy and it remains unchanged when the subsidy is introduced.

In *Scenario 2, Scenario 4, Scenario 6* and *Scenario 8,* not only are some residents worse off because of higher prices when introducing the subsidy, but also non-residents are excluded from the market. Additionally, in *Scenario 5,* as previously explained, all residents are worse off while all non-residents are excluded from the market. Only in *Scenario 9*, does consumers' welfare not change with the subsidy (they are in the worst situation before and after the introduction of the subsidy).

Proposition 3. *An ad valorem subsidy for resident passengers never enhances social welfare. In most scenarios, non-resident passengers end up excluded from the market. Moreover, residents only benefit from the subsidy when the proportion of resident passengers on each route is low enough.*

Thus, similarly to previous research, the implementation of an *ad valorem* subsidy for residents implies spending a significant amount of public funds that, in most cases, only benefits airlines, excluding non-residents and increasing prices for resident passengers. These results drive the implementation of other pricing strategies that might mitigate the aforementioned undesirable effects of subsidies for resident passengers.

3.3. Managing the inefficiencies of an ad valorem subsidy for residents through blind tickets

As previously mentioned, in most scenarios non-resident passengers are excluded from the market. However, the airline may be interested in accommodating these passengers, thereby creating an additional source of demand without affecting the existing market.

In this section, we study whether it is optimal for an airline to introduce blind tickets in a subsidised market. With this pricing strategy, the airline may sell tickets to destinations A and B, and also offer blind tickets where customers purchase a surprise flight ticket without knowing the destination. The possible outcomes are a flight ticket to either destination A or destination B. Once they pay, customers will discover the final destination.

This pricing strategy aims to (re)introduce non-resident passengers on both routes. Thus, it may be interesting to study its optimality, especially in *Scenarios 2, 3, 4, 5, 6, 7, 8* and *9,* since in all these cases, when the government introduces the subsidy only for residents, non-resident passengers are excluded from the market to at least one destination. Blind tickets may allow the airline to discriminate among passengers, avoiding the 'cannibalisation effect'. To do so, the airline should create two different markets (transparent and opaque) in order to separate residents and non-residents in such a way that consumers do not have incentives to switch from one market to the other.

Table 5
Social welfare analysis when the government introduces an *ad valorem* subsidy only for residents.

	Case 1	Case 2	Case 3	Case 4
PS	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N\theta_A\left(\frac{H-a}{1-\tau}\right)+NL$	$NL+N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$2NL$
CS $_{\mathbf{RES.A}}$	$N\theta_A a$	$N\theta_A a$	$N\theta_A(H-L(1-\tau))$	$N\theta_A(H-L(1-\tau))$
CS $_{\mathbf{RES.\ B}}$	$N\theta_B a$	$N\theta_B(H-L(1-\tau))$	$N\theta_B a$	$N\theta_B(H-L(1-\tau))$
CS $_{\mathbf{NON\text{-}RES.}}$	0	0	0	0
GS	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$	$-N\theta_A\left(\frac{H-a}{1-\tau}\right)\tau-N\theta_B L\tau$	$-N\theta_A L\tau-N\theta_B\left(\frac{H-a}{1-\tau}\right)\tau$	$-N(\theta_A+\theta_B)L\tau$
SW	$N(\theta_A+\theta_B)H$	$N\theta_A H+NL+N\theta_B(H-L)$	$N\theta_B H+NL+N\theta_A(H-L)$	$2NL+N(\theta_A+\theta_B)(H-L)$

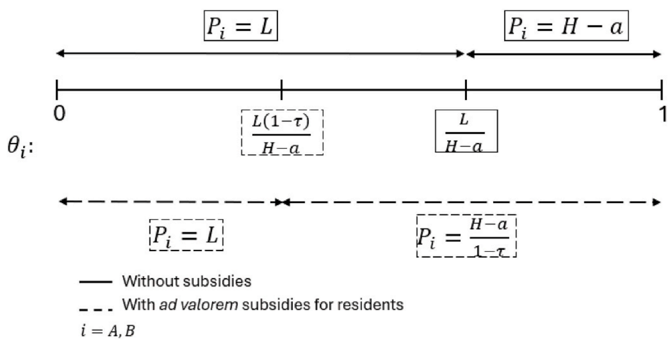

Fig. 2. Thresholds for the percentage of residents for destinations A and B for which the airline may implement the highest prices, once the *ad valorem* subsidy for residents only is introduced.

In the case of blind tickets, consumers purchase under uncertain conditions and behave as maximisers of expected utility. Thus, we make use of the Von Neumann-Morgenstern utility function (also named 'the expected utility function'), this is, the utility of buying a blind ticket is equal to the weighted sum of the utility of each destination, where weights are the probability of occurrence. We assume that both destinations are equally probable. Because of uncertainty, it is important to take into consideration consumers' risk attitudes. In the utility functions described in expressions (1), (2) and (3), α and β represent resident and non-resident passengers' risk attitudes, respectively.[5] In particular, if α (or β) $\in (0,1)$, the utility function is concave and consumers are risk-averse; if α (or β) is equal to 1, the utility function is linear and they are risk-neutral; and if α (or β) is greater than 1, the utility function is convex, and consumers are risk-loving.

Similarly to Alonso and Socorro (2024), we need to define the participation and incentive compatibility constraints. The participation constraint requires non-resident passengers to have incentives to purchase blind tickets. Regarding the incentive compatibility constraint, residents should not have incentives to purchase blind tickets and continue purchasing under perfect information conditions.

Taking into account that non-resident passengers' willingness to pay for both destinations is L, and in order to fulfil the participation constraint, the optimal price of blind tickets, P_{BT}, is determined by the following expression:

$$\frac{1}{2}(I+L-P_{BT})^{\beta}+\frac{1}{2}(I+L-P_{BT})^{\beta}=I^{\beta} \tag{4}$$

On the left-hand side, we have non-residents' expected utility when buying a blind ticket. On the right-hand side, we have non-residents' utility when not purchasing any flight ticket (it may also represent the utility that non-residents obtain when they purchase a flight in the transparent market and the price is equal to their willingness to pay, that is, L).

Notice that with the introduction of blind tickets, the airline is able to attend non-resident passengers by charging a price equal to their maximum willingness to pay for flying to these destinations. Thus, the airline does not need to introduce any promotion to attract these passengers.

Regarding resident passengers, since they are residents in one of the destinations offered through blind tickets, they are entitled to receive the subsidy when buying such an opaque product. However, with this subsidised price, residents may have incentives to purchase blind tickets, since they may be able to travel to their homes by paying $L(1-\tau)$ instead of $H-a$. Thus, for some degree of risk aversion, individual and market conditions, the expected utility of blind tickets may be larger than the utility of purchasing tickets to their homes under perfect information conditions. For this reason, and in order to fulfil the incentive compatibility constraint, the airline in such cases has to implement a discount on the price of the flight ticket in the transparent market, so that residents do not have incentives to purchase blind tickets. Let us define this discount by using x. The following expression represents the indifference condition for resident passengers, between purchasing blind tickets (left-hand side) and buying tickets to their homes under perfect information conditions (right-hand side).

$$\frac{1}{2}(I+H-L(1-\tau))^{\alpha}+\frac{1}{2}(I+L-L(1-\tau)-t)^{\alpha} = \left(I+H-\left(\frac{H-a}{1-\tau}-x\right)(1-\tau)\right)^{\alpha}. \tag{5}$$

Grouping terms and rearranging the above expression, we obtain that the optimal discount, x, to be implemented in the transparent market is:

$$x=\frac{\left[\frac{1}{2}(I+H-L(1-\tau))^{\alpha}+\frac{1}{2}(I+L\tau-t)^{\alpha}\right]^{\frac{1}{\alpha}}-I-a}{(1-\tau)} \tag{6}$$

Consumers' willingness to pay, the surplus associated with the outside option, the income, the amount of the subsidy, transportation costs and residents' risk aversion determine the optimal discount. There may exist cases in which the optimal discount is zero or even negative, which means that resident passengers do not have incentives to purchase blind tickets and no discount is needed.

