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Research paper

Blind booking: The effects on passengers' purchase decision, airlines' profitability, and tourist destinations

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A B S T R A C T

Blind booking consists of selling cheap surprise trips with a set of possible destinations, but without revealing the real destination until the payment is made. In this paper, we develop an economic model to analyse the social and private optimality of this pricing strategy in the airline industry. We perceive opaque products as a pricing strategy managed directly by airlines (without intermediaries) and simultaneously applied with other pricing strategies. Blind booking allows airlines to sell all their seats while maximising revenues and charging different prices in two parallel and independent markets: the transparent and the opaque market. Considering consumers' risk attitude, airlines must optimally choose the number of seats of each destination to be sold in each market in order to maximise their profits and create an attractive blind product. Our findings suggest that, in general, selling tickets in both markets is optimal for airlines. We show that, even when it is not optimal, it may enhance social welfare. Thus, policymakers, especially those of low-demanded destinations, should encourage airlines to introduce blind tickets. In these destinations, blind tickets imply an additional source of demand, attracting new customers and generating positive economic impacts.

1. Introduction

Air transport is the main mode of transport to many tourist destinations, and, in some cases, it constitutes up to 100 per cent of international tourism arrivals (Bieger & Wittmer, 2006). Both low-cost and full-service carriers compete in terms of market shares, capacity utilization, and profit maximisation by charging consumers different tariffs based on different willingness to pay through the so-called revenue management. The higher profit opportunities are in routes with lower airfares, higher airline market shares, or shorter distances (Yilmazkuday, 2021). A drop in air fares induces both a modal shift towards air transport and new tourist demand. It is difficult to establish the size of the new traffic generated by lower air transport fares, but it could be of the order of an increase of 50 per cent (Morley, 2007).

Consumers' heterogeneity, demand fluctuations, and the very perishable nature of seats make the setting of prices a complex decision (Alderighi et al., 2012). This frequently leads to flights with empty seats, causing financial losses for airlines. According to Gallego et al. (2008), between 20 and 30 per cent of total flight tickets, end up unsold, although these figures have increased due to the Covid-19 pandemic. Indeed, airlines reacted to the pandemic by dramatically reducing available seat miles, leaving airports nearly vacant (Rust et al., 2021).

Airlines have a high break-even load factor to avoid losses. In the case of American Airlines, Delta Airlines, United Airlines, and Southwest Airlines, it is larger than 70 per cent[1] (Floridapanhandle.com, 2022). For these reasons, airlines have been adopting different pricing strategies to optimize the perishable seat control problem. In this paper, we focus on blind tickets, a management strategy that deals with aircraft unsold capacity, generating extra revenues for airlines and a new source of demand in underdeveloped tourist destinations.

Blind tickets can be defined as goods whose characteristics or attributes are hidden to consumers during the purchasing process. Also

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[1] Data from Floridapanhandle.com airline infographic. Available at https://floridapanhandle.com/airline-profitabilitystatistics/?airline=American&seats=171+%2B+https%3A%2F%2Fwww.forbes.com%2Fsites%2Fj amesasquith%2F2020%2F03%2F31%2Fanalysis-how-much-money-do-empty-flights-really-costairlines%2F%3Fsh (accessed on 20 September 2022).

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named opaque products, they are usually introduced in non-storable good markets, like the air transport industry or the accommodation sector, among others. They consist of non-refundable tickets or tourist packages that customers buy without knowing the destination. The only information that consumers have at the moment of purchase is the set of possible destinations, and it is only after the payment is made when the final destination is revealed.

Over the years, different companies, mainly intermediaries, have implemented this new management strategy. Some of them are Drumwit, FlyKube, Randombox, Priceline, Waynabox, Wish&Fly, and WowTrip. Examples of destinations that are offered by these companies are cities in European countries, for example, Germany, Spain, or Portugal, and international countries such as the USA. Despite being a novel strategy, blind booking has been consolidated as a popular revenue management technique in tourist markets. Ampountolas et al. (2021) collected data from 140 revenue managers in hotels located mainly in the USA and Europe and conclude that 53.3 per cent of the respondent properties use a type of opaque selling mechanism.

The general mechanism of blind tickets in the airline industry is as follows (Martínez & de-Pablos-Heredero, 2017). First, customers choose the dates they want to travel, and the system provides different travel options. In the case of variable opaque products, customers can reduce some uncertainty by unselecting some destinations. Second, they pay for the package which has a fixed price, independently of the destination and the travel dates. Third, after payment, companies reveal the final destination to consumers.

The main advantage of introducing blind tickets in comparison with other pricing strategies, is that they create new demand, different from the existing market that sells regular tickets, and secures additional revenues for airlines while maintaining the existing ones (Ko & Song, 2020). Moreover, the opaque feature allows tourist firms to discount prices without cannibalizing their pricing policies and jeopardizing brand awareness (Ampountolas et al., 2021). On average, opaque booking allows customers to obtain a 44 per cent discount concerning the transparent rate (Tappata & Cossa, 2014).

Blind booking not only increases airlines' profits but also has a positive impact on social welfare and tourist destinations. Among other positive effects, flights increase wages (Bilotkach, 2015) and local employment of destinations (Percoco, 2010). Hence, tourism contributes to regional growth, especially in the case of underdeveloped destinations. Blind booking allows selling tickets of low-demanded destinations that otherwise airlines may stop offering, resulting in several economic consequences for those destinations. These blind tickets are sold to an entirely new demand, composed of price-sensitive individuals, mainly tourists, who are willing to accept uncertainty by paying a lower fare and who otherwise would not buy the tickets. Thus, this paper provides not only managers with a profitable pricing strategy but also policymakers of underdeveloped tourist destinations with a tool to promote and attract new customers.

In this paper, we develop a theoretical model for evaluating the social optimality of opaque selling. In particular, we consider blind tickets as lotteries whose prizes are flights to different destinations. Firstly, lotteries may allow to separate two markets, the regular market on which customers with strong preferences can buy under perfect information each destination directly, and the opaque one. Secondly, opaque selling avoids cannibalization. Cannibalization occurs when travellers who normally purchase from the regular channel at a higher price, end up purchasing in the opaque channel at a lower price (Granados et al., 2018).

The paper provides three main results: On the one hand, if all consumers are risk-neutral or risk-loving, opaque selling is always optimal for the firm. This result is independent of aircraft capacity and the initial demand of low-demanded destinations. On the other hand, if consumers are risk-averse, the airline needs to offer blind tickets with an additional discount. In this context, we compute the conditions that must be fulfilled for blind booking to be the optimal management strategy for the airline. Moreover, we show that opaque selling increases social welfare since it not only allows firms to deal with unsold capacity but also encourages new customers to fly to low-demanded destinations. Finally, regarding policy implications, we illustrate the additional demand and economic implications of introducing opaque selling in those underdeveloped tourist destinations.

The rest of the paper is organised as follows: In section 2, we review the existing literature on opaque selling, highlighting the main novelties of this paper concerning previous research. In section 3, we explain the case of Eurowings, an airline that is currently offering blind tickets. In section 4, we describe the main assumptions and main results of the theoretical model. In order to illustrate the main results of the model, in section 5 we provide some numerical examples to show the effects of blind booking on passengers' purchase decisions, airlines' profitability, and tourist destinations. We use these examples to compare the social welfare associated with blind booking and other possible pricing strategies. Finally, section 6 concludes.

2. Literature review

2.1. Previous research on opaque products

There exist some papers in the literature analysing the effects of opaque products.[2] Jiang (2007) studies the optimality of opaque selling considering a monopolist firm that offers two flights with different departure times. Fay and Xie (2008) consider a firm with a set of heterogeneous consumers, capacity constraints, and demand uncertainty. Huang and Yu (2014) propose a model with a monopolist firm, isolating the impact of bounded rationality through anecdotal reasoning on which consumers are homogeneous, and there is no demand uncertainty or capacity constraints.

Balestrieri et al. (2021) extend these models by considering different transportation costs. Elmachtoub and Hamilton (2021) consider one seller that offers several items with different attributes and evaluate different scenarios regarding consumers' valuation of the opaque product, distinguishing between pessimistic and risk-neutral customers. While for risk-neutral individuals the value of the opaque product is the average of the value of the different possible outcomes, for pessimistic individuals the value of the opaque product coincides with the value of the worst alternative. Moreover, extending the perception and nature of opaque products, Anderson and Xie (2012) consider an opaque bidding channel on which consumers specify the price they are willing to pay.[3]

From a multi-firm perspective, Jerath et al. (2010) propose a horizontally differentiated model with two companies that offer the same product and compete in a first period. They also consider an intermediary that sells the distressed inventory of both firms in a second period. Under this scenario, the implementation of opaque products depends on the existence of unsold units at the end of the first period and consumers' purchase decision depends on expectations about future availability. Similarly, Gallego et al. (2004) and Li et al. (2020) conceive opaque selling as a mechanism of selling end-of-the-season or distressed inventory of different products. However, airlines may be interested in selling their opaque products without making use of an intermediary.

Other studies include a Heuristic model to optimize the price that an airline should charge for a variable opaque product of a particular opaqueness (Post, 2010), or an algorithm for variable opaque products (Ko & Song, 2020).

The main results achieved by the previous literature are the following. From theoretical papers, we can conclude that opaque selling should be encouraged when customers are heterogeneous since it

[2] Opaque products, also named surprise goods in the literature, imply receiving any item out of a set of multiple items (Fay and Xie, 2010; Gönsch, 2020; Huang & Yu, 2014; Klingemann, 2020).

[3] See also Shapiro and Shi (2008), and Anderson and Celik (2020).

generates an increase in social welfare (Jiang, 2007). Its optimality relies on non-refundable and non-transferable tickets (Fay, 2008) and the level of opaqueness (Anderson & Xie, 2014; Li et al., 2020). The optimality of implementing opaque products through an intermediary depends on the market characteristics, such as brand loyalty, prices, and revenue share (Feng et al., 2021; Li et al., 2020). Additionally, paying extra fees for deselecting a certain number of potential product characteristics increases revenues and customer satisfaction (Post & Spann, 2012). From the empirical point of view, case studies on the hotel industry and grocery stores confirm that opaque products are profitable for firms. [4]

In this paper, we contribute to the existing literature in perceiving opaque products as a pricing strategy managed by airlines (without intermediaries), simultaneously applied with other pricing strategies, in order to maximise their profits (and not only as a way to manage distressed inventory). A consumer chooses whether to purchase directly a specific good (with perfect information) or an opaque product. In this framework, it is crucial to compute the optimal number of seats that the airline should detract from the transparent market in order to create an attractive blind product. Moreover, previous research assumes that all products in the lottery are equally probable. However, in our model, we implicitly define the probability of each destination in the lottery as an endogenous variable that plays a fundamental role in the opaque market strategy.

