Tesis Doctoral

Economic Analysis of Blind Tickets in Air Transport Markets

ULPGC · UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA

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Gobierno de Canarias
Consejería de Economía, Conocimiento y Empleo
Agencia Canaria de Investigación, Innovación y Sociedad de la Información

Canarias avanza con Europa

FONDO SOCIAL EUROPEO

Unión Europea

Esta tesis está cofinanciada por la Agencia Canaria de Investigación, Innovación y Sociedad de la Información de la Consejería de Economía, Conocimiento y Empleo y el Fondo Social Europeo (FSE), Programa Operativo Integrado de Canarias 2014-2020, Eje 3 Tema Prioritario 74 (85%). Convocatoria “TESIS 2021”, número de expediente TESIS2021010004.

UNIVERSIDAD DE LAS PALMAS DE GRAN CANARIA

ESCUELA DE DOCTORADO

Programa de Doctorado en Turismo, Economía y Gestión

Economic Analysis of Blind Tickets in Air Transport Markets

Tesis Doctoral presentada por Juana María Alonso Déniz

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La Directora **La Doctoranda**

Las Palmas de Gran Canaria, Julio 2024

AGRADECIMIENTOS

Quizás estas sean las líneas más difíciles de escribir de toda la tesis. Llegar hasta aquí no ha sido fácil, pero me siento tremendamente afortunada. Muchas son las personas que han pasado por mi vida a lo largo de estos casi cuatro años dedicándome infinitas sonrisas, palabras de cariño, al igual que de consuelo y ánimo en los momentos difíciles. Sientan mi más profundo agradecimiento por quitarme piedras del camino y darme luz en momentos de oscuridad.

A mi familia, no tendría con todas las líneas de esta tesis para agradecer todo lo que hacen por mí. Mi hermana, una pieza fundamental en mi puzle. Ella me trasmitió su vocación por la economía y me animó a estudiar esta apasionante carrera allá por el 2015, cuando me enfrenté a la gran decisión de qué estudiar. No te equivocaste, para mí este mundo es apasionante y gracias a ti he podido llegar a donde estoy, alegre y feliz por estar formándome en tres áreas que me apasionan: la economía, la investigación y la docencia.

A mis padres, gracias por darme la vida y darme tanto. Ambos proceden de dos lugares escondidos y preciosos de esta isla. Crecieron en familias numerosas, sin muchas posibilidades ni oportunidades económicas, pero tal y como comentan ellos a diario, no tenían mucho, pero eran felices. Un día decidieron apostar por sus sueños, dejar sus hogares y luchar por un futuro mejor. A día de hoy, con mucho esfuerzo, trabajo, sacrificios y noches sin dormir, lo han conseguido y dan gracias a la vida. Nosotras, mi hermana y yo, también deberíamos hacerlo ya que gracias a ellos hemos crecido en un hogar maravilloso, feliz y lleno de oportunidades. Hace algún tiempo, acudí a un concierto de uno de mis cantantes favoritos y al finalizar de cantar una de sus increíbles canciones dijo algo así como "que vuele alto y que vuele libre". Ustedes han apostado mucho por mí y me han dejado volar muy alto y libre. Si hoy estoy aquí es por ustedes y no me alcanzará la vida para devolverles y agradecerles tanto.

A Pilar Socorro, mi directora de tesis y, me atrevo a decir, madre institucional. No he podido elegir mejor compañera y guía en este camino. Recuerdo esa primera reunión, cuando le planteé que fueras mi directora y aceptó muy contenta y feliz. Si lo pienso, se me hace de nuevo un nudo en el estómago. Gracias por todas las oportunidades que me has dado, por todo el tiempo que me has dedicado y por trasmitirme tanto. Cuando empecé la tesis, sabía que eras una gran profesional, pero hoy confirmo que, aparte de ello, eres una gran persona y que has sido mi mejor acompañante en esta gran andadura. Ojalá seguir aprendiendo de ti.

Quiero agradecer al profesor Eric Pels que me haya brindado la oportunidad de trabajar con él y aprender tanto. Asimismo, aprovecho también para agradecer a la Agencia Canaria de Investigación, Innovación y Sociedad de la Información, órgano de la Administración Pública de la Comunidad Autónoma de Canarias, por obsequiarme con una beca para el desarrollo de esta tesis. Gracias por brindar a muchos jóvenes la oportunidad de iniciar su carrera investigadora con financiación.

Por último, quiero dedicar unas palabras a mis compañeros. A lo largo de estos años he conocido a personas increíbles con las que he compartido muchas historias de pasillo, anécdotas, congresos, almuerzos, despacho, estancias, vacaciones, etc. Muchísimas gracias a todos por estar ahí y formar parte de este proceso.

ACKNOWLEDGEMENTS

These are perhaps the most difficult lines to write in the whole thesis. Getting this far has not been easy, but I feel extremely fortunate. Many are the people who have passed through my life during these almost four years, giving me endless smiles, words of affection, as well as words of comfort and encouragement in difficult moments. I am deeply grateful to them for taking stones out of my way and giving me light in moments of darkness.

To my family, I would not have all the lines of this thesis to thank them for everything they do for me. My sister, a fundamental piece in my puzzle. She passed on her vocation for economics to me and encouraged me to study this exciting career back in 2015, when I was faced with the big decision of what to study. You weren't wrong, for me this world is exciting and thanks to you I have been able to get to where I am, happy to be training in three areas that I am passionate about: economics, research and teaching.