Notice that the discount can be optimally calculated for any degree of risk aversion. Passengers are indeed heterogeneous. In a given flight there might be risk-averse, risk-neutral and risk-loving individuals. Risk-averse individuals may require a larger discount than risk-neutral or risk-loving passengers. Thus, if the airline implements the discount according to risk-averse individuals, then risk-neutral and risk-loving passengers may also have no incentives to purchase blind tickets.

Proposition 4. *With blind tickets the airline manages to discriminate among types of passengers. Independently of their risk attitude, non-residents purchase blind tickets at price L, which coincides with their maximum willingness to pay for travelling (participation constraint). Additionally, residents are given a discount, x, so that they don't have incentives to purchase blind tickets (incentive compatibility constraint).*

[5] This utility function is frequently used in the literature when uncertainty is present. See, for instance, Tanaka et al. (2010), Von Gaudecker et al. (2011), Schleich et al. (2019), or Alonso and Socorro (2024a, 2024b).

Table 6
Economic and social consequences of implementing an *ad valorem* subsidy for resident passengers for any value of θ_A and θ_B.

	Scenario1 : $\boldsymbol{\theta_A, \theta_B < \frac{L(1-\tau)}{H-a}}$	Scenario2 : $\boldsymbol{\theta_A < \frac{L(1-\tau)}{H-a} \frac{L(1-\tau)}{H-a} \le \theta_B < \frac{L}{H-a}}$	Scenario3 : $\boldsymbol{\theta_A < \frac{L(1-\tau)}{H-a} \theta_B \ge \frac{L}{H-a}}$	Scenario4 : $\boldsymbol{\frac{L(1-\tau)}{H-a} \le \theta_A < \frac{L}{H-a} \theta_B < \frac{L(1-\tau)}{H-a}}$	Scenario5 : $\boldsymbol{\frac{L(1-\tau)}{H-a} \le \theta_A < \frac{L}{H-a} \frac{L(1-\tau)}{H-a} \le \theta_B < \frac{L}{H-a}}$	Scenario6 : $\boldsymbol{\frac{L(1-\tau)}{H-a} \le \theta_A < \frac{L}{H-a} \theta_B \ge \frac{L}{H-a}}$	Scenario7 : $\boldsymbol{\theta_A \ge \frac{L}{H-a} \theta_B < \frac{L(1-\tau)}{H-a}}$	Scenario8 : $\boldsymbol{\theta_A \ge \frac{L}{H-a} \frac{L(1-\tau)}{H-a} \le \theta_B < \frac{L}{H-a}}$	Scenario9 : $\boldsymbol{\theta_A \ge \frac{L}{H-a} \theta_B \ge \frac{L}{H-a}}$
Benchmark case :									
$\mathbf{P_A}$	L	L	L	L	L	L	$H-a$	$H-a$	$H-a$
$\mathbf{P_B}$	L	L	$H-a$	L	L	$H-a$	L	L	$H-a$
Sold tickets dest. A	N	N	N	N	N	N	$N\theta_A$	$N\theta_A$	$N\theta_A$
Sold tickets dest. B	N	N	$N\theta_B$	N	N	$N\theta_B$	N	N	$N\theta_B$
Profits	$2NL$	$2NL$	$NL+N\theta_B(H-a)$	$2NL$	$2NL$	$NL+N\theta_B(H-a)$	$NL+N\theta_A(H-a)$	$NL+N\theta_A(H-a)$	$N(\theta_A+\theta_B)H$
***Ad valorem* subsidy for resident passengers:**									
$\mathbf{P_A}$	L	L	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$
$\mathbf{P_B}$	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$
Sold tickets dest. A	N	N	N	$N\theta_A$	$N\theta_A$	$N\theta_A$	$N\theta_A$	$N\theta_A$	$N\theta_A$
Sold tickets dest. B	N	$N\theta_B$	$N\theta_B$	N	$N\theta_B$	$N\theta_B$	N	$N\theta_B$	$N\theta_B$
Profits	$2NL$	$NL+N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$NL+N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$NL+N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$NL+N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$
Change in Social Welfare (*Ad valorem* subsidy – Benchmark case):									
$\mathbf{\Delta PS}$	0	$NL+N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$N\theta_B\left(\frac{H-a}{1-\tau}\right)\tau$	$N\theta_A\left(\frac{H-a}{1-\tau}\right)-NL$	$2NL-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$NL+N\theta_B(H-a)-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N\theta_A\frac{H-a}{1-\tau}\tau$	$N\theta_A\left(\frac{H-a}{1-\tau}\right)\left(\frac{\tau}{1-\tau}\right)+N\theta_B\left(\frac{H-a}{1-\tau}\right)-NL$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\left(\frac{\tau}{1-\tau}\right)$
$\mathbf{\Delta CS_{RES.\ A}}$	$N\theta_A L\tau$	$N\theta_A L\tau$	$N\theta_A L\tau$	$-N\theta_A(H-L-a)$	$-N\theta_A(H-L-a)$	$-N\theta_A(H-L-a)$	0	0	0
$\mathbf{\Delta CS_{RES.\ B}}$	$N\theta_B L\tau$	$-N\theta_B(H-L-a)$	0	$N\theta_B L\tau$	$-N\theta_B(H-L-a)$	0	$N\theta_B L\tau$	$-N\theta_B(H-L-a)$	0
$\mathbf{\Delta CS_{NON\text{-}RES.}}$	0	0	0	0	0	0	0	0	0
$\mathbf{\Delta GS}$	$-N(\theta_A+\theta_B)L\tau$	$-N\theta_A L\tau-N\theta_B\left(\frac{H-a}{1-\tau}\right)\tau$	$-N\theta_A L\tau-N\theta_B\left(\frac{H-a}{1-\tau}\right)\tau$	$-N\theta_A\left(\frac{H-a}{1-\tau}\right)\tau-N\theta_B L\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$	$-N\theta_A\left(\frac{H-a}{1-\tau}\right)\tau-N\theta_B L\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$
$\mathbf{\Delta SW}$	$\mathbf{0}$	$\boldsymbol{NL(\theta_B-1)<0}$	$\mathbf{0}$	$\boldsymbol{NL(\theta_A-1)<0}$	$\boldsymbol{NL(-2+\theta_A+\theta_B)<0}$	$\boldsymbol{NL(\theta_A-1)<0}$	$\mathbf{0}$	$\boldsymbol{NL(\theta_B-1)<0}$	$\mathbf{0}$

Table 7
Economic consequences of implementing blind tickets in subsidised markets for any value of θ_A and θ_B.