2.2. Opaque products and other pricing strategies

Jerath et al. (2010) analyse the main similarities and differences between opaque selling and other price discrimination strategies, such as last-minute sales. Although in the short-term, it might increase revenues, in the long-term last-minute sales suppose a profit loss for airlines since consumers anticipate discounts and postpone their purchases. However, opaque selling implies that, besides offering each base product individually for sale, the airline can also design and sell any number of lotteries that award one of the base products as the final prize, but the consumer cannot observe the outcome until after purchase (Anderson & Celik, 2020). Jerath et al. (2010) conclude that opaque selling is optimal when valuations are low and that, while last-minute sales consist of increasing profits from high-value customers, opaque selling is related to creating a variety of products in order to increase prices. Therefore, the main purpose of opaque selling is to create a new market in which new customers buy the distressed inventory without altering the already existing market. This new market may be characterized by lower prices due to the lack of information given to consumers.

In the accommodation sector, by not disclosing the property's name until after it is purchased, companies can avoid rate parity issues, while benefiting from the sale of the room (Sheridan et al., 2013). In addition, the market's opacity helps to reinforce the unequal bargaining power of tour operators and the hotel sector in negotiations (Alegre et al., 2012).

As mentioned above, in this paper we study the optimality of opaque products implemented directly by airlines without any intermediary and in parallel with other pricing strategies. Thus, we contribute to the existing literature defining the participation and incentive compatibility constraints in order to guarantee that both markets – the transparent and the opaque one-coexist, avoiding a cannibalization effect.

2.3. Opaque products and the importance of risk attitude

Notice that, given the nature of opaque products, consumers purchase under uncertain conditions. For Mas-Collel et al. (1995, pp. 185), "the concept of risk aversion provides one of the central analytical techniques of economic analysis" and it is assumed whenever they handle uncertain situations. As pointed out by Crainich et al. (2013), "In many if not all textbooks of microeconomics and finance, at least one chapter is usually devoted to an analysis of risk attitudes. Risk averters and risk lovers are then described in an expected utility framework respectively by the concavity or the convexity of their utility function". Risk attitude is usually analysed through the Expected Utility Theory, which states that the decision maker chooses between risky or uncertain alternatives by comparing their expected utility values, that is, the weighted sum obtained by adding the utility values of outcomes multiplied by their respective probabilities. A utility function with the expected utility form is called a Von-Neumann-Morgenstern utility function.

Despite the importance of the Expected Utility Theory and the risk attitude of consumers when analysing optimal choice under risky or uncertain conditions, little attention has been previously paid to these analytical techniques in the existing opaque selling literature. However, as Fay and Xie (2008) state, "attitudes toward probabilistic goods depend not only on the strength of one's preference but also on one's disposition toward risk". Indeed, previous research supports that the main extensions in this area may be in consonance with implementing risk aversion (Fay & Xie, 2008).

In this paper, we conceive opaque selling as a practice of horizontally differentiated goods in which the risk attitude of consumers plays a key role. To the best of our knowledge, previous theoretical models of opaque products that include risk attitude are scarce, assuming only risk neutrality or a risk preference factor (Bai et al., 2015), but not other degrees of risk aversion. Additionally, also contributes to the existing literature in considering not only any possible degree of risk aversion, but also risk neutrality or any possible degree of risk loving. Then, applying the Expected Utility Theory, we consider that passengers behave as maximisers of their expected utility (Von Neumann-Morgenstern utility function).

3. Blind booking: the case of eurowings

Eurowings is a German low-cost airline, subsidiary of the Lufthansa Group, currently offering blind tickets. They consist of direct flights to different European cities. Depending on the departure airport, Eurowings offers blind tickets of different categories, such as "Pizza, Pasta & Amore", "Siesta & Fiesta", "Selfie Hotspots", "Adventure in the City", "Europe lies at your feet" etc. Immediately after purchase, Eurowings discloses to consumers the final destination to which they are flying, in order to give them enough time to prepare their trip.

The possible departure airports are Berlin, Düsseldorf, Hamburg, Cologne-Bonn, Prague, Salzburg, Stockholm and Stuttgart. All blind booking flights are non-stop flights. Destinations vary from German cities to Portugal, Italy, Spain, etc. Table A1 in Appendix 1 shows all possible origins and destinations offered by Eurowings through blind tickets.[5] It also contains the number of airlines that operate each of these direct routes. By analysing all pairs of origins and destinations and the availability of direct flights, we see that 47 per cent of the routes offered through blind tickets are operated only by Eurowings. Moreover, 24 per cent of them are only covered by Eurowings and another additional airline. Thus, more than 70 per cent of the air routes of blind tickets are covered by a maximum of two airlines.

If we look at specific categories offered from specific departure airports, such as "Pizza, Pasta & Amore" from Düsseldorf, we have that the possible destinations are Catania, Naples, Venice, Bologna, Milan and Rome. All these non-stop flights are offered only by Eurowings. Similarly, if we look at the category "Europe lies at your feet" from Salzburg, the possible destinations are Amsterdam, Düsseldorf, Hamburg, Cologne-Bonn, Berlin, Gran Canaria, Hurchada and Tenerife and, thus,

[4] See, for instance, Fay and Xie (2010), Anderson and Xie (2012), Green and LomanNo (2012), Yang et al. (2019), or Sasanuma et al. (2022).

[5] For more information, see https://www.eurowings.com/en/discover/offers/blind-booking.html.

seven out of these eight direct flights are offered only by Eurowings.

In next section, we develop an economic model to analyse the social and private optimality of blind booking in the airline industry. In such a model, we consider a monopolist airline. Although the airline industry is usually considered an oligopoly market, the monopoly assumption is reasonable for destinations with low demand, as those considered by Eurowings when offering blind tickets. Moreover, notice that, even though in some routes there might be two or more airlines competing in the market, airlines may have strong market power due to other reasons such as product differentiation, brand loyalty, or the existence of frequent flier programs.

4. The model

Suppose a market operated by a monopolist airline that offers flights to two possible destinations: destination A and destination B. In such a market, there are two types of consumers, denoted by type 1 and type 2, with different willingness to pay for travelling to any of these destinations. In particular, consumers have either a high willingness to pay, H, or a low willingness to pay, L, with $H > L$.

In this market, there are N_1 type 1 individuals and N_2 type 2 individuals per flight. Type 1 and type 2 consumers have different preferences over destinations. Type 1 consumers prefer to travel to destination A rather than to destination B, that is, they have a high willingness to pay, H, for destination A, and a low willingness to pay, L, for destination B. On the contrary, type 2 consumers prefer destination B and, therefore, they have a high willingness to pay, H, for destination B and a low willingness to pay, L, for destination A. All consumers have a unitary demand.

The utility functions for each type of consumers, 1 and 2, when travelling to each destination, A and B, are given by the following expressions:

$$U_1^A = (M + H - P_A)^{\alpha_i}, U_1^B = (M + L - P_B)^{\alpha_i}, i = 1, \ldots, N_1. \quad (1)$$

$$U_2^A = (M + L - P_A)^{\beta_j}, U_2^B = (M + H - P_B)^{\beta_j}, j = 1, \ldots, N_2. \quad (2)$$

where M represents individuals' initial income, and P_A and P_B denote the ticket price paid by consumers when flying to destinations A and B, respectively. α_i and β_j are positive parameters associated with the risk attitude of each consumer. In particular, if α_i (or β_j) is lower than 1, the utility function is concave and consumers are risk-averse; if α_i (or β_j) is equal to 1, the utility function is linear and they are risk-neutral; and if α_i (or β_j) is greater than 1, the utility function is convex and consumers are risk-loving.[6] The subindexes i and j imply that individuals of the same type have the same preferences over destinations, but they may have different risk attitudes.

For the sake of simplicity, we also make the following assumptions. First, the marginal operating cost for the airline is assumed to be constant and normalized to zero.[7] Second, the capacity of the aircraft used for both destinations A and B is the same and equal to K. Third, independently of the number of passengers that may be willing to travel to destinations A and B, both routes are operated. Fourth, the air carrier knows exactly the willingness to pay of both types of consumers for both destinations, that is H and L. However, it cannot distinguish the type of consumer that is buying each ticket (adverse selection problem), and, thus, it cannot discriminate prices according to consumers' type. Fifth, we assume that the airline has all the bargaining power and, therefore, it may charge the maximum price that consumers are willing to pay. For such a maximum price, consumers are indifferent between travelling or not, but we assume that they decide to travel. Finally, we assume that $M + L - H > 0$.

Once we have described the main assumptions of the model, let us study the different market situations and the possible strategies that the airline should adopt in order to maximise its profits, given that consumers decide to buy a ticket if the utility they obtain by travelling is higher than or equal to the utility of not travelling, which is given by M^{α_i} for type 1 consumers and M^{β_j} for type 2 consumers.

4.1. *Case 1: there is an excess demand of passengers with high willingness to pay on both routes: $N_1 \geq K$ and $N_2 \geq K$*

Suppose an initial scenario in which there is an excess demand of passengers with high willingness to pay in both routes, what implies that $N_1 \geq K$ (with K being the aircraft capacity in destination A), and $N_2 \geq K$ (with K being the aircraft capacity in destination B). In this case, the airline sets a price equal to the maximum willingness to pay in both routes $P_A = P_B = H$. For such prices, N_1 type 1 consumers are willing to fly to destination A and N_2 type 2 consumers are willing to fly to destination B. Since aircraft capacity is equal to K, and $N_1 \geq K$ and $N_2 \geq K$, only K type 1 consumers manage to buy a ticket to travel to destination A, and only K type 2 consumers manage to buy a ticket to travel to destination B.

Proposition 1. *If there is an excess demand of passengers with high willingness to pay in both routes* (*Case* 1), *the optimal strategy for the air carrier is to charge prices equal to the maximum willingness to pay in both destinations, $P_A = P_B = H$, and the airline's optimal profits are equal to $\pi_0 = 2KH$.*

4.2. *Case 2: one of the destinations has a demand of passengers with high willingness to pay lower than the aircraft's capacity, while the other destination faces a situation of excess demand: $N_i < K$, $N_j \geq K$, and $N_i + N_j \geq 2K$, with $i \neq j$; $i, j = 1, 2$*

Let us consider now the case in which one of the destinations has a demand of high willingness to pay passengers lower than the aircraft's capacity, while the other destination faces a situation of excess demand. For instance, suppose that destination A is the one with lower demand, that is $N_1 < K$, while destination B is the most demanded one, that is $N_2 \geq K$ (the same reasoning can be applied in the opposite situation, where $N_1 \geq K$ and $N_2 < K$). In the same way, let us assume that all the available seats of destination A can be plenty covered by all the passengers who prefer to travel to destination B but are not able to do so due to the excess demand : $N_2 + N_1 \geq 2K$.