To my parents, thank you for giving me life and giving me so much. They both come from two hidden and beautiful places on this island. They grew up in large families, without many economic possibilities and opportunities, but as they say every day, they didn't have much, but they were happy. One day, they decided to go for their dreams, leave their homes and fight for a better future. Today, with a lot of effort, hard work, sacrifices and sleepless nights, they have achieved it and they thank life. We, my sister and I, should do the same, because thanks to them we have grown up in a wonderful home, happy and full of opportunities. Some time ago, I went to a concert of one of my favourite singers and at the end of one of his amazing songs he said something like ‘may I fly high and fly free’. You have bet a lot on me, and you have let me fly high and free. If I am here today it is because of you, and I will never be able to repay you and thank you so much.

To Pilar Socorro, my thesis supervisor and, dare I say it, my institutional mother. I could not have chosen a better companion and guide on this journey. I remember that first meeting, when I asked her to be my director and she accepted very happily. If I think about it, I get a knot in my stomach again. Thank you for all the opportunities you have given me, for all the time you have dedicated to me and for transmitting so much to me. When I started my thesis, I knew you were a great professional, but today I can confirm that, apart from that, you are a great person and that you have been my best companion on this great journey. I hope to continue learning from you.

I would like to thank Professor Eric Pels for giving me the opportunity to work with him and learn so much. I would also like to take this opportunity to thank the *Agencia Canaria de Investigación, Innovación y Sociedad de la Información*, a body of the Public Administration of the Autonomous Community of the Canary Islands, for giving me a grant for the development of this thesis. Thank you for giving many young people the opportunity to start their research career with funding.

Finally, I would like to dedicate a few words to my colleagues. Throughout these years I have met incredible people with whom I have shared many stories, anecdotes, congresses, lunches, offices, stays, holidays, etc. Thank you all so much for being there and for being part of this process.

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RESUMEN EN ESPAÑOL

Las aerolíneas operan en entornos comerciales competitivos sometidos a continuos cambios, haciendo frente a demandas fluctuantes y teniendo en cuenta que los bienes o servicios que prestan son no almacenables. Tanto las aerolíneas de bajo coste como las de servicio completo compiten en términos de cuotas de mercado, utilización de capacidad y maximización de los beneficios cobrando diferentes precios en función de las disposiciones a pagar de los consumidores, a través de la denominada práctica de gestión de ingresos o *revenue management.*

El principal objetivo y tema de investigación de esta tesis doctoral es el estudio de los impactos económicos y la rentabilidad social y privada de los denominados billetes a ciegas o *blind tickets* en el ámbito del transporte aéreo, modelizando el comportamiento de empresas y consumidores como agentes maximizadores de beneficios y utilidad, respectivamente.

Los productos opacos o billetes a ciegas consisten en bienes o servicios en los que empresas, proveedores o intermediarios ocultan cierta información acerca de los atributos del producto en el momento de compra. En el caso del sector del transporte aéreo, esta estrategia de precios se refiere a un método de compra de billetes en el que ciertos detalles del viaje, tales como los horarios de salida y llegada, la identidad de la aerolínea o el destino, no se revelan hasta una vez hecho el pago.

Eurowings (filial de Lufthansa) es un ejemplo de aerolínea de bajo coste, que actualmente ofrece estos billetes a ciegas. Eurowings permite a los viajeros reservar vuelos con descuento sin conocer el destino exacto hasta después de haber realizado la compra. Los consumidores deben elegir el aeropuerto de salida, las fechas de viaje y un tema de viaje para sus vacaciones, tales como "Pizza, Pasta & Amore", "Siesta & Fiesta" o "Aventura en la ciudad". Cada tema incluye diferentes destinos posibles y los consumidores descubren el destino final de su viaje inmediatamente después de realizar el pago, de modo que tienen tiempo suficiente para preparar su viaje.

Waynabox, Drumwit o FlyKube son otros ejemplos de empresas que ofrecen productos opacos en el sector del transporte aéreo y alojamiento. En el sector del alojamiento, *PortAventura World,* un complejo de ocio ubicado en Cataluña (España) con diferentes parques temáticos y hoteles de cuatro y cinco estrellas, también vende productos opacos. En su página web, los clientes pueden reservar alojamiento en sus diferentes hoteles temáticos, o también pueden comprar el *Roulette Hotel* a través del cual los consumidores son asignados aleatoriamente a uno de sus hoteles de cuatro estrellas. En el sector del alquiler de coches, la empresa Sixt ofrece el *Lucky Dip Car*. El cliente que elige esta categoría paga el precio "Compact" sin conocer el vehículo que recibirá. Una vez que llegue a la oficina de Sixt para recoger su vehículo, se le informará de la categoría obtenida.

Como estrategia de discriminación de precios, los billetes a ciegas permiten a las empresas cobrar precios diferentes a distintos consumidores creando dos mercados distintos: el mercado transparente y el opaco. Esto permite a las aerolíneas a hacer frente a los asientos no vendidos, los cuales oscilan entre un 20% y un 30% (Gallego et al., 2008). En el mercado transparente, los clientes conocen todas las características y atributos de los productos antes de comprarlos. En el mercado opaco, el vendedor oculta parte de la información sobre el producto hasta que se realiza el pago. Mientras que aquellos consumidores con preferencias fuertes por viajar a un determinado destino compran en el mercado transparente a precios superiores, aquellos más sensibles al precio son atendidos en el mercado opaco con ciertos descuentos. La principal ventaja de esta estrategia de precios recae en crear una nueva demanda diferente del mercado existente, garantizando ingresos adicionales para las aerolíneas. Sin embargo, a la hora de implementar los billetes a ciegas es importante considerar el posible efecto de canibalización el cual consiste en que los consumidores que ya compraban anteriormente terminen comprando en el mercado opaco.

En cada capítulo de esta tesis doctoral evaluamos la optimalidad de los billetes a ciegas bajo distintas características y condiciones de mercado. Desarrollamos diferentes modelos económicos consolidando los billetes a ciegas como una estrategia de precios rentable para destinos turísticos en desarrollo y mercados de transporte aéreo con subvenciones. A continuación, se presenta un resumen de cada capítulo de esta tesis y de los principales resultados obtenidos.