Benchmark case	Scenarios 1, 2, 4 and 5:	Scenarios 3 and 6:	Scenarios 7 and 8:	Scenario 9:
$\mathbf{P_A}$	L	L	$H-a$	$H-a$
$\mathbf{P_B}$	L	$H-a$	L	$H-a$
Sold tickets dest. A	N	N	$N\theta_A$	$N\theta_A$
Sold tickets dest. B	N	$N\theta_B$	N	$N\theta_B$
Profits	$2NL$	$NL+N\theta_B(H-a)$	$NL+N\theta_A(H-a)$	$N(\theta_A+\theta_B)(H-a)$

Ad valorem subsidy only for resident passengers	Scenario 1:	Scenario 2:	Scenario 3:	Scenario 4:	Scenario 5:	Scenario 6:	Scenario 7:	Scenario 8:	Scenario 9:
$\mathbf{P_A}$	L	L	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$
$\mathbf{P_B}$	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$
Sold tickets dest. A	N	N	N	$N\theta_A$	$N\theta_A$	$N\theta_A$	$N\theta_A$	$N\theta_A$	$N\theta_A$
Sold tickets dest. B	N	$N\theta_B$	$N\theta_B$	N	$N\theta_B$	$N\theta_B$	N	$N\theta_B$	$N\theta_B$
Profits	$2NL$	$NL+N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$NL+N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$NL+N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$NL+N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$

Blind tickets in subsidised markets (*ad valorem* subsidy only for resident passengers)			
$\mathbf{P_A}$	$\frac{H-a}{1-\tau}-x$	**PS**	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-x\right)+NL(2-\theta_A-\theta_B)$
$\mathbf{P_B}$	$\frac{H-a}{1-\tau}-x$	$\mathbf{CS_{RES.\ A}}$	$N\theta_A(a+x(1-\tau))$
$\mathbf{P_{BT}}$	L	$\mathbf{CS_{RES.\ B}}$	$N\theta_B(a+x(1-\tau))$
Sold tickets dest. A	N	$\mathbf{CS_{NON\text{-}RES.}}$	0
Sold tickets dest. B	N	**GS**	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-x\right)\tau$
Profits	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-x\right)+NL(2-\theta_A-\theta_B)$	**SW**	$NH(\theta_A+\theta_B)+NL(2-\theta_A-\theta_B)$

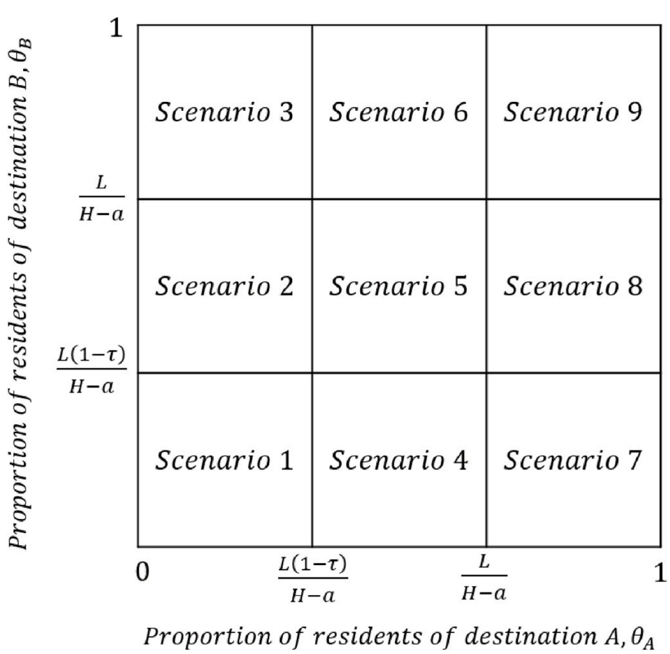

Fig. 3. Definition of different scenarios depending on the proportion of residents at each destination, θ_A and θ_B.

Expressions (7), (8) and (9) show the derivatives of the discount, x, with respect to the high willingness to pay, H, the surplus of the outside option, a, and the cost of travelling between destinations A and B, t.

$$\frac{\partial x}{\partial H}=\frac{2^{\frac{-1}{\alpha}}(I+H-L(1-\tau))^{\alpha-1}\left[(I+H-L(1-\tau))^{\alpha}+(I-t+L\tau)^{\alpha}\right]^{\frac{1-\alpha}{\alpha}}}{1-\tau}>0. \quad (7)$$

$$\frac{\partial x}{\partial a}=\frac{1}{\tau-1}<0 \quad (8)$$

$$\frac{\partial x}{\partial t}=\frac{2^{\frac{-1}{\alpha}}\left[(I+H-L(1-\tau))^{\alpha}+(I-t+L\tau)^{\alpha}\right]^{\frac{1-\alpha}{\alpha}}(I-t+L\tau)^{\alpha-1}}{\tau-1}<0. \quad (9)$$

The greater the willingness to pay sfor the destination of residence (H) is, the higher the price residents pay to fly to that destination. Therefore, a higher discount is required, so that there is no incentive to buy blind tickets. Additionally, the lower the surplus of the outside option, a, the higher the price that residents pay for travelling to their homes and, thus, a larger discount is needed. The higher the transportation cost t, the more expensive it is to travel to the destination of residence if, after buying the blind ticket, the final destination obtained is not the home destination. Therefore, the lottery becomes less attractive, and a lower discount is required. This is formally stated in the following lemma.

Lemma 1. *The discount required to fulfil the incentive compatibility constraint is higher the greater the willingness to pay for the destination of residence* (H)*, the lower the surplus of the outside option* (a)*, and the lower the cost of travelling between destinations A and B* (t).

With the implementation of blind tickets, all tickets from both destinations are sold. In social terms, we guarantee that all non-resident passengers purchase flight tickets and travel to destination A or B. Regarding the profitability for airlines, all resident passengers purchase flight tickets at a price equal to $\frac{H-a}{1-\tau}-x$. Thus, while in some cases the airline loses some revenues because of the discount, in other scenarios this pricing strategy allows airlines to increase profits. Tables 7 and 8 show the main results of introducing blind tickets in subsidised markets, as well as a comparison with respect to the benchmark case (no subsidies) and the case of the *ad valorem* subsidy for resident passengers without blind tickets. We analyse the optimality of blind tickets considering that the optimal discount is a positive number.

Introducing blind tickets enhances social welfare with respect to both the benchmark case and the case of an *ad valorem* subsidy only for resident passengers. As shown in Table 8, only when the proportion of residents of both destinations is very low, does implementing blind tickets result in the same level of social welfare with respect to the case in which the government introduces a resident subsidy. However, in the remaining cases, implementing blind tickets increases social welfare. Notice that this increase depends on passengers' willingness to pay and the proportion of residents at destination A and destination B, but not on passengers' risk attitude.

Proposition 5. *An ad valorem subsidy for resident passengers combined with blind tickets never decreases social welfare. Moreover, unless the proportion of residents at both destinations is very low (Scenario 1), blind tickets always increase social welfare in subsidised air transport markets and this increase does not depend on individuals' risk attitude.*

Table 8 includes a profitability constraint that shows the maximum discount above which it would not be profitable for the airline to introduce blind tickets.

In *Scenario 1*, the implementation of blind tickets results in an increase in the price paid by resident passengers. This scenario shows an example that should not be allowed by the public authorities. If the proportion of residents is low, $\theta_A, \theta_B < \frac{L(1-\tau)}{H-a}$, the airline exercises its maximum market power by increasing the price paid by resident travellers. Therefore, under these circumstances, although blind tickets do not generate any social welfare change, their sale should be prohibited since it only benefits the airline (it does not benefit resident passengers, which is the aim of the policy).

In *Scenario 2* and *Scenario 3*, the implementation of blind tickets results in an increase in the price paid by residents of destination A. Regarding destination B, while resident passengers pay lower fares, non-residents can travel to destination B through blind tickets. Thus, blind tickets solve the inefficiency derived from the *ad valorem* subsidy and increase social welfare because new non-resident passengers travel to destination B. In *Scenario 3*, with the introduction of the *ad valorem* subsidy, non-resident passengers decide not to travel to destination A because of the increase in prices. However, blind tickets guarantee that all non-resident passengers travel to destinations A and B. While residents of destination B are worse off because of higher fares, residents of destination A benefit from the discount. Overall, blind tickets suppose an increase in social welfare.

In *Scenario 4* and *Scenario 7*, non-resident passengers do not travel to destination A because of the subsidy. Blind tickets reduce the price paid by residents of destination A, and allow non-residents to travel to destination B. However, residents of destination B are worse off because of higher fares.

Regarding *Scenario 5*, *Scenario 8* and *Scenario 9,* the introduction of the *ad valorem* subsidy excludes all non-resident passengers from the market. Thanks to blind tickets, not only do non-resident passengers travel to both destinations, but residents also benefit from paying lower fares because of the discount. In social terms, these are the most favourable scenarios for introducing blind tickets since they would benefit all passengers. In fact, even if the necessary discount is so high that introducing blind tickets is unprofitable for the airline, policymakers should encourage them and even compensate the airline since this pricing strategy benefits all passengers.