Under these assumptions, the airline needs to decide the best pricing strategy. Although the airline knows consumers' willingness to pay for both destinations, it faces an adverse selection problem due to the fact that it cannot distinguish consumers' types. In other words, the airline does not have any way of knowing the type of the passenger, type 1 or type 2, that actually purchases a ticket for each of the destinations. Under these conditions, three main pricing strategies can be identified.

Strategy 1: Set $P_A = P_B = H$.

Strategy 1 implies charging both types of consumers a ticket price based on their maximum willingness to pay. For such prices, N_1 type 1 consumers are willing to fly to destination A and N_2 type 2 consumers are willing to fly to destination B. In the case of destination B, a situation of sold-out is initially achieved, since there is an excess demand ($N_2 \geq K$). In other words, K type 2 consumers buy a ticket for destination B, although there are still $(N_2 - K)$ type 2 consumers who have a high

[6] This power utility function is commonly used in the literature since it enables the modelling of any degree of risk aversion through its exponent (see, for example, Tanaka et al., 2010; Von Gaudecker et al., 2011; or Schleich et al., 2019).

[7] The assumption of constant marginal costs is quite common in the air transport literature. Oum and Waters (1997) find many examples of constant returns to scale for the case of airlines (seven out of ten studies). However, considering decreasing marginal costs (economies of scale) would reinforce even more ours results regarding the profitability of blind booing for airlines and tourist destinations.

willingness to pay for destination B but are unable to travel because of the lack of capacity. On the contrary, in destination A the airline is only able to sell N_1 seats which is lower than K, but these seats cannot be covered by type 2 individuals since their willingness to pay for destination A is lower than the price charged by the airline, that is $L < H$. These results are illustrated in Fig. 1.

Under this strategy, the airline leaves free $K - N_1$ seats of destination A, and the airline's profits under this strategy are given by the following expression:

$$\pi_1 = N_1 H + KH. \tag{3}$$

Strategy 2: Set $P_A = L$ and $P_B = H$.

Strategy 2 implies reducing the price of destination A in order to sell all the available seats, K. Notice that now all type 1 consumers buy N_1 tickets of destination A at a lower price, L, in comparison with *Strategy 1*. In the case of type 2 passengers, they buy K tickets for destination B at the same price as in *Strategy 1*. Since destination A is now charged at a price equal to the willingness to pay of type 2 individuals, L, the $(N_2 - K)$ passengers that are unable to travel to destination B because of the lack of capacity now decide to buy tickets to destination A.[8] Fig. 2 illustrates this strategy. As $N_2 + N_1 \geq 2K$, under this strategy, the company sells $2K$ air tickets, and its profits are given by:

$$\pi_2 = KL + KH. \tag{4}$$

By comparing the profits given by expressions (3) and (4), we can state the following proposition.

Proposition 2. *In Case* 2 , *Strategy* 1 *will be more profitable for the airline as long as* $N_1 H \geq KL$. *On the contrary, Strategy* 2 *will be dominant if* $KL \geq N_1 H$.

Strategy 1 implies a trade-off between decreasing prices in order to increase the demand of destination A and keeping high ticket prices but uncovering the aircraft capacity in destination A. However, the airline may use an even better pricing strategy than *Strategy 1* or *Strategy 2*, which would allow it to sell all the tickets in destination A without reducing the price to the N_1 type 1 consumers.

Strategy 3: Create two markets: the transparent market and the opaque market. In the transparent market, set $P_A = P_B = H$. In the opaque market, set P_R.

Opaque products consist of creating a new market. Hereinafter, we will differentiate two markets: the transparent market where individuals can directly buy tickets with perfect information, and the opaque market where, at the moment of purchasing, consumers do not know which of the destinations are buying.

Under this strategy, the airline charges the tickets of both destinations A and B in the transparent market at a price equal to H but extracts some seats, N_R^B, of destination B from the transparent market in order to create a lottery in the opaque market composed by the $K - N_1$ seats left of destination A, denoted by N_R^A, and the N_R^B seats subtracted from destination B. The lottery aims to attract the $(N_2 - K)$ type 2 consumers who are left out of the transparent market of destination B.

The reasoning of this strategy is represented in Fig. 3. In the case of destination A, all those seats that are not sold under perfect information are included in the lottery. Regarding destination B, the airline needs to optimally decide how many seats to include in the lottery, this is N_R^B.

With uncertainty, consumers' choice is based on comparing the expected utility of buying a blind ticket with the utility they obtain when buying a ticket in the transparent market (at prices $P_A = P_B = H$), or with the utility they obtain when they decide not to travel. The expected utility function (or Von Neumann-Morgenstern utility function) is defined as the weighted sum of the utility of each random outcome, where weights are given by the corresponding probabilities (Davis et al., 1998). Thus, type 1 and type 2 individuals' expected utility, $E[U_1]$ and $E[U_2]$, depends on individuals' risk attitude (represented by the parameters α_i and β_j), the probabilities of each destination, and the price of the lottery, P_R. The probabilities of each destination are assumed to be endogenous and given by the ratio between the number of seats of each destination and the total number of seats offered in the opaque market.

$$E[U_1] = \frac{N_R^A}{N_R^A + N_R^B}[M + H - P_R]^{\alpha_i} + \frac{N_R^B}{N_R^A + N_R^B}[M + L - P_R]^{\alpha_i} \tag{5}$$

$$E[U_2] = \frac{N_R^A}{N_R^A + N_R^B}[M + L - P_R]^{\beta_j} + \frac{N_R^B}{N_R^A + N_R^B}[M + H - P_R]^{\beta_j}. \tag{6}$$

The price charged by the airline for the lottery P_R depends on the probability of each destination in the lottery, the maximum willingness to pay of type 2 consumers for destination A and destination B, respectively, and a discount $D \geq 0$:

$$P_R = \frac{N_R^A}{N_R^A + N_R^B}L + \frac{N_R^B}{N_R^A + N_R^B}H - D. \tag{7}$$

The expected utility of both types of consumers when they buy the blind ticket, $E[U_1]$ and $E[U_2]$, depends on the probability of destination A and destination B, and on the utility that they get from each destination, given the price of the lottery, as it is shown in the following expressions:

$$E[U_1] = \frac{N_R^A}{N_R^A + N_R^B}\left[M + \frac{N_R^A}{N_R^A + N_R^B}(H - L) + D\right]^{\alpha_i} + \frac{N_R^B}{N_R^A + N_R^B}\left[M + \frac{N_R^B}{N_R^A + N_R^B}(L - H) + D\right]^{\alpha_i}. \tag{8}$$

$$E[U_2] = \frac{N_R^A}{N_R^A + N_R^B}\left[M + \frac{N_R^B}{N_R^A + N_R^B}(L - H) + D\right]^{\beta_j} + \frac{N_R^B}{N_R^A + N_R^B}\left[M + \frac{N_R^A}{N_R^A + N_R^B}(H - L) + D\right]^{\beta_j}. \tag{9}$$

All the notation of the model is summarized in Table 1.

The main purpose of *Strategy 3* is to maintain the level of demand of N_1 type 1 consumers in destination A, and $(K - {N_R}^B)$ type 2 consumers in destination B in the transparent market. Because of the capacity constraints, there are $(N_2 - K + {N_R}^B)$ type 2 consumers who cannot buy a ticket for destination B in the transparent market, the objective of *Strategy 3* is to attract $({N_R}^A + {N_R}^B)$ type 2 individuals to buy the opaque product.

Thus, on the one hand, the lottery must not be attractive for type 1 individuals (incentive compatibility constraint). This situation can be achieved when the airline chooses N_R^B such that the expected utility that type 1 individuals get from the lottery is lower than or equal to the utility they get from buying air tickets for destination A in the transparent market, which is given by M^{α_i} (recall that in the transparent market $P_A = H$). On the other hand, in order to create an attractive product for the $(N_2 - K + {N_R}^B)$ type 2 individuals, the airline must set the value of N_R^B that makes the expected utility of the lottery greater than or equal to the utility they get when they do not fly to any destination, which is given by M^{β_j} (participation constraint).

[8] Notice that, if there exists a large number of type 2 individuals, it is possible that all of them end up purchasing all the tickets of destinations A and B.

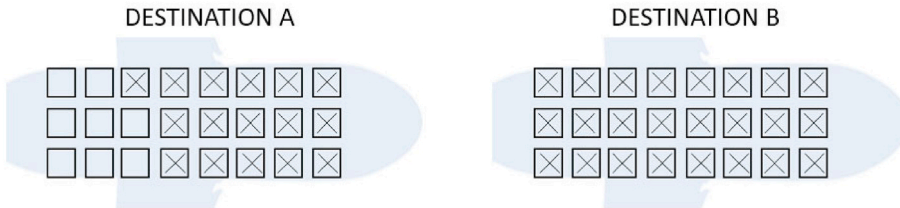

Fig. 1. Representation of the number of seats sold in destination A and B when implementing Strategy 1 ($P_A = P_B = H$) under conditions of excess demand only in destination B.

Fig. 2. Representation of the number of seats sold in destination A and B when implementing Strategy 2 ($P_A = L$ *and* $P_B = H$) under conditions of excess demand only in destination B.

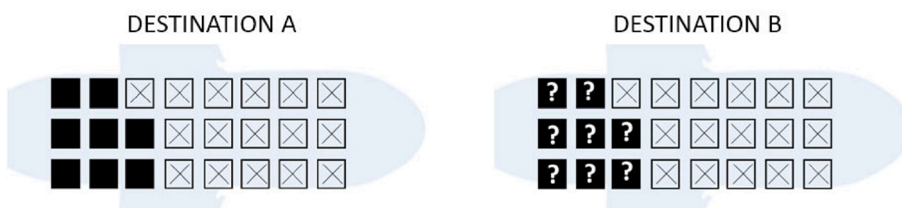

Fig. 3. Representation of the number of seats of both destinations to be included in the lottery when implementing Strategy 3 (blind booking) under conditions of excess demand only in destination B.

Therefore, when implementing opaque selling, the airline must set the optimal N_R^B and D that fulfils the following two conditions considering the risk attitude of both type of consumers:

$$G_1\left(N_R^B\right) = E[U_1] - M^{\alpha_i} \leq 0. \tag{10}$$

$$G_2\left(N_R^B\right) = E[U_2] - M^{\beta_j} \geq 0, \tag{11}$$

where $G_1(N_R^B)$ represents the incentive compatibility constraint associated with type 1 consumers. $G_2(N_R^B)$ represents the participation constraint associated with type 2 individuals. Recall that subindexes i and j represent that, within each type, individuals have the same preferences over destinations, although, within each type, they may have different risk attitudes. This is formally stated in the following lemma.

Table 1
Summary of notation.