En el Capítulo 3, desarrollamos un modelo teórico para evaluar la optimalidad privada y social de los billetes a ciegas. Consideramos una aerolínea que ofrece vuelos a dos posibles destinos atendiendo a dos tipos de consumidores con diferente disposición a pagar por cada destino. En este capítulo, evaluamos las posibles estrategias que la aerolínea debería adoptar para maximizar sus beneficios bajo diferentes condiciones de mercado. Dada la incertidumbre existente a la hora de comprar billetes a ciegas, aplicamos la Teoría de la Utilidad Esperada considerando diferentes grados de aversión al riesgo de los pasajeros. Además, ilustramos el impacto económico de la introducción de esta ingeniosa estrategia de precios para los destinos, en términos de llegadas adicionales de turistas, ingresos de los huéspedes, pernoctaciones y gasto turístico.

Los principales resultados del Capítulo 3 sugieren que en tanto en cuanto los individuos son neutrales o amantes del riesgo, los billetes a ciegas son siempre óptimos para las aerolíneas, independientemente de la capacidad del avión y de la demanda existente de los destinos. Si consideramos individuos aversos al riesgo, las aerolíneas deben ofrecer estos productos con un descuento adicional. En este capítulo demostramos también que aun cuando los billetes a ciegas no sean óptimos para las aerolíneas, fomentan el bienestar social. Así pues, los responsables de los destinos turísticos, especialmente aquellos con poca demanda, deberían incentivar a las aerolíneas a aplicar esta estrategia de precios, ya que permiten a los clientes comprar billetes más baratos generando una fuente adicional de demanda y numerosos impactos económicos positivos en dichos destinos.

En el Capítulo 4, desarrollamos un modelo teórico y un análisis de demanda de los billetes a ciegas. Teóricamente, desarrollamos un modelo económico considerando una aerolínea que puede ofrecer dos vuelos a un conjunto de destinos horizontalmente diferenciados en relación con sus atributos de sol y playa y culturales. Evaluamos la optimalidad de introducir billetes a ciegas para un conjunto de consumidores heterogéneos. A diferencia del Capítulo 3, consideramos los billetes a ciegas como un mecanismo para gestionar los billetes no vendidos en el que todos los destinos son equiprobables considerando la aversión al riesgo de los individuos mediante una función de utilidad cóncava. En cuanto al análisis de la demanda, hasta donde sabemos, somos las primeras en evaluar cómo perciben los clientes esta estrategia de precios. Para ello, desarrollamos un análisis de sentimientos, utilizando diferentes técnicas de procesamiento del lenguaje natural, con el fin de analizar el contenido de las reseñas online publicadas por individuos que ya han comprado este producto.

Los principales resultados del Capítulo 4 se resumen a continuación. En relación con el modelo teórico, concluimos que los productos opacos aumentan el bienestar social y pueden incrementar los beneficios de las aerolíneas en hasta un 30%. Además, demostramos que la aversión al riesgo de los individuos influye considerablemente en la optimalidad de estos productos. Así pues, ignorar el grado de aversión al riesgo de los consumidores (asumiendo que son neutrales al riesgo) implica que los individuos no tengan incentivos a comprar estos productos, derivando en una pérdida de beneficios para las aerolíneas de hasta un 25%. De acuerdo con el análisis empírico, los resultados sugieren que los productos opacos son hoy en día una estrategia de precios muy popular entre los consumidores. Más del 87% de las opiniones son positivas, manifiestan la intención de volver a comprar estos productos y destacan que son una forma de viajar a destinos poco demandados o menos conocidos que, de otro modo, los consumidores nunca habrían elegido. En general, el Capítulo 4 mostramos que los productos opacos son una estrategia de precios rentable para las aerolíneas, los viajeros y los destinos turísticos.

Las subvenciones a los pasajeros que viven en islas o regiones remotas son habituales en los mercados aéreos europeos. En España, por ejemplo, se concede una subvención *ad valorem* a los residentes de Canarias, Baleares, Ceuta y Melilla. Artículos previos destacan que este tipo de política da lugar a algunas ineficiencias cuando las aerolíneas tienen poder de mercado. En concreto, los pasajeros residentes pagan tarifas más elevadas y los pasajeros no residentes pueden decidir no viajar a estos destinos dado el incremento en precios. En el Capítulo 5, desarrollamos un modelo económico para analizar la optimalidad de introducir billetes a ciegas con el fin de hacer frente a las posibles ineficiencias derivadas de aplicar una subvención *ad valorem* a pasajeros residentes.

Los resultados del Capítulo 5 sugieren que los billetes a ciegas son una estrategia de precios óptima para (re)introducir a pasajeros no residentes en mercados aéreos donde existe una subvención solo para residentes. Con esta estrategia de precios, las aerolíneas pueden llenar aviones atendiendo a pasajeros no residentes mediante billetes a ciegas cobrándoles su máxima disposición a pagar por viajar a estos destinos. Con el fin de evitar la canibalización y que los residentes terminen comprando billetes a ciegas, la aerolínea puede ofrecer a los residentes un descuento adicional. Unas tarifas más bajas implican una disminución del importe de la subvención y una reducción del gasto público. La principal contribución de este capítulo es proporcionar una estrategia de precios que gestiona las ineficiencias de una política existente derivando en ingresos adicionales para las aerolíneas, tarifas más bajas para los pasajeros residentes, la posibilidad de viajar para los no residentes y la ausencia de financiación pública para su implementación.