Finally, in *Scenario 6,* blind tickets allow non-residents to travel to destination A. Residents pay lower fares because of the discount. Additionally, public expenditure is reduced because of lower fares.

This model highlights interesting insights for policymakers. Overall, non-resident passengers benefit from blind tickets. The proportion of residents determines to what extent blind tickets increase social welfare and benefit resident passengers. In most scenarios resident passengers benefit from blind tickets since they pay lower fares. However, there exist other scenarios in which residents pay higher fares. Policymakers should take these latter cases into account and consider possible alternatives to limit the market power of airlines and redistribute their profits.

In all scenarios, we compute the maximum discount for residents such that above that threshold it would be unprofitable for the airline to sell blind tickets (profit constraint). Policymakers should also take this information into account and analyse whether it is optimal to encourage the airline to implement blind tickets since they benefit resident and non-resident passengers.

4. Some numerical illustrations: the case of Spain

In order to illustrate the main results of the model, let us consider the following numerical examples based on real data. In Spain, residents of the Canary Islands, Balearic Islands and the autonomous cities of Ceuta and Melilla benefit from an *ad valorem* subsidy. The subsidy applies to all routes from the place of residence to the mainland of Spain and inter-island routes. In 2018 the *ad valorem* subsidy in Spain was increased up to 75 per cent and the public expenditure has climbed to nearly 800 million euros, with significant price increases to non-residents (de Rus and Socorro, 2022).

According to Eurostat (2023), Europeans spent on average €952 on a foreign trip in 2022. Thus, in our numerical illustrations, individuals are assumed to have an income equal to €1000. The proportion of resident passengers in each subsidised route is taken from de Rus and Socorro (2022). Although flight ticket prices are constantly fluctuating due to factors such as, among others, seasonality and how far in advance the purchase is made, the values related to willingness to pay and transportation costs are selected based on a variety of plausible real-world data for the selected routes.[6] Since routes are not always covered by the same aircraft, we consider different aircraft sizes (136, 150 and 200 seats) in order to illustrate the results of the paper.[7]

Let us start with the following example (*numerical example 1*). At the time of writing, only one airline is covering the subsidised routes Zaragoza - Tenerife and Zaragoza – Mallorca through direct flights. Thus, let us consider Zaragoza as city C, Tenerife as destination A, and Mallorca as destination B. According to de Rus and Socorro (2022), the percentage of residents in the route Zaragoza – Tenerife is 34.7 %, while in the route Zaragoza – Mallorca is 36.6 %. In addition, let us consider that the high willingness to pay, H, the surplus of the outside option, a, and the low willingness to pay, L, are equal to €200, €50 and €50, respectively. All the data consider in this example are summarized in Table 9.

Table 10 shows the main results of the benchmark case, the case of the *ad valorem* subsidy for resident passengers and the case of the *ad valorem* subsidy for resident passengers combined with blind tickets. Notice that the analysis is made for one specific flight. If the airline operates more than one flight on the route, all results should be multiplied accordingly.

In the benchmark case, since the proportion of residents is large enough, the airline charges the high fare and only residents travel to both destinations. With the *ad valorem* subsidy for resident passengers

[6] Specifically, all routes in the different examples are operated by either Binter or Vueling airlines. Data on willingness to pay and transport costs are based on a range of plausible real-world figures, sourced directly from their official websites.

[7] The smallest aircraft that usually operates on these routes are the Embraer 195-E2 and the AIRBUS A320-214, with 132 seats; and the largest aircraft is usually the BOEING 737-8AS, with 189 seats.

Table 8
Social consequences of implementing blind tickets in subsidised markets for any value of θ_A and θ_B.

Changes in Social Welfare (Blind tickets in subsidised markets – Benchmark case)

	Scenarios 1,2,4 and 5	Scenarios 3,6	Scenarios 7 and 8	Scenario 9
ΔPS	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-x\right)+NL(1-\theta_A-\theta_B)$	$NL(1-\theta_A-\theta_B)+N\theta_A\left(\frac{H-a}{1-\tau}-x\right)+N\theta_B\left(\frac{H-a}{1-\tau}-x+H-a\right)$	$NL(1-\theta_A-\theta_B)+N\theta_A\left(\frac{H-a}{1-\tau}-x-H+a\right)-N\theta_B\left(\frac{H-a}{1-\tau}-x\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-x-H+a\right)+NL(2-\theta_A-\theta_B)$
Profit constraint	$\left(\frac{H-a}{1-\tau}\right)-x>L$	$L+\theta_A\left(\frac{H-a}{1-\tau}-x-L\right)+\theta_B\left(\frac{H-a}{1-\tau}-x+H-a-L\right)>0$	$L+\theta_A\left(\frac{H-a}{1-\tau}-x-H+a-L\right)+\theta_B\left(\frac{H-a}{1-\tau}-x-L\right)>0$	$(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-H-a-x-L\right)+2L>0$
$\Delta CS_{RES.\ A}$	$N\theta_A(L+a+x(1-\tau)-H)$	$N\theta_A(a+x(1-\tau)-H+L)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$
$\Delta CS_{RES.\ B}$	$N\theta_B(L+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$	$N\theta_B(a+x(1-\tau)-H+L)$	$N\theta_B x(1-\tau)$
$\Delta CS_{NON\text{-}RES.}$	0	0	0	0
ΔGS	$-N(\theta_A+\theta_B)\tau\left(\frac{H-a}{1-\tau}-x\right)$	$-N(\theta_A+\theta_B)\tau\left(\frac{H-a}{1-\tau}-x\right)$	$-N(\theta_A+\theta_B)\tau\left(\frac{H-a}{1-\tau}-x\right)$	$-N(\theta_A+\theta_B)\tau\left(\frac{H-a}{1-\tau}-x\right)$
ΔSW	$\mathbf{0}$	$\boldsymbol{NL(1-\theta_B)>0}$	$\boldsymbol{NL(1-\theta_A)>0}$	$\boldsymbol{NL(2-\theta_A-\theta_B)>0}$

Changes in Social Welfare (Blind tickets in subsidised markets - *Ad valorem* subsidy only for resident passengers)

	Scenario 1	Scenarios 2 and 3	Scenario 4	Scenarios 5 and 6	Scenario 7	Scenarios 8 and 9
ΔPS	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-x\right)+NL(1-\theta_A-\theta_B)$	$N\theta_A\left(\frac{H-a}{1-\tau}-x\right)-N\theta_B x+NL(1-\theta_A-\theta_B)$	$N\theta_B\left(\frac{H-a}{1-\tau}-x\right)-N\theta_A x+NL(1-\theta_A-\theta_B)$	$NL(2-\theta_A-\theta_B)-Nx(\theta_A+\theta_B)$	$N\theta_B\left(\frac{H-a}{1-\tau}-x\right)-N\theta_A x+NL(1-\theta_A-\theta_B)$	$NL(2-\theta_A-\theta_B)-Nx(\theta_A+\theta_B)$
Profit constraint	$x<\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{\theta_A}{\theta_A+\theta_B}\right)\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{\theta_B}{\theta_A+\theta_B}\right)\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{2-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{\theta_B}{\theta_A+\theta_B}\right)\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{2-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$
$\Delta CS_{RES.\ A}$	$N\theta_A(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_A(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$
$\Delta CS_{RES.\ B}$	$N\theta_B(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$	$N\theta_B(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$	$N\theta_B(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$
$\Delta CS_{NON\text{-}RES.}$	0	0	0	0	0	0
ΔGS	$-N(\theta_A+\theta_B)\tau\left(\frac{H-a}{1-\tau}-x-L\right)$	$-N\theta_A\tau\left(\frac{H-a}{1-\tau}-x-L\right)+N\theta_B x\tau$	$N\theta_A x\tau-N\theta_B\tau\left(\frac{H-a}{1-\tau}-x-L\right)$	$N(\theta_A+\theta_B)x\tau$	$N\theta_A x\tau-N\theta_B\tau\left(\frac{H-a}{1-\tau}-x-L\right)$	$N(\theta_A+\theta_B)x\tau$
ΔSW	$\mathbf{0}$	$\boldsymbol{NL(1-\theta_B)>0}$	$\boldsymbol{N\theta_B L+NL(1-\theta_A-\theta_B)>0}$	$\boldsymbol{NL(2-\theta_A-\theta_B)>0}$	$\boldsymbol{N\theta_B L+NL(1-\theta_A-\theta_B)>0}$	$\boldsymbol{NL(2-\theta_A-\theta_B)>0}$

Table 9
Numerical example 1: routes, parameter values and data sources.