Notation	Definition
H	High willingness to pay for a destination
L	Low willingness to pay for a destination
N_1	Number of type 1 individuals in the market per flight
N_2	Number of type 2 individuals in the market per flight
M	Individual's income
P_A	Ticket price of destination A
P_B	Ticket price of destination B
α_i	Positive parameter that shows type 1 consumers' risk attitude
β_j	Positive parameter that shows type 2 consumers' risk attitude
K	Aircraft's capacity of destinations A and B
P_R	Lottery price
N_R^A	Unsold seats of destination A in the transparent market and included in the opaque market
N_R^B	Seats subtracted from destination B in the transparent market and included in the opaque market
$E[U_1]$	Expected utility of type 1 individuals
$E[U_2]$	Expected utility of type 2 individuals
D	Fixed discount applied on the lottery price
$\overline{N_1}$	Lowest demand of destination A that guarantees that risk-loving type 1 individuals have no incentives to purchase discounted blind tickets

Lemma 1. *In Case 2, the opaque selling technique will be feasible for the airline if it sets the number of seats of destination B included in the lottery* N_R^B *and the discount in order to attract type 2 individuals D, such that the following two conditions are satisfied*: $G_1(N_R^B) \leq 0$ *and* $G_2(N_R^B) \geq 0$.

The function $G_2(N_R^B) = 0$ implicitly defines the minimum discount that must be offered in order to guarantee that type 2 consumers buy the lottery.

Proposition 3. *In Case* 2, *independently of type* 1 *consumers' risk attitude, if all type* 2 *individuals are risk-neutral or risk-loving, the airline can introduce blind booking and set a discount in the opaque market equal to zero,* $D = 0$.

Proof: *In the case of type* 1 *consumers,* $G_1(N_R^B)$, *is a linear combination composed of two terms, where the first one is greater than* M^{α_i} *and the second one is lower than* M^{α_i}. *Considering that type* 1 *individuals must not have incentives to buy the lottery, the term lower than* M^{α_i} *needs to have a greater impact in this linear combination. This is only possible if* $N_R^B \geq N_R^A$.

Regarding type 2 *individuals and* $G_2(N_R^B)$, *in the case of risk-neutral individuals, any positive number of seats subtracted by the airline from the transparent market,* N_R^B, *will fulfil the condition. Regarding risk-loving individuals, any positive number of seats of destination B will satisfy the constraint since, as before, one of the terms is lower than* M^{β_j} *while the other is greater than* M^{β_j}. *This completes the proof.* ∎

If all type 2 individuals are risk-neutral or risk-loving, the profits that the airline obtains applying Strategy 3 are given by the following expression:

$$\pi_3 = N_1H + \left(K - N_R^B\right)H + \left(N_R^A + N_R^B\right)\left(\frac{N_R^A}{N_R^A + N_R^B}L + \frac{N_R^B}{N_R^A + N_R^B}H\right), \quad (12)$$

that can be rewritten as:

$$\pi_3 = (K + N_1)H + N_R^A L. \quad (13)$$

Notice that, in this case, airline profits with Strategy 3 are independent of the number of seats that the airline extracts from the transparent market of destination B to the lottery, N_R^B.

Proposition 4. *In Case 2, if all type 2 passengers are risk-neutral or risk-loving, Strategy 3 (blind booking) will be always the optimal pricing strategy for the airline, independently of the number of seats that the airline extracts from the transparent market of destination B to the opaque market.*

Strategy 3 assumes that, in order to be the most profitable one, all type 2 passengers need to be risk-neutral or risk-loving since, without a discount, risk-averse type 2 individuals will not buy the lottery. This assumption can be considered restrictive since, given the heterogeneity of the society, there can be some risk-averse type 2 individuals. Denoting by q the proportion of type 2 individuals that are risk-neutral or risk-loving in the market, let us determine the threshold value for q that makes *Strategy 3* the most profitable for the airline. By definition, $(1-q)$ is the proportion of risk-averse type 2 individuals. The number of tickets sold in the lottery will depend on the proportion of type 2 individuals who are risk-neutral and risk-loving. Thus, airlines' profits are given by:

$$\pi_{3.1} = N_1H + \left(K - N_R^B\right)H + q\left(N_R^A + N_R^B\right)\left(\frac{N_R^A}{N_R^A + N_R^B}L + \frac{N_R^B}{N_R^A + N_R^B}H\right) = (K + N_1)H + qN_R^A L - (1-q)N_R^B H. \quad (14)$$

In comparison with *Strategy 1*, the profits of *Strategy 3* will be larger if the following constraint is fulfilled:

$$q > \frac{N_R^B H}{N_R^A L + N_R^B H} = c_1. \quad (15)$$

In comparison with *Strategy 2*, *Strategy 3* will be optimal for the airline if the proportion of risk-neutral and risk-loving type 2 consumers is greater than the following expression:

$$q > \frac{KL + N_R^B H - N_1 H}{N_R^A L + N_R^B H} = c_2. \quad (16)$$

Proposition 5. *In Case 2, there exist two thresholds c_1 and c_2 for the proportion of type 2 individuals that are risk-neutral or risk-loving, q, such that: (a) If $KL > N_1H$ and: (a.1) $c_2 < q$, Strategy 3 dominates; (a.2) $q < c_2$, Strategy 2 is the dominant one according to Proposition 2. (b) If $KL < N_1H$ and: (b.1) $c_1 < q$, Strategy 3 dominates; (b.2) $q < c_1$, Strategy 2 is the dominant one according to Proposition 2.*

All these results are summarized in Figs. 4 and 5.

According to these results, the airline should not apply *Strategy 3* (blind booking) when the proportion of type 2 individuals that are risk-averse achieves a certain threshold, as is represented in Figs. 4 and 5. Nonetheless, the airline can achieve an equilibrium on which opaque selling supposes the optimal strategy independently of type 2 consumers' risk attitude. In this case, the airline must set a positive discount D in order to attract those risk-averse type 2 consumers. Notice that this discount is higher, the higher the proportion of risk-averse type 2 individuals is.

The airline must determine, first, the optimal N_R^B that makes the lottery not attractive to type 1 individuals (incentive compatibility constraint) and, second, the optimal discount D that, on the one hand, makes the lottery attractive for risk-averse type 2 individuals (participation constraint) and, on the other hand, guarantees that type 1 individuals will not change their purchase decision from the transparent market to the opaque one (incentive compatibility constraint).

The profits that the airline obtains by applying a positive discount to the lottery in order to attract risk-averse type 2 individuals are given by the following expression:

$$\pi_{3.2} = N_1H + \left(\left(K - N_R^B\right)H + \left(N_R^A + N_R^B\right)\left(\frac{N_R^A}{N_R^A + N_R^B}L + \frac{N_R^B}{N_R^A + N_R^B}H - D\right)\right). \quad (17)$$

Notice that in comparison with the profits of *Strategy 3* without a discount, π_3 (applied when all consumers are risk-neutral or risk-loving), when there are some risk-averse individuals and the airline implements a discount to the price of the lottery, the profits not only depend on the discount but also the number of seats subtracted from destination B, N_R^B.

The profits obtained when applying *Strategy 3* (blind booking) with a discount can be rewritten as:

$$\pi_{3.2} = (K + N_1)H + N_R^A L - D\left(N_R^A + N_R^B\right). \quad (18)$$

Despite the conditions that the airline must fulfil when designing the lottery, which are $G_1(N_R^B)$ and $G_2(N_R^B)$, a third constraint appears when implementing a discount, which is associated with the threshold of D from which opaque selling becomes suboptimal in comparison with *Strategy 1* or *Strategy 2*. The value of the threshold depends on N_1H and KL.

Let us denote by D^* the maximum discount that the airline can implement in order to attract risk-averse type 2 individuals whose value can be either $\frac{N_R^A L}{N_R^A + N_R^B}$ or $\frac{N_R^A L - KL + N_1 H}{N_R^A + N_R^B}$ depending on the values of N_1H and KL.

$$D^* = \begin{cases} \dfrac{N_R^A L}{N_R^A + N_R^B}, \text{if } KL < N_1H \\ \dfrac{N_R^A L - KL + N_1H}{N_R^A + N_R^B}, \text{if } KL > N_1H. \end{cases} \quad (19)$$

Proposition 6. *In Case 2, independently of type 1 and type 2 consumers' risk attitude, blind booking will be optimal for the airline if it sets the number of seats of destination B included in the lottery N_R^B, and the discount in order to attract all type 2 individuals D, such that the following three conditions are satisfied: $G_1(N_R^B) \le 0$, $G_2(N_R^B) \ge 0$, and $D \le D^*$.*

Corollary 1. *In order to satisfy the three constraints specified in Proposition 6, the level of demand of destination A, N_1, needs to be large enough, $N_1 > \overline{N_1}$.*

The company may have a minimum level of demand for destination A that guarantees that, if it designs a lottery composed of the N_R^A seats from destination A and the N_R^B from destination B and applies a discount D, independently of their risk attitude, all type 1 individuals and all type 2 individuals will continue purchasing in the transparent market and in the opaque market, respectively. Therefore, *Strategy 3* is always the optimal one.

Bellow this minimum demand, some type 1 consumers may still be willing to buy in the transparent market, but very risk-loving type 1 individuals deviate from the transparent market since $G_1(N_R^B) \ge 0$. In

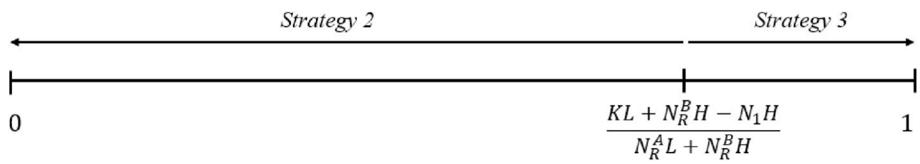

Fig. 4. Optimal pricing strategy for the airline as a function of the proportion of type2 consumers that are risk-neutral or risk-loving, with $KL > N_1 H$.

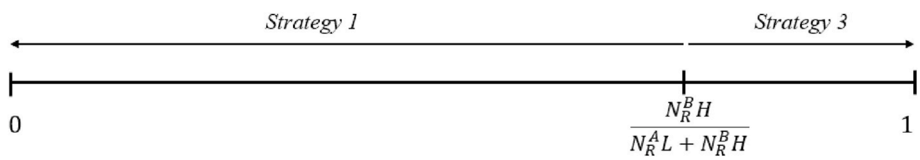

Fig. 5. Optimal pricing strategy for the airline as a function of the proportion of type 2 consumers that are risk-neutral or risk-loving, with $KL < N_1 H$.

Table 2
Individuals and market characteristics in *Scenario 1*.

	Type 1 individuals	Type 2 individuals
Willingness to pay	Porto: $H = 120$ Paris: $L = 50$	Porto: $L = 50$ Paris: $H = 120$
Number of individuals	$N_1 = 105$	$N_2 = 300$
Individuals' risk attitude	20% risk-loving with $\alpha_i \geq 1.4$ 80% risk-averse or risk-neutral	60% very risk-averse with $\beta_j = 0.1$ 40% risk-neutral or risk-loving
Aircraft (A320–214) capacity	$K = 150$	
Individual's income	$M = 1000$	

Table 3
Optimal pricing strategy for the airline in *Scenario 1*.