En resumen, esta tesis doctoral contribuye a la literatura existente de billetes a ciegas en cuatro términos. En primer lugar, bajo diferentes condiciones de mercado y características de los individuos, estudiamos la optimalidad de los billetes a ciegas como estrategia de precios gestionada directamente por una aerolínea, sin necesidad de recurrir a intermediarios y aplicada simultáneamente con otras estrategias de precios. En segundo lugar, en cada capítulo aplicamos la Teoría de la Utilidad Esperada y, por tanto, consideramos los distintos grados de aversión al riesgo de los individuos a la hora de adquirir estos productos. En tercer lugar, aportamos evidencia empírica de cómo perciben los clientes estos productos basándonos en las preferencias reveladas. En cuarto lugar, ofrecemos a los gobiernos una estrategia de precios que gestiona las ineficiencias derivadas de las subvenciones *ad valorem* para pasajeros residentes en los mercados del transporte aéreo.

CHAPTER 1.

INTRODUCTION

Airlines continuously deal with fluctuating demand and changing competitive business environments in addition to the non-storable nature of the goods or services they provide. 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 their varying willingness to pay, a practice known as revenue management.

The main objective and research topic of this Ph. D. thesis dissertation is the study of the economic effects and social and private profitability of the so-called blind tickets in the air transport industry, modelling the behaviour of firms and consumers, as profit and utility maximisers, respectively.

Opaque products or blind tickets consist of goods or services in which providers withhold some information about the product attributes at the moment of purchase. In the case of the airline industry, this pricing strategy refers to a travel booking method where certain details of the trip, such as the exact flight times, airline identity, or destination are not revealed until after the booking is made.

Eurowings (a subsidiary of Lufthansa) is an example of a low-cost carrier currently offering blind tickets. Eurowings, allows travellers to book flights at a discounted rate without knowing the exact destination until after the purchase is made. Consumers must choose the departure airport, travel dates and a travel topic, such as "Pizza, Pasta & Amore", "Siesta & Fiesta" or "Adventure in the City". Each topic includes different possible destinations and consumers find out their travel destination right at the end of the booking process so that they have enough time to prepare their trip.

Waynabox, Drumwit or FlyKube are other examples of companies that offer opaque products in the air transport and accommodation industry. In the accommodation industry, PortAventura World, an entertainment resort in Catalonia (Spain) with different theme parks and four and five-star hotels, also sells opaque products. On their website, customers can book accommodation in their different theme hotels, or they can also purchase the Roulette Hotel on which consumers are randomly allocated to one of their four-star hotels. In the rent-a-car industry, the firm Sixt offers the Lucky Dip Car. The customer who chooses this category pays the "Compact" price without knowing the vehicle he will receive. Once he arrives at the Sixt office to pick up his vehicle, he will be informed of the category obtained.

As a price discrimination strategy, opaque products allow firms to charge different prices to different consumers by creating two different markets, the transparent market and the opaque one. This allows airlines to deal with unsold tickets which usually range between 20 and 30 per cent (Gallego et al., 2008). In the transparent market, customers are aware of all the characteristics and attributes of products before purchasing them. In the opaque market, the seller withholds some information about the product until the payment is made. While consumers with strong preferences buy in the transparent market and are charged high prices, certain discounts are given to price-sensitive consumers to deal with uncertainty in the opaque market (Anderson and Xie, 2012). Therefore, 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 and Song, 2020). In fact, they may be implemented to avoid the so-called cannibalization effect in which consumers with strong preferences end up purchasing flight tickets at low prices.

In each chapter of this Ph. D. thesis dissertation, we evaluate the optimality of blind tickets under different market conditions. We provide different economic models on which blind tickets are a profitable pricing strategy in order to generate new demand in low-demanded destinations and an optimal pricing strategy in subsidised air transport markets. The following provides a summary of each chapter of this thesis, and the main results achieved.

In Chapter 3, we develop a theoretical model in order to evaluate the private and social optimality of blind booking. We consider an airline that offers flights to two possible destinations to two types of consumers with different willingness to pay for each destination. Under different market conditions, we evaluate the possible strategies that the airline should adopt in order to maximise its profits. Because of the uncertainty when purchasing blind tickets, we apply the Expected Utility Theory considering different passengers' degrees of risk aversion. Additionally, we illustrate the economic impact of introducing this ingenious pricing strategy for low-demanded destinations, in terms of additional tourist arrivals, guest revenues, overnight stays and tourism expenditure.

The main results of Chapter 3 suggest that as long as individuals are risk-neutral or risk-loving, blind tickets are always optimal for the airline, independently of aircraft capacity and the existing demand of destinations. When considering risk-averse individuals, the airline may offer blind tickets with an additional discount. Additionally, even when there exist cases in which blind tickets are not optimal for airlines, they enhance social welfare. Thus, policymakers, especially those of low-demanded destinations, should encourage airlines to implement this pricing strategy since they allow customers to purchase cheaper tickets generating an additional source of demand and several positive economic impacts in such destinations.

In Chapter 4, we develop a theoretical model and a demand analysis of blind tickets. Regarding the former, we develop an economic model considering an airline that may offer two flights to a set of horizontally differentiated destinations regarding their sun-and-beach and cultural attributes. In such a market, we evaluate the optimality of introducing blind tickets to a set of heterogeneous consumers. Different from Chapter 3, we consider blind tickets as a mechanism to manage unsold tickets on which all destinations are equally probable and model individuals' risk aversion through a concave utility function. Regarding the demand analysis, to the best of our knowledge, we are the first ones to evaluate how customers perceive blind tickets. To do so, we develop a sentiment analysis, using different natural language processing techniques, in order to analyse the content of online reviews posted by individuals who have already purchased this product.