Numerical example 1	
Routes	Zaragoza (city C) – Tenerife (destination A) Zaragoza (city C) – Mallorca (destination B)
Parameters	$H = 200;\ a = 50;\ t = 130;\ L = 50;\ N = 150;\ \tau = 0.75;\ I = 1000;$ $\theta_A = 0.347;\ \theta_B = 0.366;\ \alpha = 1.5$
Data sources (*)	De Rus and Socorro (2022); Eurostat (2023); https://www.vueling.com/es.

(*) Data collected in December 2024.

Table 10
Main results of *numerical example 1.*

	Benchmark case	*Ad valorem* subsidy for resident passengers	Blind tickets in subsidised air markets
Case/Scenario in corresponding Table	*Case 1* in Tables 2 and 3	*Case 1* in Tables 4 and 5 and *Scenario 9* in Table 6	*Scenario 9* in Table 7
Justification of Case/Scenario	$\theta_A, \theta_B > \dfrac{50}{200-50}$		
P_A	€ 150	€ 600	€ 591.29
P_B	€ 150	€ 600	€ 591.29
P_{BT}	–	–	€ 50
x	–	–	€ 8.71
Tickets sold dest. A	52	52	52
Tickets sold dest. B	55	55	55
Tickets sold BLIND TICKETS	–	–	193
PS	€ 16050	€ 64200	€ 72918.03
$CS_{RES.\ A}$	€ 2600	€ 2600	€ 2713.23
$CS_{RES.\ B}$	€ 2750	€ 2750	€ 2869.76
$CS_{NON\text{-}RES.}$	€ 0	€ 0	€ 0
GS	€ 0	€ – 48150	€ – 47451.02
SW	€ 21400	€ 21400	€ 31050

only, the airline proportionally increases the prices and only resident passengers continue travelling to both destinations. On both routes, non-residents do not travel to any destination, either with or without the *ad valorem* subsidy only for residents. The implementation of the *ad valorem* subsidy supposes more than €48,000 additional revenue for the airline.

When implementing blind tickets in the subsidised market, all non-resident passengers purchase in this market and they are charged their maximum willingness to pay. Additionally, resident passengers benefit from a discount when travelling to their homes, which also implies a decrease in public expenditure. This discount is insufficient since there exists a high transportation cost when moving between Tenerife and Mallorca. Overall, this numerical example shows that implementing blind tickets in a subsidised market enhances social welfare by more than 40 per cent with respect to the benchmark case, resulting in a better social equilibrium.

Table 11 shows the changes in social welfare, as well as the changes in producer, consumers and government surpluses under three different situations. The first column shows the changes in social welfare when, compared to the benchmark case, an *ad valorem* subsidy for residents is introduced. In this first situation, the airline appropriates the whole subsidy and the social welfare does not change. Therefore, the subsidy for residents is completely ineffective. The second column shows the changes derived from implementing blind tickets in a subsidised market. In this second situation, all agents are better off than in the situation in which an *ad valorem* subsidy for residents is implemented without blind tickets. The third column shows the changes resulting from introducing blind tickets in a subsidised market in comparison with the case in which there are no subsidies (i.e., the benchmark case). While the social welfare does not change when an *ad valorem* subsidy for residents is introduced and the airline completely appropriates such a subsidy, there exists an increase in social welfare if this subsidy is introduced in combination with blind tickets.

Table 11
Changes in social welfare with data from *numerical example 1.*

	Ad valorem subsidy – Benchmark case	Blind tickets in subsidised air markets – *Ad valorem* subsidy	Blind tickets in subsidised air markets – Benchmark case
Case/ Scenario	*Scenario 9*in Table 6	*Scenario 9*in Table 8	*Scenario 9*in Table 8
ΔPS	€ 41,850	€ 8,718.03	€ 56,868.03
$\Delta CS_{RES.\ A}$	€ 0	€ 113.23	€ 113.23
$\Delta CS_{RES.\ B}$	€ 0	€ 119.76	€119.76
$\Delta CS_{NON\text{-}RES.}$	€ 0	€ 0	€ 0
ΔGS	€ – 48,150	€ 698.98	€ – 47,451.02
ΔSW	€ 0	€ 9,650	€ 9,650

According to previous research and as shown in this paper, the introduction of the subsidy increases the airline's market power. Indeed, in the case analysed in *Numerical example 1,* the airline appropriates the whole subsidy. When introducing blind tickets in the subsidised market, the airline loses some revenues from resident passengers that are compensated for by the additional revenues from blind tickets. Moreover, resident passengers are better off because of lower fares and all non-resident passengers travel to both destinations. Their surplus is also zero, but the difference between the benchmark case and the case of the *ad valorem* subsidy is that with blind tickets, they do travel, paying a price equal to their willingness to pay.

This numerical example illustrates a situation in which, with the implementation of blind tickets in subsidised air markets, both the airline and resident passengers are better off, non-resident passengers are not excluded from the market, and public expenditure is reduced. Moreover, if we compare the surpluses of blind tickets in subsidised air markets with respect to the benchmark case, we can conclude that both the airline and resident passengers are better off, and non-residents decide to travel. Overall, therefore, blind tickets increase social welfare.

The profitability of implementing blind tickets for airlines and resident passengers depends on the size of the discount given to resident passengers. Residents' risk attitude determines the optimal discount. Fig. 4 shows, for any possible risk attitude of resident passengers, the changes in producer surplus, consumer surplus, government surplus, and social welfare when introducing blind tickets in a subsidised market with respect to, either the case in which we only have an *ad valorem* subsidy, or the benchmark case.

Notice that, when comparing the case of blind tickets and the case of the *ad valorem* subsidy, if residents' risk attitude is lower than 1.27 no discount for residents is needed. Results show that the degree of residents' risk aversion affects the change in the producer, residents and government surpluses but not the change in social welfare. If residents are risk-loving, the airline loses some profits while residents are better off. Additionally, there is a decrease in government surplus. Overall, risk attitude implies a trade-off between producer, residents and government surpluses.

When comparing the case of blind tickets and the benchmark case, we observe that again the change in social welfare does not depend on residents' risk attitude, although it slightly affects the change in producer, residents and government surpluses.

The size of the subsidy directly affects the amount of the discount needed in order to avoid the deviation of resident passengers to the opaque market. Fig. 5 extends the sensitivity analysis depending on the amount of the subsidy, τ. It also shows the changes in producer surplus, consumer surplus and government surplus and social welfare when introducing blind tickets in subsidised markets with respect to the base cases.