	Strategy 1	Strategy 2	Strategy 3.1
Prices	$P_{PORTO} = 120$ $P_{PARIS} = 120$	$P_{PORTO} = 50$ $P_{PARIS} = 120$	$P_{PORTO} = 120$ $P_{PARIS} = 120$ $D = 0$ $P_R = 85.38$
Constraints	–	–	$G_1(N_R^B) \leq 0\ \forall \alpha_i$ $G_2(N_R^B) \geq 0$ if $\beta_j \geq 1$
Sold tickets	**In the transparent market:** *Porto* : 105 *Paris* : 150	**In the transparent market:** *Porto* : 150 *Paris* : 150	**In the transparent market:** *Porto* : 105 *Paris* : 104 **In the opaque market:** *Lottery* : 91 *out of a total of* 91 *Porto* : 45 *Paris* : 46 **TOTAL:** *Porto* : 150 *Paris* : 150
Profits	$\pi_1 = 30600$	$\pi_2 = 25500$	$\pi_{3.1} = 32849.58$

this latter case, the profits the airline obtains from type 1 individuals in the transparent market are reduced by the proportion of very risk-loving type 1 individuals that decide to buy in the opaque market and, thus, under these very restrictive conditions, *Strategy 3* can become suboptimal. Therefore, if the level of demand in destination A is not high enough, the optimality of opaque selling depends on the proportion of very risk-averse type 2 individuals, their degree of aversion toward risk, and the proportion of very risk-loving type 1 individuals.

5. Numerical illustrations: effects on passengers' purchase decision, airlines' profitability, and tourist destinations

In order to illustrate the main results of the paper, let us consider some numerical examples based on different market conditions. In particular, consider an airline that offers two possible destinations: Porto and Paris. Based on popularity and real demand, let us assume that destination A is Porto, while Paris is destination B. Type 1 individuals are willing to pay €120 for a flight to Porto and €50 to Paris. On the contrary, type 2 individuals are willing to pay €50 for a flight to Porto and €120 to Paris.

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 *M* equal to €1000. Additionally, we suppose that both routes are operated with an AIRBUS A320-214, with 150 seats of capacity. [9] In all the different scenarios, we assume that as long as individuals are indifferent between two destinations, they purchase the one for which they have a higher willingness to pay.

Scenario 1: According to Gallego et al. (2008), let us initially consider that the number of unsold tickets of Porto in the transparent market is equal to 30 per cent. Therefore, regarding consumers, suppose there is a potential demand of 105 type 1 consumers and 300 type 2 consumers per flight to these two possible destinations. Moreover, consider the following characteristics regarding the risk attitude of type 1 and type 2 individuals: 60% of type 2 individuals are very risk-averse ($\beta_j = 0.1$), while the rest of type 2 consumers are risk-neutral or risk-loving. Additionally, there is a considerable proportion of risk-loving type 1 individuals (20%) with $\alpha_i \geq 1.4$. The other proportion of type 1 consumers (80%) are risk averse or risk neutral.

Table 2 summarizes market and individuals characteristics in *Scenario 1*.

With these initial market conditions, we look for the optimal pricing strategy for the airline. Table 3 summarizes the main results and conditions for each pricing strategy.

In the absence of blind tickets, the airline only has two possible pricing strategies: *Strategy 1* on which it sells as much as possible at a price equal to the maximum willingness to pay, and *Strategy 2* on which it decreases the price of the low-demanded destination in order to sell all tickets. Without opaque selling, the optimal pricing strategy for the airline is *Strategy 1*. The reason is that in order to sell all tickets of Porto, the airline would have to decrease the price so much that it prefers to charge individuals the maximum willingness to pay and leave 45 unsold tickets. Thus, without blind booking, there would be 45 passengers per flight not arriving in Porto.

When implementing blind tickets, the airline may create a lottery with all the unsold tickets of Porto, 45, and 46 tickets of Paris in order to guarantee the incentive compatibility and participation constraints. Regarding *Strategy 3* (blind booking), if the airline implements blind booking without any discount (*Strategy* 3.1), there are 180 risk-averse

[9] For more numerical illustrations, and in order to validate the robustness of the model to changes in the parameters, see Appendix 2.

type 2 individuals with $\beta_j = 0.1$ that have no incentives to buy the lottery. However, 120 risk-neutral and risk-loving type 2 individuals prefer to purchase the lottery, rather than purchasing under perfect information conditions. Thus, for these 120 type 2 individuals the expected utility of the lottery is larger than the utility of purchasing tickets to Paris, and the airline is able to sell all tickets included in the lottery without discount. Moreover, there are enough risk-averse individuals so that the airline also sells all tickets to Paris in the transparent market. Therefore, under these market conditions and according to the level of profits, the optimal pricing strategy for the airline is *Strategy 3.1* (blind tickets without any discount).

The results we present in this first scenario are similar to what is proposed in previous literature. The optimal pricing strategy is to implement blind tickets without any discount, and therefore, ignoring risk-averse type 2 individuals. The fact that justifies this result is that there are so many type 2 individuals that, even taking into account the proportion of risk-averse, the airline is able to sell all tickets to risk-neutral and risk-loving individuals. In turn, risk-averse type 2 individuals purchase tickets to Paris in the transparent market.

Table 4 compares social welfare between *Strategy 1* and *Strategy 3.1* (optimal pricing strategies with and without blind tickets) in *Scenario 1*. Producer surplus coincides with airline's profits, while consumer surplus is computed as the difference between individuals' willingness to pay and the price they finally pay.

Regarding *Strategy 1*, consumer surplus is equal to 0 since consumers are charged their maximum willingness to pay. In the case of *Strategy 3.1* (blind tickets without discount), the consumer surplus in both the transparent market and the opaque market is equal to 0.42. Regarding the latter, only type 2 consumers purchase the lottery and we need to consider their willingness to pay for each destination. According to the results, *Strategy 3.1* is not only optimal for the airline, but also is socially desirable. Moreover, notice that by implementing blind tickets, the airline sells 150 tickets to Paris and 150 tickets to London. In the case of Paris, the number of passengers per flight does not change while 45 new passengers fly to Porto. Based on the information proposed by DataBank World Development Indicators (2022) and Instituto Nacional de Estatística Portugal (2019), we can approximate the possible economic impact of these 45 new passengers on Porto, which statistically belongs to the North Region (NUTS II). Based on data from 2019, each international tourist spends on average €406.62 in Portugal and stays 1,84 overnights in Porto. Additionally, 5,873,025 guests stayed in the North region of Portugal, generating an average guest revenue in accommodation of €84.65.

Taking into consideration this data, Table 5 summarizes the possible economic impact of the new passengers to Porto, considering different flight frequencies per year. The second and third column assumes that there exist one and two flights per week. On the contrary, the third and fourth columns consider two possible situations in which the airline decides to increase flight frequency from one to two and three weekly flights, respectively. Let us assume that if the airline decides to increase the frequency to Porto is because there is enough potential demand. The reason for considering these scenarios is related to the fact that, when implementing opaque selling, unsold tickets almost disappear and, thus, the airline may be interested in increasing connectivity with those initially low-demanded destinations.

Table 4
Social welfare analysis for *Scenario 1*.

	Strategy 1	Strategy 3.1
Producer surplus	30600 €	32849.58 €
Consumer surplus	0 €	0.42 € [a]
Social welfare	30600 €	32850 €

[a] Consumer surplus: $45(50 - 85.38) + 46(120 - 85.38) = 0.42$.

Table 5
Possible economic impact in destination A (Porto) of implementing opaque selling in *Scenario 1*.

	1 flight per week	3 flights per week	Increase in frequency from 1 to 2 flights per week	Increase in frequency from 1 to 3 flights per week
New annual passengers arriving in Porto	2340	7020	10,140	17,940
Total guest revenue (€)	198,081	594,243	858,351	1,518,621
Impact on overnight stay (total nights) considering average length of stay	4,306	12,917	18,658	33,010
Total tourism expenditure (€)	951,490.80	2,854,472.40	4,123,126.8	7,294,762.8

Regarding tourism expenditure, opaque selling may generate an economic impact in Porto which ranges from 900 thousand euros to more than 7 million euros. This tourism expenditure may be transferred to the local economy, for instance, to restaurants or local shops. In the case of the accommodation industry, new passengers may increase total overnights, generating additional revenues of more than 1.5 million euros at most. These figures highlight the relevance of implementing opaque selling whose benefits can be summarized in fourfold. First, the airline sells all tickets of both destinations without decreasing prices too much. Second, consumers are able to travel to destinations at lower prices based on their willingness to pay. Third, since new individuals are arriving at low-demanded destinations, opaque selling encourages the development of the local economy through the considerable local economic impact that it generates in low-demanded destinations.

Scenario 2: Considering the same market conditions, let's define another scenario with different individuals' characteristics regarding risk attitude. Specifically, let's consider that 80 per cent of type 2 individuals are very risk-averse ($\beta_j = 0.1$). Similarly, let's consider that 5 percent of type 1 individuals are risk-loving with $\alpha_i \geq 1.4$. These considerations are realistic in the sense that literature supports that most individuals are risk-averse. Table 6 summarizes market and individuals characteristics in *Scenario 2*.

Table 7 summarizes the prices, constraints, and profits of each strategy for *Scenario 2*.

Similar to *Scenario 1*, without blind tickets, the optimal pricing strategy for the airline is *Strategy 1*. Thus, it is optimal again for the airline to have some unsold tickets rather than lowering prices.

Regarding *Strategy 3*, if the airline does not implement an additional discount (*Strategy 3.1*), it loses the demand of those risk-averse type 2

Table 6
Individuals and market characteristics in *Scenario 2*.

	Type 1 individuals	Type 2 individuals
Willingness to pay	Porto: $H = 120$ Paris: $L = 50$	Porto: $L = 50$ Paris: $H = 120$
Number of individuals	$N_1 = 105$	$N_2 = 300$
Individuals' risk attitude	5% risk-loving with $\alpha_i \geq 1.4$	80% very risk-averse with $\beta_j = 0.1$
	95% risk-averse or risk-neutral	20% risk-neutral or risk-loving
Aircraft (A320–214) capacity	$K = 150$	
Individual's income	$M = 1000$	

Table 7
Optimal pricing strategy for the airline in *Scenario 2*.