The results of Chapter 4 are summarized as follows. Regarding the theoretical model, we prove that blind tickets enhance social welfare and may improve profits by up to 30 per cent. Additionally, we demonstrate the importance of considering individuals' risk attitudes and we conclude that ignoring consumers' risk aversion (that is, assuming risk neutrality) when selling opaque products may result in a profit loss for airlines of 25 per cent. According to the empirical analysis, results suggest that opaque products are nowadays a very popular pricing strategy among consumers. More than 87 per cent of the reviews are positive, manifest the repurchase intention and highlight that they are a way of travelling to low-demanded or less-known destinations that otherwise customers would have never chosen. Overall, Chapter 4 demonstrates that opaque products are a profitable pricing strategy for airlines, travellers and tourist destinations.

Subsidies for passengers living in islands or remote regions are common in European air transport markets. For instance, in Spain, an *ad valorem* subsidy is granted to residents of the Canary Islands, Balearic Islands, Ceuta and Melilla. Previous research highlights that this kind of policy results in some inefficiencies when carriers have market power. In particular, resident passengers pay higher fares and mom-resident passengers may be excluded from the market because of the increase in ticket prices. In Chapter 5, we develop a theoretical model to analyse the optimality of introducing blind tickets to manage the inefficiencies derived from implementing an *ad valorem* subsidy only for resident passengers.

Results of Chapter 5 suggest that blind tickets are an optimal pricing strategy for reintroducing those non-resident passengers in subsidised air transport markets. With this pricing strategy, airlines may sell all tickets and charge non-resident passengers their maximum willingness to pay through blind tickets. In order to avoid the cannibalization effect, the airline may provide residents with an additional discount. Lower fares imply a decrease in the amount of the subsidy and a reduction in public expenditure. Therefore, to the best of our knowledge, this chapter is the first one to provide a pricing strategy that mitigates the inefficiencies associated with subsidies for residents, allowing additional revenues for airlines, lower fares for resident passengers, and the reintroduction of non-residents in the market. Moreover, no public funds are needed for its implementation.

Summarizing, the main contribution of this Ph. D. thesis dissertation to the existing literature on blind tickets is fourfold. First, under different market conditions and individuals' characteristics, we study the optimality of blind tickets as a pricing strategy managed directly by an airline (without intermediaries) and simultaneously applied with other pricing strategies. Second, in each chapter we apply the Expected Utility Theory and, thus, consider different individuals' degrees of risk aversion when purchasing these products. Third, we provide empirical evidence of how customers perceive these products based on revealed preferences. Fourth, we provide governments with a pricing strategy that manages the inefficiencies of *ad valorem* subsidies for resident passengers in air transport markets.

CHAPTER 2.

LITERATURE REVIEW

In this thesis dissertation we study the optimality of blind tickets under different settings. Thus, in this chapter we first provide a major revision of previous research on opaque products. Then, we include sub-sections with a revision of different methodologies and the implications of interventions in air transport markets, in line with the models developed in Chapter 4 and 5.

2.1. Previous research on opaque products

Opaque products, opaque selling and surprise goods are used interchangeably in the literature and imply receiving any item out of a set of multiple items (Fay and Xie, 2010; Huang and Yu, 2014; Gönsch, 2020; Klingemann, 2020). In air transport, Jiang (2007) is the pioneer in the analysis of opaque products. She studies their optimality departing from a monopolist firm that offers flights with two different departure times: morning and night flights. In Chapter 4, we depart from the model developed by Jiang (2007) and adapt it in order to consider a situation in which consumers have heterogeneous preferences over different destinations.

Different authors have extended the model proposed by Jiang (2007). For instance, Fay and Xie (2008) consider a firm with a set of heterogeneous consumers, capacity constraints and demand uncertainty while Huang and Yu (2014) focus on the impact of bounded rationality through anecdotal reasoning. 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.

From a multi-firm perspective, Jerath et al. (2010) study the optimality of these products in a dynamic setting considering two competing firms 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. In both Chapter 3, 4 and 5 we consider blind tickets as a pricing strategy directly managed by airlines, without making use of an intermediary. In Chapter 4, similar to Gallego et al. (2004) and Li et al. (2020), we conceive opaque selling as a mechanism of selling end-of-the-season or distressed inventory of different products.

Chen et al. (2024) analyse probabilistic selling in vertical markets. In addition, other theoretical 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 and Song, 2020).[1]

From an empirical point of view in the tourism industry, Granados et al. (2008) analyse the differences in prices between regular and opaque airline tickets. Post and Spann (2012) study the profitability of opaque flight tickets at Germanwings (a subsidiary of Lufthansa), while Lee et al. (2012), using similar data, focus on choice models. Similarly, Granados et al. (2018) use data from an international airline to investigate the demand and cannibalization effects of this kind of products. Other empirical studies of opaque

[1] See also Shapiro and Shi (2008), Fay and Xie (2010), Alegre et al., (2012), Sheridan et al. (2013), Chen and Bell (2017) and Anderson and Celik (2020).

products in the hotel industry are, for instance, Courty and Liu (2013), Lee and Jang (2013), Chen and Yuan (2014) or Huang et al. (2018).

Results from previous theoretical papers suggest that opaque selling is socially optimal when consumers are heterogeneous (Jiang, 2007). Additionally, in a multiproduct setting, opaque products are optimal when they are offered by a multi-product monopolist (Balestrieri et al., 2021), or when it is socially optimal to serve all consumers with a product (Anderson and Celik, 2020). Regarding consumers' characteristics, heterogeneity and bounded rationality are key determinants of their optimality (Feng et al., 2021; Huang and Yu, 2014). Product characteristics, such as the level of opaqueness (Anderson and Xie, 2014), their non-refundable or transferable nature (Fay, 2008), as well as additional fees for reducing uncertainty, enhance their profitability and customer satisfaction (Post and Spann, 2012). When considering an intermediary, the optimality of opaque selling depends on prices, brand loyalty and revenue share (Feng et al., 2021; Li et al., 2020). In a vertical setting, opaque products are optimal as long as exist consumers with bounded rationality and products have a certain degree of differentiation (Chen et al., 2024).