As long as the *ad valorem* subsidy is lower than 0.706 no discount is needed. Similar to the previous analysis, social welfare remains the same independently of the *ad valorem* subsidy. When comparing the case of

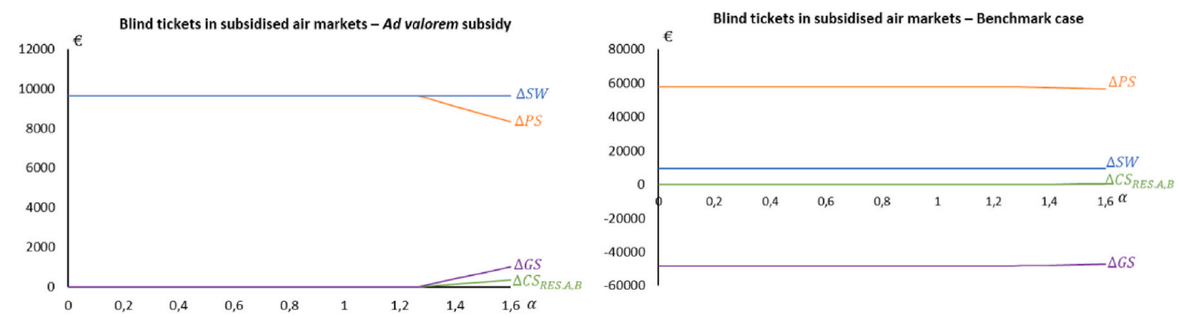

Fig. 4. Changes in private and social welfare depending on residents' risk attitude in *numerical example 1*.

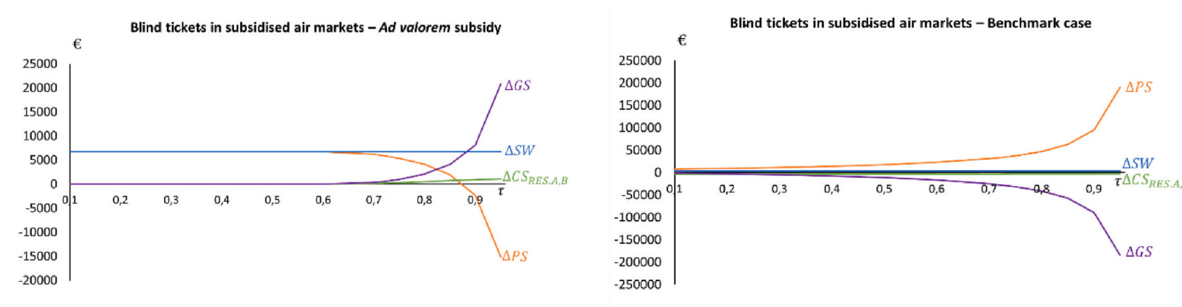

Fig. 5. Changes in private and social welfare depending on the amount of the subsidy, τ, in *numerical example 1*.

Table 12
Numerical example 2: routes, parameter values and data sources.

Numerical example 2	
Routes	Málaga (city C) – Fuerteventura (destination A) Málaga (city C) – Tenerife (destination B)
Parameters	$H = 160$; $a = 60$; $t = 55$; $L = 35$; $N = 150$; $\tau = 0.75$; $I = 1000$; $\theta_A = 0.337$; $\theta_B = 0.378$; $\alpha = 1.5$
Data sources (*)	De Rus and Socorro (2022); Eurostat (2023); https://www.bintercanarias.com/es

(*) Data collected in December 2024.

blind tickets and the case of the *ad valorem* subsidy, larger subsidies require larger discounts, reducing private profitability. However, when comparing blind tickets and the benchmark case, despite the larger discount needed with the increase of the *ad valorem* subsidy, the airline is better off because of the introduction of non-resident passengers in the market (recall that in the benchmark case of *numerical example 1*, non-residents were excluded from the market: case 1 in Tables 2 and 3). See also that the increase in the amount of the subsidy implies a reduction in the government surplus. This numerical example reinforces the main results of this paper.

In order to show the robustness of the results, let us consider another two Spanish subsidised routes (*numerical example 2*): Málaga - Fuerteventura and Málaga - Tenerife. At the time of writing, both are operated by just one airline.[8] Let us consider Málaga as city C, Fuerteventura as destination A, and Tenerife as destination B. The proportion of residents on both routes, θ_A and θ_B, are equal to 33.7 and 37.8 per cent, respectively (de Rus and Socorro, 2022). Moreover, let us consider that the willingness to pay for travel in the case of resident passengers, H, is equal to €160, while the surplus of the outside option, a, the low willingness to pay, L, are equal to €60 and €35, respectively. The data for this second example, called *Numerical example 2*, is summarized in Table 12.

Table 13 shows the main results associated with each case, depending on whether there exist -or not-the *ad valorem* subsidy in combination -or not-with blind tickets. Similarly to the previous example, according to the number of passengers willing to travel on each route, we are assuming that the analysis is just for one flight.

In the benchmark case, because of the low proportion of residents in Fuerteventura willing to travel from Málaga, the airline implements the lower fare, L, and all passengers travel to Fuerteventura. Regarding the Málaga-Tenerife route, since the proportion of Tenerife residents willing to travel from Málaga exceeds the corresponding threshold, the airline charges the high fare, $H - a$, on this route. Thus, only residents of Tenerife travel from Málaga.

When implementing the *ad valorem* subsidy, the proportion of residents of both Fuerteventura and Tenerife exceeds the minimum threshold for the airline to apply the high price, $\frac{H-a}{1-\tau}$. Thus, non-resident passengers do not fly to any of these destinations. As shown in Tables 11 and in the case of the Málaga-Fuerteventura route prices are quadrupled, while in the case of Málaga-Tenerife the increase is even greater, from €35 to €400.

When introducing blind tickets, they are sold at a price equal to €35 and the optimal discount needed for residents is equal to €12.63. Despite the airline losing some revenue from resident passengers because of the discount, the sale of blind tickets compensates these losses. Thus, in this scenario, by introducing blind tickets, the airline accommodates non-resident passengers in both markets and increases its profits.

To evaluate the changes in all surpluses and social welfare, Table 14 provides a comparison of the different situations.

As previously stated, the implementation of the subsidy excludes non-resident passengers from both markets, while residents of Fuerteventura are worse off because of higher fares. Overall, the introduction of an *ad valorem* subsidy for residents results in a loss of social welfare.

When introducing blind tickets in subsidised air markets, all non-resident passengers decide to fly on both routes, although there is no change in their consumer surplus since they are charged their maximum willingness to pay for travelling. Residents also benefit from blind tickets since they pay lower fares for travelling to their homes. Additionally, the ticket price reduction in the transparent market produces a decrease in

[8] Data collected in December 2024.

Table 13
Main results of *numerical example 2.*

	Benchmark case	*Ad valorem* subsidy for resident passengers	Blind tickets in subsidised air markets
Case/Scenario in corresponding Table	*Case 3* in Tables 2 and 3	*Case 1* in Tables 4 and 5 and *Scenario 6* in Table 6	*Scenario 6* in Table 7
Justification of Case/Scenario	$\theta_A < \frac{35}{160-60}$ $\theta_B > \frac{35}{160-60}$	$\frac{35(1-0.75)}{160-60} < \theta_A < \frac{35}{160-60}$; $\theta_B > \frac{35}{160-60}$	
P_A	€ 35	€ 400	€ 387.37
P_B	€ 100	€ 400	€ 387.37
P_{BT}	–	–	€ 35
x	–	–	€ 12.63
Tickets sold dest. A	150	51	51
Tickets sold dest. B	57	57	57
BLIND TICKETS sold	–	–	192
PS	€ 10,950	€ 43,200	€ 48,555.96
$CS_{RES.\ A}$	€ 6,375	€ 3,060	€ 3,221.16
$CS_{RES.\ B}$	€ 3,420	€ 3,420	€ 3,600.12
$CS_{NON\text{-}RES.}$	€ 0	€ 0	€ 0
GS	€ 0	€ − 32,400	€ − 31376.97
SW	€ 20,745	€ 17,280	€ 24,000.27