	Strategy 1	Strategy 2	Strategy 3	
			3.1	3.2
Prices	$P_{PORTO} = 120$ $P_{PARIS} = 120$	$P_{PORTO} = 50$ $P_{PARIS} = 120$	$P_{PORTO} = 120$ $P_{PARIS} = 120$ $D = 0$ $P_R = 85.38$	$P_{PORTO} = 120$ $P_{PARIS} = 120$ $D = 0.55$ $P_R = 84.83$
Constraints	–	–	$G_1(N_R^B) \leq 0\ \forall \alpha_i$ $G_2(N_R^B) \geq 0$ if $\beta_j \geq 1$	$G_1(N_R^B) \geq 0$ if $\alpha_j \geq 1.4$ $G_2(N_R^B) \geq 0\ \forall \beta_j$ $D \leq D^*$
Sold tickets	**In the transparent market:** *Porto* : 105 *Paris* : 150	**In the transparent market:** *Porto* : 150 *Paris* : 150	**In the transparent market:** *Porto* : 105 *Paris* : 104 **In the opaque market:** *Lottery* : 60 *out of a total of* 91 *Porto* : 14 *Paris* : 46 **TOTAL:** *Porto* : 119 *Paris* : 150	**Result 1:** **In the transparent market:** *Porto* : 100 *Paris* : 104 **In the opaque market:** *Lottery* : 91 *out of a total of* 91 *Porto* : 45 *Paris* : 46 **TOTAL:** *Porto* : 145 *Paris* : 150 **Result 2:** **In the transparent market:** *Porto* : 105 *Paris* : 104 **In the opaque market:** *Lottery* : 91 *out ofa total of* 91 *Porto* : 45 *Paris* : 46 TOTAL: *Porto* : 150 *Paris* : 150
Profits	$\pi_1 = 30600$	$\pi_2 = 25500$	$\pi_{3.1} = 30202.8$	$\pi_{3.2,RESULT\ 1} = 32199.53$ $\pi_{3.2,RESULT\ 2} = 32799.53$ $\overline{\pi}_{3.2} = 32499.53$ (*)

(*) In expected terms.

individuals in the opaque market what makes such a strategy suboptimal. Of the total number of type 2 individuals, 60 of them are risk-neutral or risk-loving while 240 are risk-averse. Those risk-averse type 2 individuals purchase in the transparent market since their utility is larger than the expected utility of purchasing blind tickets. On the contrary, those 60 risk-neutral and risk-loving individuals purchase blind tickets. However, notice that the number of type 2 risk-neutral and risk-loving individuals (60) is lower than the number of tickets we have in the lottery (91). Therefore, if the airline implements blind tickets without any discount, it will not be able to sell all tickets for both destinations.

According to *Strategy 3.2*, in order to fulfil the participation constraint for those very risk-averse individuals, the airline should implement a discount, $D = 0.55$. When implementing the discount, those risk-loving type 1 individuals have incentives to purchase the lottery, therefore it is difficult to anticipate what type of individuals end up purchasing in each market. In order to analyse the optimality of this strategy, we can calculate expected profits, distinguishing two extreme cases: *Result 1:* all type 1 risk-loving individuals purchase the lottery. Thus, the airline sells only 100 tickets to Porto in the transparent market; *Result 2:* only type 2 individuals purchase the lottery, and type 1 individuals continue purchasing in the transparent market. By calculating expected profits, it is optimal for the airline to implement blind tickets with an optimal discount (*Strategy 3.2*), although some risk-loving type 1 individuals may deviate to the market of blind tickets.

Table 8 compares social welfare between *Strategy 1* and *Strategy 3.2* (optimal pricing strategies with and without blind tickets) in *Scenario 2*. When considering *Strategy 3.2.*, we need to calculate social welfare in two extreme cases and then compute it in expected terms. In the first case, both type 1 risk-loving and type 2 individuals purchase the lottery. So, when calculating the consumer surplus, we need to take into consideration 5 risk-loving type 1 individuals and 86 type 2 individuals. Regarding *Result 2*, remember that only type 2 individuals purchase the lottery, thus we only consider their willingness to pay. By comparing both pricing strategies, we conclude that *Strategy 3.2* is not only optimal for the airline, but it is also socially desirable.

Table 8
Social welfare analysis for *Scenario 2*.

	Strategy 3.1	Strategy 3.2	
		Result 1	Result 2
Producer surplus	30600€	32199.53 €	32799.53 €
Consumer surplus	0 €	46.63 € [a]	50.47 € [b]
Social welfare	30600 €	32548.08 € [c]	

[a] Consumer surplus (Result 1): $45\left(\frac{5}{91}(120 - 84.83) + \frac{86}{91}(50 - 84.83)\right) + 46\left(\frac{5}{91}(50 - 84.83) + \frac{86}{91}(120 - 84.83)\right) = 46.63$.
[b] Consumer surplus (Result 2): $45(50 - 84.83) + 46(120 - 84.83) = 50.47$.
[c] In expected terms.

Table 9
Individuals and market characteristics in *Scenario 3*.

	Type 1 individuals	Type 2 individuals
Willingness to pay	Porto: $H = 120$ Paris: $L = 50$	Porto: $L = 50$ Paris: $H = 120$
Number of individuals	$N_1 = 95$	$N_2 = 300$
Individuals' risk attitude	60% risk-loving with $\alpha_i \geq 1.2$ 40% risk-averse or risk-neutral	74% very risk-averse with $\beta_j = 0.1$ 26% risk-neutral or risk-loving
Aircraft (A320–214) capacity	$K = 150$	
Individual's income	$M = 1000$	

Besides an increase in social welfare, blind booking implies more passengers flying to Porto and, thus, we should also consider the positive impact that these new passengers have on this tourist destination. Results are similar to *Scenario 1*. Notice that in the first scenario, 45 new passengers arrive in the city per flight. In *Scenario 2*, according to the optimal pricing strategy (blind tickets with an optimal discount), and the two possible results, 42 new passengers in expected terms arrive in the city. Therefore, the economic impact in Porto is similar to the one analysed in Table 5.

Scenario 3: Let us now assume the same market conditions as before but considering that there are 95 type 1 individuals. Additionally, 60 per cent of them are risk-loving type 1 individuals ($\alpha_j \geq 1.2$) while 74% type 2 individuals are very risk-averse ($\beta_j = 0.1$). Table 9 shows the characteristics of this third scenario.

Table 10 summarizes the prices, constraints, and profits of each strategy for *Scenario 3*.

When the airline introduces blind tickets without discount (*Strategy 3.1*), only 78 type 2 individuals have incentives to purchase the lottery. Thus, the airline remains with 33 unsold tickets of Porto. If it implements blind tickets with the optimal discount (*Strategy 3.2*), all type 2 individuals desire to purchase the lottery. However, with such a discount, the 57 risk-loving type 1 individuals have also incentives to purchase the lottery. For these individuals, the expected utility of the lottery is larger than the utility they get when purchasing tickets to Porto. Thus, we need to distinguish between two extreme cases, similar to *Scenario 2*, depending on whether type 1 risk-loving individuals deviate or not, and calculate profits in expected terms.

According to the results shown in Table 10, blind tickets are not optimal for the airline. Contrary to previous scenarios, when the airline needs to deal with a large amount of risk-averse type 2 individuals and risk-loving type 1 individuals, it is not optimal to introduce blind tickets. Thus, in this scenario, the optimal pricing strategy is *Strategy 1*. It is better for the airline to sell less at higher prices, rather than introducing blind tickets.

Regarding social welfare in *Scenario 3* (see Table 11), the socially optimal pricing strategy is blind tickets without discount (*Strategy 3.1*). This result is especially relevant for policymakers of low-demanded destinations, such as Porto. They may be interested in compensating airlines in order to implement blind tickets since this pricing strategy increases social welfare and results in new passengers arriving in the city.

With blind tickets without a discount (*Strategy 3.1*), 22 new passengers arrive at Porto per flight in comparison with *Strategy 1* (the optimal pricing strategy for the airline in *Scenario 3*). Based on the economic data of Porto, Table 12 summarizes the possible economic impact on this tourist destination per year.

In comparison with *Scenario 1*, the economic effects on the local economy of Porto are lower since fewer new passengers arrive in the city. However, it is important to highlight that policymakers may be interested in compensating airlines for introducing blind tickets since only with one flight per week the impact on tourism expenditure is more than 400 thousand euros per year and can lead to more than 5 million euros. Regarding the accommodation sector, these new tourists may generate more than 2 thousand overnight stays in Porto and more than 96 thousand in revenues. Thus, under this scenario, we demonstrate that despite it is not optimal for airlines to introduce blind tickets, this pricing strategy is socially optimal and provides large benefits for tourist destinations.

6. Conclusions

This paper studies the effects on consumers' purchase decisions,

Table 10
Optimal pricing strategy for the airline in *Scenario 3*.

	Strategy 1	Strategy 2	Strategy 3	
			3.1	3.2
Prices	$P_{PORTO} = 120$ $P_{PARIS} = 120$	$P_{PORTO} = 50$ $P_{PARIS} = 120$	$P_{PORTO} = 120$ $P_{PARIS} = 120$ $D = 0$ $P_R = 85.31$	$P_{PORTO} = 120$ $P_{PARIS} = 120$ $D = 0.55$ $P_R = 84.77$
Constraints	–	–	$G_1(N_R^B) \leq 0\ \forall \alpha_i$ $G_2(N_R^B) \geq 0$ if $\beta_j \geq 1$	$G_1(N_R^B) \geq 0$ if $\alpha_j \geq 1.2$ $G_2(N_R^B) \geq 0\ \forall \beta_j$ $D \leq D^*$
Sold tickets	**In the transparent market:** *Porto* : 95 *Paris* : 150	**In the transparent market:** *Porto* : 150 *Paris* : 150	**In the transparent market:** *Porto* : 95 *Paris* : 94 **In the opaque market:** *Lottery* : 78 *out of a total of* 111 *Porto* : 22 *Paris* : 56 **TOTAL:** *Porto* : 117 *Paris* : 150	**<u>Result 1:</u>** **In the transparent market:** *Porto* : 38 *Paris* : 94 **In the opaque market:** *Lottery* : 111 *out of a total of* 111 *Porto* : 55 *Paris* : 56 **TOTAL:** *Porto* : 93 *Paris* : 150 **<u>Result 2:</u>** **In the transparent market:** *Porto* : 195 *Paris* : 94 **In the opaque market:** *Lottery* : 111 *out of a total of* 111 *Porto* : 55 *Paris* : 56 **TOTAL:** *Porto* : 150 *Paris* : 150
Profits	$\pi_1 = 29400$	$\pi_2 = 25500$	$\pi_{3.1} = 29334.18$	$\pi_{3.2,RESULT\ 1} = 25249.47$ $\pi_{3.2,RESULT\ 2} = 32089.47$ $\overline{\pi}_{3.2} = 28669.47$ (*)

(*) In expected terms.

Table 11
Social welfare analysis for *Scenario 3*.