The main results of empirical studies suggest that opaque products are usually offered at a 38 per cent discount in comparison with regular products (Granados et al., 2018) and that customers frequently reduce uncertainty by deleting destinations close to their departure airport (Lee et al., 2012). In the case of Germanwings, opaque products represented about 4 per cent of profits between 2009 and 2010 (Post and Spann, 2012). Moreover, empirical studies also suggest that opaque products are profitable for firms (See, for instance, Tan, 1999; Anderson and Xie, 2012; Green and Lomanno, 2012; Yang et al., 2019 or Sasanuma et al., 2022).

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. Given the nature of opaque products, when consumers purchase them, they are unaware of the final good or service they may be awarded. Thus, they buy under uncertain conditions. 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 and Xie, 2008).

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”.

Most previous research on opaque products consider risk neutrality or a risk preference factor (Bai et al., 2015). Therefore, one of the main contributions of this thesis dissertation is that in each model we take into consideration different degrees of consumers’ risk aversion. For instance, in Chapter 3 we conceive opaque selling as a practice of horizontally differentiated goods in which the risk attitude of consumers plays a key role. We do not only model any possible degree of risk aversion, but also risk neutrality or any possible degree of risk loving.

2.2. Previous research on online reviews

Users frequently express their thoughts and opinions on the internet generating a large number of reviews about tourist attractions (Hamid et al., 2021). Additionally, more than half of travellers plan their itineraries by browsing reviews when choosing attractions or hotel accommodations (Wei and Song, 2022).

Previous studies show that the more complex a trip becomes, the higher the importance of information sources (Bieger and Laesser, 2004). Considering opaque selling in the air transport industry as a difficult trip in the sense that consumers buy tickets to unknown destinations, online reviews may suppose an important determinant of purchase decision.

Sentiment analysis, also called opinions mining, is used for analysing people’s opinions towards products or services (Liu, 2010). It aims to evaluate whether a textual item expresses a positive or negative opinion, in general terms or about a given entity (Nakov et al., 2019). Typical tasks of sentiment analysis are finding a suitable collection of reviews, pre-processing texts by using natural language processing techniques and identifying sentiment in texts (Schmunk et al., 2013).

Authors suggest that sentiment analysis may be helpful in investigating topics, such as destination image, service recovery, consumer characteristics, profitability and purchase or booking decisions, among others (Micera and Crispino, 2017; Xu et al., 2019; Anagnostopoulou et al., 2020; Nie et al., 2020; Gour et al., 2021). Additionally, sentiment analysis has become increasingly popular not only in the academic field but also in the hospitality and tourism industry as the industry is strongly affected by consumers' emotions and satisfaction (Alaei et al.,2019).

Despite there exist different studies applying sentiment analysis in different fields of tourism, there is no previous research regarding opaque selling. In Chapter 4, through different natural language processing techniques, the reviews are analysed in terms of polarity, intensity, and emotions. This analysis supposes a measure to test the impact of these products among consumers and tourist destinations.

2.3. Previous research on air transport subsidies to resident passengers

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

Subsidies for resident passengers can be provided either as an *ad valorem* subsidy (a percentage discount on the ticket price) or as 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 those discounted routes are more expensive and high-demanded than domestic routes. Fageda et al. (2016) also find that subsidised routes are more expensive than unsubsidized 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. In addition, de Rus and Socorro (2022) analyse the efficiency of both types of subsidies. They find that a fixed discount per trip is always superior to an *ad valorem* subsidy. Moreover, de Rus and Socorro (2022) prove that the degree of competition in 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 not affected by the discount. AIReF (2020) also analyse the economic effects of the change in the subsidy using two databases, one with 2 million flights from July 2009 to June 2019 and another one with more than 100 million subsidized tickets from July 2009 to June 2019. In order to perform the analysis, AIReF (2020) divides the number of passenger trips in 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 in subsidised routes, with a positive relation between the proportion of resident passengers in a given route and the increase in prices.

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

In Chapter 5, we propose blind tickets as an optimal pricing strategy in order to manage some of the inefficiencies *ad valorem* subsidies to resident passengers in the absence of perfect competition. To the best of our knowledge, we are the first one in providing an alternative pricing strategy that may coexist with such policy, limits the market power of the airline and enhances social welfare.

CHAPTER 3.

BLIND BOOKING: THE EFFECTS ON PASSANGERS' PURCHASE DECISION, AIRLINES' PROFITABILITY, AND TOURIST DESTINATIONS

In this chapter, we first introduce the case of Eurowings, an airline that is currently offering blind tickets. Then, 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.

3.1. 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 (section 3.5.) shows all possible origins and destinations offered by Eurowings through blind tickets.[2] 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, 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

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

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.

3.2. 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:

$$U_1^A = (M + H - P_A)^{\alpha_i}, U_1^B = (M + L - P_B)^{\alpha_i}, i = 1, \dots, N_1. \quad (3.1)$$

$$U_2^A = (M + L - P_A)^{\beta_j},\ U_2^B = (M + H - P_B)^{\beta_j}, j = 1, \dots, N_2. \quad (3.2)$$

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.[3] The

[3] 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).

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.[4] 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.

3.2.1. 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

[4] 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.

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* $\pi_0 = 2KH$.

3.2.2. 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 $i \neq j$; $i, j = 1, 2$.