Table 14
Changes in social welfare with data from *Numerical example 2.*

	Ad valorem subsidy – Benchmark case	Blind tickets in subsidised air markets – *Ad valorem* subsidy	Blind tickets in subsidised air markets – Benchmark case
Case/Scenario	*Scenario 6* in Table 6	*Scenario 6* in Table 8	*Scenario 6* in Table 8
ΔPS	€ 32250	€ 5355.96	€ 37605.96
$\Delta CS_{RES.\ A}$	€ − 3315	€ 161.16	€ − 3153.84
$\Delta CS_{RES.\ B}$	€ 0	€ 161.16	€ 180.12
$\Delta CS_{NON\text{-}RES.}$	€ 0	€ 0	€ 0
ΔGS	€ − 32400	€ 1023.03	€ − 31376.97
ΔSW	€ − 3465	€ 6720.27	€ 3255.27

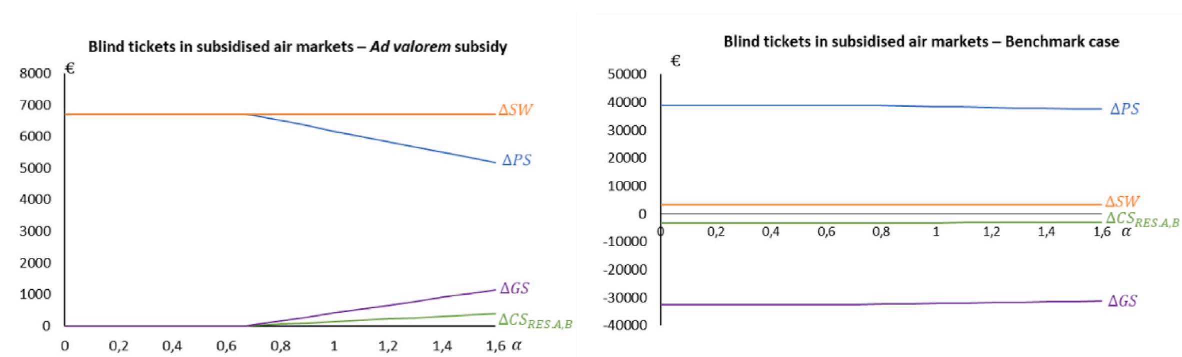

Fig. 6. Changes in private and social welfare depending on residents' risk attitude in *Numerical example 2.*

public expenditure. Therefore, blind tickets suppose an increase in social welfare. Although the increase in social welfare is mostly derived from the revenues of non-resident passengers, it is important to highlight the benefits that these new tourists arriving on both islands may have. More tourists may imply higher tourism expenditure and employment in Fuerteventura and Tenerife.

Comparing the surpluses of blind tickets in subsidised air markets with respect to the benchmark case, we can see that in this example residents of Fuerteventura are worse off. The reason is that these passengers pay low fares in the benchmark case. Government expenditure is also higher. Despite this fact, there is an increase in social welfare. Therefore, the airline might be able to compensate residents of Fuerteventura and taxpayers and still be better off than in the benchmark case.

Similar to the previous example, Fig. 6 shows, for any degree of residents' risk aversion, the changes in producer surplus, residents surplus, government surplus, and social welfare when introducing blind tickets in a subsidised market with respect to, either the case in which we have an *ad valorem* subsidy only, or the benchmark case.

Results show that if residents have a risk attitude lower than 0.67, no discount is needed. When α increases, the optimal discount increases too and, while residents benefit from a larger discount, the airline loses some revenues. As shown in both figures, independently of residents' risk attitude, blind tickets are always optimal for airlines. According to the right side of the figure, when introducing blind tickets with respect to the benchmark case, resident passengers are always worse-off because of the increase in prices. Despite this, there is an increase in social welfare which is independent of the degree of residents' risk aversion.

Fig. 7 shows, similar to the previous example, the changes in producer surplus, consumers surplus, government surplus and social welfare depending on the size of the *ad valorem* subsidy.

In this example, if τ is lower than 0.66 no discount is needed. Similar to the previous example, when comparing the introduction of blind tickets in subsidised markets airlines are worse off as long as τ increases. On the contrary, when comparing the introduction of blind tickets with

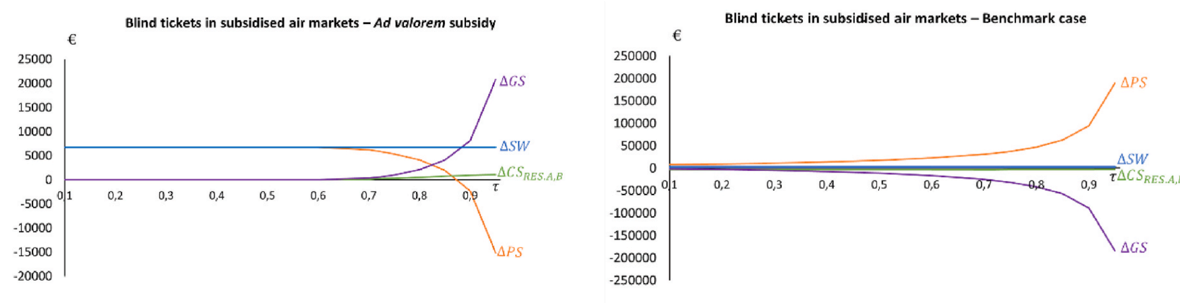

Fig. 7. Changes in private and social welfare depending on the amount of the subsidy, τ, in *Numerical example 2.*

respect to the benchmark case those private losses are compensated with additional revenues. See that in this case the introduction of blind tickets allows airlines to charge larger prices to resident passengers of destination A and introduce those non-residents willing to travel to destination B.

Both numerical examples show different market conditions and results. Despite their differences, both examples show how blind tickets solve the inefficiencies derived from the *ad valorem* subsidy and imply an increase in social welfare that does not depend on passengers' risk attitude. Thus, these results may be of interest to both airlines and policymakers.[9]

5. Conclusions

Subsidies for residents in air transport are commonly used for addressing disparities in connectivity and access to essential services in remote and disadvantaged regions. While the liberalisation of air transport markets has improved social welfare and economic efficiency globally, it has not fully resolved the challenges faced by residents in isolated areas, such as islands or geographically remote locations. These areas often lack sufficient market demand to attract competitive airline services, leading to limited connectivity and disproportionately high airfares.

Although these kinds of subsidies aim to increase air connectivity and social cohesion in disadvantaged areas, the existing literature highlights their inefficiencies. In general, subsidies for resident passengers may result in higher ticket prices and the exclusion of non-resident passengers. Regarding tourism, this policy implies lower tourism demand and expenditure at destinations. Thus, although subsidies for resident passengers may be justified for equity reasons, they involve significant inefficiencies and undesirable effects, especially when there is low competition and the proportion of residents is high.

This paper analyses the optimality of blind tickets in order to manage those inefficiencies. Blind tickets consist of surprise flights in which customers purchase a flight ticket without knowing the destination they are flying to. Once they pay, they receive detailed information about the final destination.

Prior research on blind tickets highlights their profitability for airlines and their success among customers. In this paper, we show that they might also be a socially-optimal pricing strategy to solve the inefficiencies derived from *ad valorem* subsidies in air transport markets. This pricing strategy increases airline's profits by creating two different markets (the transparent market and the opaque market), which allows the airline to discriminate between resident and non-resident passengers. Additionally, this pricing strategy may improve travellers' welfare. On the one hand, the implementation of blind tickets never implies a price increase for resident passengers in subsidised markets. On the contrary, in most cases they can benefit from additional discounts. On the other hand, blind tickets reintroduce non-resident passengers into the market.

Therefore, blind tickets always improve social welfare in subsidised markets, as long as there are inefficiencies present, which is typically the case unless the share of residents is very low or there is strong competition on the route.