	Strategy 1	Strategy 2	Strategy 3		
			3.1	3.2	
				Result 1	Result 2
Producer surplus	29400 €	25500 €	29334.18 €	25249.47 €	32089.47€
Consumer surplus	0 €	4071.43 €	1165.82 €	24.58 € [a]	60.53 € [b]
Social welfare	29400 €	29571.43 €	30500 €	28712.02 € [c]	

[a] Consumer surplus (Result 1): $55\left(\frac{57}{111}(120-84.77)+\frac{56}{113}(50-84.77)\right)+56\left(\frac{57}{111}(50-84.77)+\frac{56}{113}(120-84.77)\right)=24.58.$
[b] Consumer surplus (Result 2): $55(50-84.77)+56(120-84.77)=60.53.$
[c] In expected terms.

Table 12
Possible economic impact in destination A (Porto) of implementing opaque selling in *Scenario 3*.

	1 flight per week	3 flights per week	Increase in frequency from 1 to 2 flights per week	Increase in frequency from 1 to 3 flights per week
New annual passengers arriving in Porto	1144	3432	7228	13,312
Total guest revenue (€)	96,839.60	290,518.8	611,850.2	1,126,860.8
Impact on overnight stay (total nights) considering average length of stay	2105	6315	13,300	24,494
Total tourism expenditure (€)	465,173.28	1,395,519.84	2,939,049.36	5,412,925.44

airlines' profitability, and tourist destinations of an original revenue management technique used in markets with non-storable goods: the so-called opaque selling. In the air transport sector, this strategy, also named blind booking, consists of selling a tourist package with a set of possible destinations, but without revealing the real destination until the payment is made. Therefore, consumers buy under uncertain conditions.

Despite the importance of consumers' risk attitude when analysing optimal choices under risky or uncertain conditions, little attention has been previously paid to this issue in the existing opaque selling literature. In this paper, we apply the Expected Utility Theory to analyse the optimality of opaque products and, considering different passengers' risk attitudes and some assumptions on the market structure, we describe the conditions that must be fulfilled for blind booking to be the optimal management strategy for the airline.

In order to illustrate the main results of the model, we provide some numerical examples to show the effects of blind booking on passengers' purchase decisions, airlines' profitability, and tourist destinations. We use these examples to compare the social welfare associated with blind booking and other possible pricing strategies. On the one hand, we show that, in general, selling tickets both in the transparent market and in the opaque market is the optimal pricing strategy for the airline. However, if there is a high proportion of very risk-averse individuals for the opaque market and a high proportion of risk-loving passengers for the transparent market, blind booking may not be optimal for the airline. On the other hand, we show that, even in those cases where opaque selling is not optimal for the airline, it may be social welfare-enhancing. Therefore, policymakers, especially those of low-demanded destinations, should encourage airlines to introduce blind tickets, since with this pricing strategy both consumers and tourist destinations are better off. On the one hand, blind tickets allow customers to buy cheaper tickets in the opaque market and fly to destinations they would not visit in the absence of this management strategy. On the other hand, since blind tickets suppose an additional source of demand, they attract new customers and, thus, generate positive economic impacts on underdeveloped tourist destinations.

Our model includes some simplifying assumptions and, therefore, has some limitations. We consider a monopolist airline that offers two possible destinations for two possible types of consumers (individuals of the same type have the same preferences over destinations, but they may have different risk attitudes). Future research may be needed to include competition among airlines, more possible destinations, and more heterogeneity among consumers.

Finally, we would like to highlight that, although this paper has analysed the private and social optimality of opaque selling in the airline industry, our results could be extended to any horizontally differentiated firm that sells non-storable goods.

CRediT authorship contribution statement

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

Declaration of competing interest

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APPENDIX 1

Table A1
Level of competition in all routes offered by Eurowings through blind booking (*)

Route (direct flights)	Airlines	Route (direct flights)	Airlines
BERLIN - DÜSSELDORF	EUROWINGS	DÜSSELDORF - ROVANIEMI	EUROWINGS
BERLIN - GRAN CANARIA	EUROWINGS, EASYJET, RYANAIR	DÜSSELDORF - TROMSø	EUROWINGS
BERLIN - GOTHENBURG	EUROWINGS	DÜSSELDORF - IVALO	EUROWINGS
BERLIN - INSSBRUCK	EUROWINGS	DÜSSELDORF - KITTILÄ	EUROWINGS
BERLIN - COLOGNE-BONN	EUROWINGS	DÜSSELDORF - REYKJAVIK	EUROWINGS, PLAY
BERLIN - MALAGA	EUROWINGS, EASYJET, RYANAIR	DÜSSELDORF - STOCKHOLM	EUROWINGS, SAS
BERLIN - FUERTEVENTURA	EUROWINGS, EASYJET, RYANAIR	DÜSSELDORF - AGADIR	EUROWINGS, TUIFLY, CONDOR
BERLIN - GRAZ	EUROWINGS	DÜSSELDORF - FUNCHAL	EUROWINGS, TUIFLY, CONDOR
BERLIN - HELSINKI	EUROWINGS, FINNAIR	DÜSSELDORF - HURGHADA	EUROWINGS, CONDOR, TUIFLY, AIR CAIRO, CORENDON
BERLIN - COPENHAGEN	EUROWINGS, EASYJET, SAS, NORWEGIAN	DÜSSELDORF - MARRAKESCH	EUROWINGS
BERLIN - LANZAROTE	EUROWINGS, EASYJET, RYANAIR	DÜSSELDORF - LARNACA	EUROWINGS, TUIFLY
BERLIN - ROVANIEMI	EUROWINGS	HAMBURG - BUDAPEST	EUROWINGS
BERLIN - STOCKHOLM	EUROWINGS, SAS, NORWEGIAN	HAMBURG - GRAZ	EUROWINGS
BERLIN - TENERIFE	EUROWINGS, EASYJET, RYANAIR	HAMBURG - LONDON	EUROWINGS, BRITISH AIRWAYS
BERLIN - PALMA DE MALLORCA	EUROWINGS, EASYJET, RYANAIR	HAMBURG - MUNICH	EUROWINGS, CONDOR, LUFTHANSA
BERLIN - SALZBURG	EUROWINGS	HAMBURG - PARIS	EUROWINGS, AIR FRANCE
BERLIN - STUTTGART	EUROWINGS	HAMBURG - SALZBURG	EUROWINGS
BERLIN - TROMSø	EUROWINGS, NORWEGIAN	HAMBURG - DÜSSELDORF	EUROWINGS
COLOGNE BONN - BARCELONA	EUROWINGS, RYANAIR	HAMBURG - COLOGNE (BONN)	EUROWINGS
COLOGNE BONN - BOLOGNA	EUROWINGS, RYANAIR	HAMBURG - MILAN	EUROWINGS
COLOGNE BONN - EDINBURGH	EUROWINGS	HAMBURG - OSLO	EUROWINGS, NORWEGIAN, SAS
COLOGNE BONN - LONDON	EUROWINGS, BRITISH AIRWAYS	HAMBURG - ROME	EUROWINGS, WIZZ AIR, AIR MALTA
COLOGNE BONN - MUNICH	EUROWINGS, LUFTHANSA	HAMBURG - ZÜRICH	EUROWINGS, SWISS
COLOGNE BONN - SALZBURG	EUROWINGS	HAMBURG - STUTTGART	EUROWINGS
COLOGNE BONN - BERLIN	EUROWINGS	HAMBURG - AMSTERDAM	EUROWINGS, KLM
COLOGNE BONN - BUDAPEST	EUROWINGS, WIZZ AIR	HAMBURG - LISSABON	EUROWINGS, TAP PORTUGAL
COLOGNE BONN - HAMBURG	EUROWINGS	HAMBURG - VIENNA	EUROWINGS, AUSTRIAN, TUIFLY
COLOGNE BONN - MILAN	EUROWINGS	HAMBURG - INSSBRUCK	EUROWINGS
COLOGNE BONN - ROME	EUROWINGS, RYANAIR	HAMBURG - LONDON	EUROWINGS, BRITISH AIRWAYS
COLOGNE BONN - VIENNA	EUROWINGS, RYANAIR, AUSTRIAN	HAMBURG - NICE	EUROWINGS
COLOGNE BONN - ZÜRICH	EUROWINGS	HAMBURG - TROMSø	EUROWINGS
COLOGNE BONN - SARAJEVO	EUROWINGS	HAMBURG - BARCELONA	EUROWINGS, VUELING
COLOGNE BONN - ZAGREB	EUROWINGS	HAMBURG - FUERTEVENTURA	EUROWINGS, CONDOR, NORWEGIAN
COLOGNE BONN - CATANIA	EUROWINGS	HAMBURG - GRAN CANARIA	EUROWINGS, CONDOR, NORWEGIAN
COLOGNE BONN - FUERTEVENTURA	EUROWINGS, CONDOR, RYANAIR	HAMBURG - LA PALMA	EUROWINGS, CONDOR
COLOGNE BONN - GRAN CANARIA	EUROWINGS, CONDOR, RYANAIR	HAMBURG - MALAGA	EUROWINGS, NORWEGIAN, CONDOR, RYANAIR
COLOGNE BONN - LISBON	EUROWINGS, RYANAIR	HAMBURG - PALMA DE MALLORCA	EUROWINGS, CONDOR, RYANAIR
COLOGNE BONN - PALMA DE MALLORCA	EUROWINGS, CONDOR, RYANAIR, LEAV AVIATION	HAMBURG - FARO	EUROWINGS, NORWEGIAN
COLOGNE BONN - TENERIFE	EUROWINGS, CONDOR, RYANAIR	HAMBURG - FUNCHAL	EUROWINGS, CONDOR
COLOGNE BONN - FARO	EUROWINGS, RYANAIR	HAMBURG - HURGHADA	EUROWINGS, CONDOR, CORENDON
COLOGNE BONN - FUNCHAL	EUROWINGS	HAMBURG - LANZAROTE	EUROWINGS, CONDOR, NORWEGIAN
COLOGNE BONN - LANZAROTE	EUROWINGS, CONDOR, RYANAIR	HAMBURG - TENERIFE	EUROWINGS, CONDOR, NORWEGIAN
COLOGNE BONN - MALAGA	EUROWINGS, RYANAIR	PRAG - BARCELONA	EUROWINGS, RYANAIR, VUELING
COLOGNE BONN - SPLIT	EUROWINGS	PRAG - FUNCHAL	EUROWINGS, SMARTWINGS
COLOGNE BONN - THESSALONIKI	EUROWINGS, AEGEAN	PRAG - COPENHAGEN	EUROWINGS, RYANAIR, SAS, NORWEGIAN
DÜSSELDORF - BUDAPEST	EUROWINGS	PRAG - ROME	EUROWINGS, RYANAIR, SKY EXPRESS, WIZZ AIR, AIR MALTA
DÜSSELDORF - DRESDEN	EUROWINGS	PRAG - DÜSSELDORF	EUROWINGS
DÜSSELDORF - SPLIT	EUROWINGS, CONDOR, CROATIA AIRLINES	PRAG - GENEVA	EUROWINGS, EASYJET
DÜSSELDORF - ZAGREB	EUROWINGS	PRAG - MALAGA	EUROWINGS, SMARTWINGS, RYANAIR
DÜSSELDORF - BUCHAREST	EUROWINGS	PRAG - STOCKHOLM	EUROWINGS, SAS, NORWEGIAN
DÜSSELDORF - KRAKOW	EUROWINGS	SALZBURG - AMSTERDAM	EUROWINGS, EASYJET, TRANSAVIA
DÜSSELDORF - PRISTINA	EUROWINGS, CONDOR, GP AVIATION	SALZBURG - DÜSSELDORF	EUROWINGS
DÜSSELDORF - TIRANA	EUROWINGS	SALZBURG - HAMBURG	EUROWINGS
DÜSSELDORF - BERGEN	EUROWINGS	SALZBURG - COLOGNE-BONN	EUROWINGS
DÜSSELDORF - CATANIA	EUROWINGS	SALZBURG - BERLIN	EUROWINGS
DÜSSELDORF - NAPLES	EUROWINGS	SALZBURG - GRAN CANARIA	EUROWINGS
DÜSSELDORF - VENICE	EUROWINGS	SALZBURG - HURGHADA	EUROWINGS
DÜSSELDORF - BOLOGNA	EUROWINGS	SALZBURG - TENERIFE	EUROWINGS
DÜSSELDORF - MILAN	EUROWINGS	STOCKHOLM - BERLIN	EUROWINGS, SAS, NORWEGIAN
DÜSSELDORF - ROME	EUROWINGS	STOCKHOLM - HAMBURG	EUROWINGS, SAS
DÜSSELDORF - ALICANTE	EUROWINGS	STOCKHOLM - STUTTGART	EUROWINGS
DÜSSELDORF - BILBAO	EUROWINGS	STOCKHOLM - DÜSSELDORF	EUROWINGS, SAS
DÜSSELDORF - GRAN CANARIA	EUROWINGS, TUIFLY, CONDOR, CORENDOR	STOCKHOLM - PRAGUE	EUROWINGS, SAS, NORWEGIAN
DÜSSELDORF - JEREZ DE LA FRONTERA	EUROWINGS, TUIFLY, CONDOR	STUTTGART - AMSTERDAM	EUROWINGS, KLM