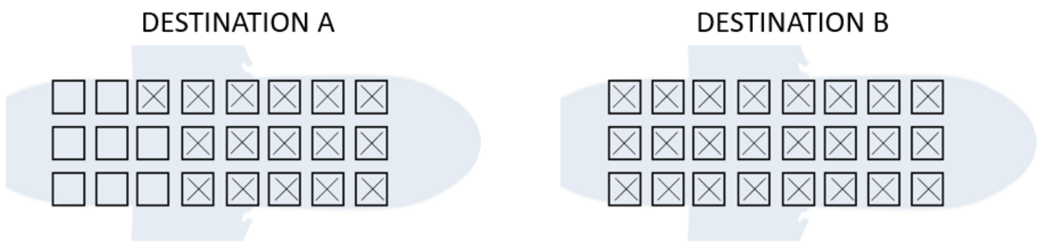
Let us consider now the case in which one of the destinations has a demand of high willingness to pay passengers lower than the aircraft's capacity, while the other destination faces a situation of excess demand. For instance, suppose that destination A is the one with lower demand, that is $N_1 < K$, 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 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 Figure 3.1.

Figure 3. 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



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:

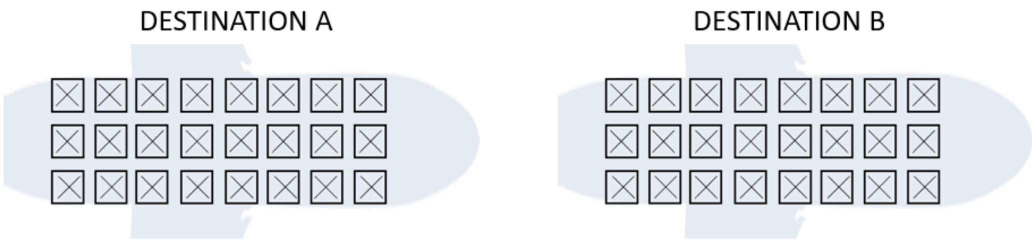
$$\pi_1 = N_1 H + KH. \tag{3.3}$$

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.[5] Figure 3.2 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:

$$\pi_2 = KL + KH. \quad (3.4)$$

Figure 3. 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



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* $N_1H \geq KL$*. On the contrary, Strategy 2 will be dominant if* $KL \geq N_1H$*.*

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.

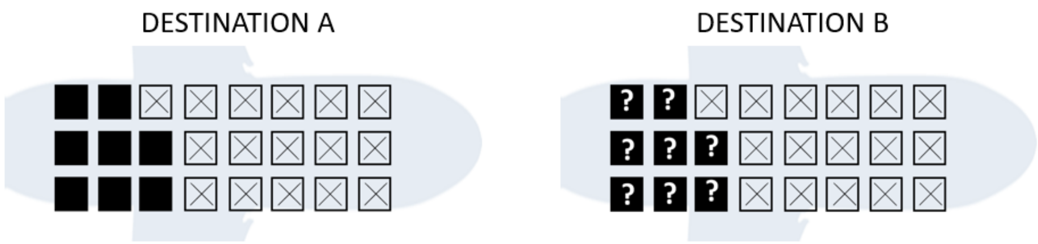
Under this strategy, the airline charges the tickets of both destinations A and B in the transparent market at a price equal to H but extracts some seats, N_R^B, of destination B from

[5] 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.

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 the following figure. 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.

Figure 3. 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.



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.

$$E[U_1] = \frac{N_R^A}{N_R^A + N_R^B}[M + H - P_R]^{\alpha_i} + \frac{N_R^B}{N_R^A + N_R^B}[M + L - P_R]^{\alpha_i} \quad (3.5)$$

$$E[U_2] = \frac{N_R^A}{N_R^A + N_R^B}[M + L - P_R]^{\beta_j} + \frac{N_R^B}{N_R^A + N_R^B}[M + H - P_R]^{\beta_j}. \quad (3.6)$$

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 $D \geq 0$:

$$P_R = \frac{N_R^A}{N_R^A+N_R^B} L + \frac{N_R^B}{N_R^A+N_R^B} H - D. \tag{3.7}$$

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:

$$E[U_1] = \frac{N_R^A}{N_R^A+N_R^B}\left[M + \frac{N_R^A}{N_R^A+N_R^B}(H-L) + D\right]^{\alpha_i} + \frac{N_R^B}{N_R^A+N_R^B}\left[M + \frac{N_R^B}{N_R^A+N_R^B}(L-H) + D\right]^{\alpha_i}. \tag{3.8}$$

$$E[U_2] = \frac{N_R^A}{N_R^A+N_R^B}\left[M + \frac{N_R^B}{N_R^A+N_R^B}(L-H) + D\right]^{\beta_j} + \frac{N_R^B}{N_R^A+N_R^B}\left[M + \frac{N_R^A}{N_R^A+N_R^B}(H-L) + D\right]^{\beta_j}. \tag{3.9}$$

All the notation of the model is summarized in the following table.

Table 3. 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

The main purpose of *Strategy 3* is to maintain the level of demand of N_1 type 1 consumers in destination A, and $\left(K - {N_R}^B\right)$ type 2 consumers in destination B in the transparent market. Because of the capacity constraints, there are $\left(N_2 - K + {N_R}^B\right)$ 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 $\left(N_2 - K + {N_R}^B\right)$ 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).

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:

$$G_1(N_R^B) = E[U_1] - M^{\alpha_i} \leq 0. \tag{3.10}$$

$$G_2(N_R^B) = E[U_2] - M^{\beta_j} \geq 0, \tag{3.11}$$

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.