In practice, when implementing blind tickets, it is crucial for airlines to understand the risk attitudes of resident passengers in order to prevent them from shifting to the opaque market. It is widely accepted that individuals are generally risk-averse (see, for instance, Ariffin et al., 2018; Cohen and Einav, 2007; Guenther et al., 2021; Tan, 1999). Moreover, during the booking process, airlines may collect personal information—such as age, gender, and advance purchase time—which can serve as proxies for individuals' risk attitudes. Nevertheless, in this paper, we demonstrate that even in the worst-case scenario, where residents are risk-loving, blind tickets always increase social welfare and may also enhance airline profits. Furthermore, we show that the increase in social welfare resulting from the combination of blind tickets and subsidies for residents is independent of passengers' risk attitudes. Therefore, our results are robust and applicable under various market conditions.

To the best of our knowledge, this paper is the first to provide an alternative pricing strategy that may coexist with subsidies for residents, mitigating the inefficiencies associated with such subsidies and enhancing social welfare. Thus, the results of this paper have different policy implications. First, they solve the two main inefficiencies derived from the subsidy: the increase in ticket prices and the exclusion of non-residents. Second, they do not require any additional public funds for their implementation since the policy is also optimal for the airline. Third, both resident passengers travelling at lower fares and non-residents reintroduced in the market, generate additional inbound and outbound tourism demand. Consequently, implementation of this policy may lead to additional tourist expenditure and, therefore, to the growth and development of tourism economies.

The findings and policy recommendations presented above open avenues for practical implementation. Policymakers and stakeholders in the aviation and tourism sectors can consider this framework to promote air connectivity and economic growth without additional public expenditure. Furthermore, understanding passengers' risk attitudes and preferences more deeply might enable airlines to refine the implementation of such pricing strategies, maximising both profitability and social welfare.

Finally, the potential for increased tourism demand and expenditure due to improved connectivity aligns with global efforts to promote sustainable and inclusive economic development in remote and disadvantaged regions. By fostering collaboration between governments, airlines, and regional authorities, blind ticket strategies could catalyse long-term growth in these areas, ensuring a balance between equity and efficiency in transport and tourism markets.

[9] For additional numerical illustrations, and in order to validate the robustness of the main results, see the appendix.

CRediT authorship contribution statement

Juana M. Alonso: Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis. **M. Pilar Socorro:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

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Declaration of interests

None.

APPENDIX

In order to further illustrate, under different market conditions, how the use of blind tickets increases social welfare on subsidised routes, two additional numerical illustrations are included in this appendix. To demonstrate the robustness of the results to risk attitude, we consider two different risk attitudes for resident passengers in each numerical example. In all cases, there is an increase in social welfare when blind tickets are introduced.

Numerical example 3 considers the case of the following subsidised routes: Málaga - Gran Canaria and Málaga - Tenerife. At the time of writing, only one airline is covering both routes through direct flights.[10] Let us consider Málaga as city C, Gran Canaria as destination A, and Tenerife as destination B. In order to show that the results are robust to changes in risk attitude, we consider two possible risk attitudes for residents: $\alpha = 1.2$. and $\alpha = 0.6$. The remaining data is as follows: $H = 120$; $a = 30$; $t = 50$; $L = 80$; $N = 200$; $\tau = 0.75$; $I = 1000$; $\theta_A = 0.5$; $\theta_B = 0.378$.

Table A1
Main results of *numerical example 3.*

Málaga (city C) – Gran Canaria (destination A)
Málaga (City C) – Tenerife (destination B)
H = 120; a = 30; t = 50; L = 80; N = 200; τ = 0.75; I = 1000;
θ_A = 0.5; θ_B = 0.378

	$\alpha = 1.2$		$\alpha = 0.6$	
	Ad valorem subsidy for resident passengers	Blind tickets in subsidised air transport markets	Ad valorem subsidy for resident passengers	Blind tickets in subsidised air transport markets
Case/Scenario in corresponding Table	*Case 1* in Tables 4 and 5 and *Scenario 5* in Table 6	*Scenario 5* in Table 7	*Case 1* in Tables 4 and 5 and *Scenario 5* in Table 6	*Scenario 5* in Table 7
P_A	€ 360	€ 259.23	€ 360	€ 261.54
P_B	€ 360	€ 259.23	€ 360	€ 261.54
P_{BT}	–	€ 80	–	€ 80
x	–	€ 100.77	–	€ 98.46
Tickets sold dest. A	100	100	100	100
Tickets sold dest. B	76	76	76	76
Tickets sold blind tickets	–	224	–	224
PS	€ 63,360	63,544.48	63,360	63.951.04
CS_{RA}	€ 3,000	5,519.25	3,000	5,641.5
CS_{RB}	€ 2,280	4,194.63	2,280	4,150.74
CS_{NR}	€ 0	€ 0	€ 0	€ 0
GS	− 47,520	− 34,218.36	− 47,520	− 34,523.28
SW	21,120	39,040	21,120	39,040

Blind tickets in subsidised air transport markets – Ad valorem subsidy for resident passengers
Scenario 5 in Table 8

ΔPS	€ 184.48	€ 591.04
ΔCS_{RA}	€ 2,519.25	€ 2,461.5
ΔCS_{RB}	€1,914.63	€ 1,870.74
ΔCS_{NR}	€ 0	€ 0
ΔGS	€ 13,301.64	€ 12,996.72
ΔSW	€ 17,920	€ 17,920

[10] Data collected in December 2024.

Numerical example 4 considers the case of the following subsidised routes: A Coruña - Gran Canaria and A Coruña - Tenerife. At the time of writing, only one airline is covering both routes through direct flights.[11] Let us consider A Coruña as city C, Gran Canaria as destination A, and Tenerife as destination B. In order to show that the results are robust to changes in the risk attitude, we consider two possible risk attitudes for residents: $\alpha = 1.5$. and $\alpha = 0.4$. The remaining data is as follows: $H = 160$; $a = 40$; $t = 100$; $L = 50$; $N = 136$; $\tau = 0.75$; $I = 1000$; $\theta_A = 0.368$; $\theta_B = 0.245$.

Table A2
Main results of *numerical example 4*.

A Coruña (city C) – Gran Canaria (destination A)
A Coruña (city C) – Tenerife (destination B)
$H = 160$; $a = 40$; $t = 100$; $L = 50$; $N = 136$; $\tau = 0.75$; $I = 1000$;
$\theta_A = 0.368$; $\theta_B = 0.245$

	$\alpha = 1.5$		$\alpha = 0.4$	
	Ad valorem subsidy for resident passengers	Blind tickets in subsidised air transport markets	*Ad valorem* subsidy for resident passengers	Blind tickets in subsidised air transport markets
Case/Scenario in corresponding Table	*Case 1* in Tables 4 and 5 and *Scenario 5* in Table 6	*Scenario 5* in Table 7	*Case 1* in Tables 4 and 5 and *Scenario 5* in Table 6	*Scenario 5* in Table 7
P_A	€ 560	€ 460	€ 560	€ 482.72
P_B	€ 560	€ 460	€ 560	€ 482.72
P_{BT}	–	€ 80	–	€ 80
x	–	€ 100	–	77.28
Tickets sold dest. A	50	50	50	50
Tickets sold dest. B	33	33	33	33
Tickets sold blind tickets	–	189	–	189
PS	€ 46,480	€ 47,630	€ 46,480	€ 49,515.76
CS_{RA}	€ 1,000	€ 2,250	€ 1,000	€ 1,966
CS_{RB}	€ 660	€ 1,485	€ 660	€ 1,297.56
CS_{NR}	€ 0	€ 0	€ 0	€ 0
GS	€ – 34,860	€ – 28,635	€ – 34,860	€ – 30,049.32
SW	€ 13,280	€ 22,730	€ 13,280	€ 22,730

Blind tickets in subsidised air transport markets – Ad valorem subsidy for resident passengers		
ΔPS	€ 1,150	€ 3,035.77
ΔCS_{RA}	€ 1,250	€966
ΔCS_{RB}	€ 825	€ 637.56
ΔCS_{NR}	€ 0	€ 0
ΔGS	€ 6,225	€ 4,810.68
ΔSW	€ 9,450	€ 9,450

Data availability

No data was used for the research described in the article.

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