(*continued on next page*)

Table A1 (*continued*)

Route (direct flights)	Airlines	Route (direct flights)	Airlines
DÜSSELDORF - LANZAROTE	EUROWINGS, TUIFLY, CONDOR, CORENDOR	STUTTGART - BERLIN	EUROWINGS
DÜSSELDORF - PALMA DE MALLORCA	EUROWINGS, TUIFLY, CONDOR, CORENDOR	STUTTGART - HAMBURG	EUROWINGS
DÜSSELDORF - BARCELONA	EUROWINGS, VUELING	STUTTGART - LONDON	EUROWINGS, BRITISH AIRWAYS
DÜSSELDORF - FUERTEVENTURA	EUROWINGS, TUIFLY, CONDOR, CORENDOR	STUTTGART - ROME	EUROWINGS
DÜSSELDORF - IBIZA	EUROWINGS, TUIFLY, CONDOR	STUTTGART - VALENCIA	EUROWINGS
DÜSSELDORF - LA PALMA	EUROWINGS, CONDOR	STUTTGART - BARCELONA	EUROWINGS, VUELING
DÜSSELDORF - MALAGA	EUROWINGS, CONDOR	STUTTGART - BREMEN	EUROWINGS
DÜSSELDORF - VALENCIA	EUROWINGS	STUTTGART - LISBON	EUROWINGS
DÜSSELDORF - TENERIFE	EUROWINGS, TUIFLY, CONDOR, CORENDOR	STUTTGART - MILAN	EUROWINGS
DÜSSELDORF - ATHEN	EUROWINGS, AEGEAN, SKY EXPRESS	STUTTGART - STOCKHOLM	EUROWINGS
DÜSSELDORF - FARO	EUROWINGS, CONDOR, TUIFLY	STUTTGART - BUDAPEST	EUROWINGS, WIZZ AIR
DÜSSELDORF - LISBON	EUROWINGS, TAP PORTUGAL, NEOS	STUTTGART - PRISTINA	EUROWINGS, CONDOR, GP AVIATION
DÜSSELDORF - PORTO	EUROWINGS	STUTTGART - SPLIT	EUROWINGS
DÜSSELDORF - WESTERLAND SYLT	EUROWINGS	STUTTGART - VIENNA	EUROWINGS, AUSTRIAN
DÜSSELDORF - BERLIN	EUROWINGS	STUTTGART - BUCHAREST	EUROWINGS
DÜSSELDORF - NICE	EUROWINGS	STUTTGART - SARAJEVO	EUROWINGS
DÜSSELDORF - VIENNA	EUROWINGS, AUSTRIAN	STUTTGART - TIRANA	EUROWINGS
DÜSSELDORF - BIRMINGHAM	EUROWINGS	STUTTGART - ZAGREB	EUROWINGS
DÜSSELDORF - EDINBURGH	EUROWINGS	STUTTGART - ATHEN	EUROWINGS, AEGEAN
DÜSSELDORF - GRAZ	EUROWINGS	STUTTGART - FARO	EUROWINGS, TUIFLY
DÜSSELDORF - LONDON	EUROWINGS, BRITISH AIRWAYS	STUTTGART - FUNCHAL	EUROWINGS, TUIFLY, CONDOR
DÜSSELDORF - NEWCASTLE	EUROWINGS	STUTTGART - HURGHADA	EUROWINGS, CONDOR, CORENDON, TUIFLY, AIR CAIRO
DÜSSELDORF - SALZBURG	EUROWINGS	STUTTGART - LANZAROTE	EUROWINGS, TUIFLY, NORWEGIAN
DÜSSELDORF - ZÜRICH	EUROWINGS, SWISS	STUTTGART - NAPLES	EUROWINGS
DÜSSELDORF - DRESDEN	EUROWINGS	STUTTGART - CATANIA	EUROWINGS
DÜSSELDORF - GENEVA	EUROWINGS	STUTTGART - FUERTEVENTURA	EUROWINGS, TUIFLY, NORWEGIAN, CONDOR
DÜSSELDORF - LYON	EUROWINGS	STUTTGART - GRAN CANARIA	EUROWINGS, TUIFLY, NORWEGIAN, CONDOR
DÜSSELDORF - MANCHESTER	EUROWINGS	STUTTGART - LA PALMA	EUROWINGS
DÜSSELDORF - THESSALONIKI	EUROWINGS, AEGEAN	STUTTGART - MALAGA	EUROWINGS
DÜSSELDORF - GOTHENBURG	EUROWINGS	STUTTGART - TENERIFE	EUROWINGS, NORWEGIAN, TUIFLY, CONDOR
DÜSSELDORF - KIRUNA	EUROWINGS	STUTTGART - PALMA DE MALLORCA	EUROWINGS, NORWEGIAN, CONDOR, TUIFLY
DÜSSELDORF - COPENHAGEN	EUROWINGS, SAS	STUTTGART - THESSALONIKI	EUROWINGS, AEGEAN

(*) This information was consulted in February 2024.

APPENDIX 2

Table A2
Additional numerical illustrations

		Scenario 4	Scenario 5	Scenario 6	Scenario 7
Willingness to pay	Type 1 individuals	Porto: $H = 120$ Paris: $L = 50$	Porto: $H = 120$ Paris: $L = 50$	Porto: $H = 140$ Paris: $L = 80$	Porto: $H = 140$ Paris: $L = 80$
	Type 2 individuals	Porto: L $= 50$ Paris: H $= 120$	Porto: L $= 50$ Paris: H $= 120$	Porto: L $= 80$ Paris: H $= 140$	Porto: L $= 80$ Paris: H $= 140$
Number of individuals	Type 1 individuals	$N_1 = 105$	$N_1 = 105$	$N_1 = 60$	$N_1 = 60$
	Type 2 individuals	$N_2 = 300$	$N_2 = 300$	$N_2 = 200$	$N_2 = 200$
Individuals' risk attitude	Type 1 individuals	20% risk-loving with $\alpha_i \geq 1.4$ 80% risk-averse or risk-neutral	20% risk-loving with $\alpha_i \geq 1.4$ 80% risk-averse or risk-neutral	30% risk-loving with $\alpha_i \geq 1.5$ 70% risk-averse or risk-neutral	30% risk-averse with $\alpha_i < 1$ 70% risk-averse or risk-neutral
	Type 2 individuals	60% risk-averse with $\beta_j = 0.1$ 30% risk-neutral or risk-loving	80% risk-averse with $\beta_j < 1$ 20% risk-neutral or risk-loving	65% risk-averse with $\beta_j < 1$ 35% risk-neutral or risk-loving	65% risk-averse with $\beta_j < 1$ 35% risk-neutral or risk-loving
Aircraft capacity		$K = 150$	$K = 140$	$K = 100$	$K = 100$
Individuals' income		$M = 800$	$M = 1000$	$M = 800$	$M = 500$
Strategy 1	Sold tickets	255	245	160	160
	Prices	120	120	140	140
	Profits	30600	29400	22400	22400
Strategy 2	Sold tickets	300	280	200	200
	Prices	Porto: 5 0; Paris: 12 0	Porto: 5 0; Paris: 12 0	Porto: 8 0; Paris: 14 0	Porto: 8 0; Paris: 14 0
	Profits	25500	23800	22000	22000
Strategy 3.1	Sold tickets in TM	209	209	119	119
	Prices TM	120	120	140	140
	Sold tickets in OM	91	60	70	70
	Discount	0	0	0	0

(*continued on next page*)

Table A2 (*continued*)

		Scenario 4	Scenario 5	Scenario 6	Scenario 7
	Price of the lottery	85.38	85.49	110.37	110.37
	Profits	**32849.58**	30209.4	**24385.90**	**24385.90**
Strategy 3.2, Result 1	Sold tickets in TM	–	209	101	77
	Prices TM	–	120	140	140
	Sold tickets in OM	–	71	81	81
	Discount	–	0.55	0.51	0.81
	Price of the lottery	–	84.94	109.86	109.56
	Profits	–	31110.74	23038.66	19654.36
Strategy 3.2, Result 2	Sold tickets in TM	–	–	119	119
	Prices TM	–	–	140	140
	Sold tickets in OM	–	–	81	81
	Discount	–	–	0.51	0.51
	Price of the lottery	–	–	109.86	109.56
	Profits	–	–	25558.66	25534.36
Strategy 3.2	Profits	–	**31110.74** (*)	24298.66 (**)	22594.36 (**)

(***) TM refers to transparent market, while OM refers to opaque market.

(*) Under this scenario and market conditions, when implementing blind tickets with an optimal discount, risk-loving type 1 individuals have no incentives to buy the lottery. Thus, under Strategy 3.2, there exists only one possible result on which all type 1 and some type 2 individuals buy in the transparent market and the rest of type 2 individuals purchase the lottery.

(**) In expected terms.

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