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:

$$\pi_3 = N_1H + (K - N_R^B)H + \left(N_R^A + N_R^B\right)\left(\frac{N_R^A}{N_R^A + N_R^B}L + \frac{N_R^B}{N_R^A + N_R^B}H\right), \qquad (3.12)$$

that can be rewritten as:

$$\pi_3 = (K + N_1)H + N_R^A L. \qquad (3.13)$$

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:

$$\pi_{3.1} = N_1H + (K - N_R^B)H + q(N_R^A + N_R^B)\left(\frac{N_R^A}{N_R^A + N_R^B}L + \frac{N_R^B}{N_R^A + N_R^B}H\right) = (K + N_1)H + qN_R^A L - (1 - q)N_R^B H. \qquad (3.14)$$

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

$$q > \frac{N_R^B H}{N_R^A L + N_R^B H} = c_1. \qquad (3.15)$$

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:

$$q > \frac{KL + N_R^B H - N_1 H}{N_R^A L + N_R^B H} = c_2. \qquad (3.16)$$

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 Figure 3.4 and Figure 3.5.

Figure 3. 4. Optimal pricing strategy for the airline as a function of the proportion of type2 consumers that are risk-neutral or risk-loving, with $KL > N_1H$

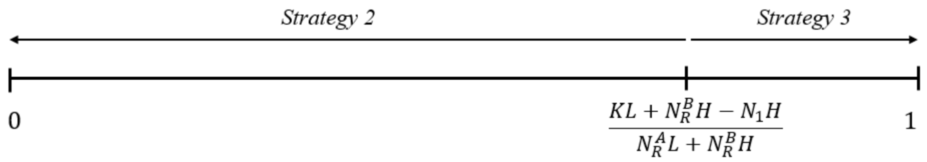
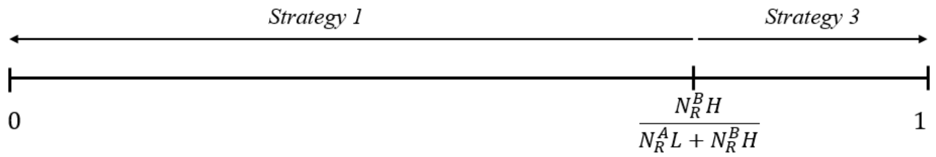


Figure 3. 5. Optimal pricing strategy for the airline as a function of the proportion of type 2 consumers that are risk-neutral or risk-loving, with $KL < N_1H$



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 Figure 3.4 and Figure 3.5. 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:

$$\pi_{3.2} = N_1H + ((K - N_R^B)H + \left(N_R^A + N_R^B\right)\left(\frac{N_R^A}{N_R^A+N_R^B}L + \frac{N_R^B}{N_R^A+N_R^B}H - D\right). \qquad (3.17)$$

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:

$$\pi_{3.2} = (K + N_1)H + N_R^A L - D\left(N_R^A + N_R^B\right). \qquad (3.18)$$

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 $\frac{N_R^A L-KL+N_1H}{N_R^A+N_R^B}$ depending on the values of N_1H and KL.

$$D^* = \begin{cases} \frac{N_R^A L}{N_R^A+N_R^B}, & if\ KL < N_1H \\ \frac{N_R^A L-KL+N_1H}{N_R^A+N_R^B}, & if\ KL > N_1H. \end{cases} \qquad (3.19)$$

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:* $G_1(N_R^B) \leq 0$, $G_2(N_R^B) \geq 0$, *and* $D \leq D^*$.

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 $G_1(N_R^B) \geq 0$. In 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.

3.3. Numerical Illustrations: Effects on passengers' purchase decision, airlines' profitability, and tourist destinations

In order to illustrate the main results of the model, 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. [6] 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.

[6] For more numerical illustrations, and in order to validate the robustness of the model to changes in the parameters, see Appendix 2 (section 3.6.).

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 3.2 summarizes market and individuals characteristics in *Scenario 1*.

Table 3. 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	$M = 1000$	

With these initial market conditions, we look for the optimal pricing strategy for the airline. Table 3.3 summarizes the main results and conditions for each pricing strategy.

Table 3. 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	$\boldsymbol{\pi_1 = 30600}$	$\boldsymbol{\pi_2 = 25500}$	$\boldsymbol{\pi_{3.1} = 32849.58}$

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 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 these120 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 3.4 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.

Table 3. 4. Social welfare analysis for *Scenario 1*

	Strategy 1	*Strategy 3.1*
Producer surplus	30600 €	32849.58 €
Consumer surplus	0 €	0.42 € (*)
Social welfare	30600 €	32850 €

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

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 3.5 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 3. 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	2,340	7,020	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 3. 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 $\alpha_i \geq 1.4$ 95% risk-averse or risk-neutral	80% very risk-averse with $\beta_j = 0.1$ 20% risk-neutral or risk-loving
Aircraft (A320-214) capacity	$K = 150$	
Individual's income	$M = 1000$	

Table 3.7 summarizes the prices, constraints, and profits of each strategy for *Scenario 2*.

Table 3. 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	**<u>Result 1:</u>** **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 **<u>Result 2:</u>** **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	$\boldsymbol{\pi_1 = 30600}$	$\boldsymbol{\pi_2 = 25500}$	$\boldsymbol{\pi_{3.1} = 30202.8}$	$\pi_{3.2,RESULT\ 1} = 32199.53$ $\pi_{3.2,RESULT\ 2} = 32799.53$ $\boldsymbol{\pi_{3.2} = 32499.53}$(*)

(*) In expected terms.

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 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 3.8 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 3. 8. Social welfare analysis for *Scenario 2*

	Strategy 1	*Strategy 3.2*	
		Result 1	*Result 2*
Producer surplus	30600 €	32199.53 €	32799.53 €
Consumer surplus	0 €	46.63 € (*)	50.47 € (**)
Social welfare	30600 €	32548.08 € (***)	

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

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 3.9 shows the characteristics of this third scenario.

Table 3. 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	$M = 1000$	

Table 3.10 summarizes the prices, constraints, and profits of each strategy for *Scenario 3*.

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

	Strategy 1	***Strategy 2***	***Strategy 3***	
			3.1	**3.2**
Prices	$P_{PORTO} = 120$ $P_{PARIS} = 120$	$P_{PORTO} = 50$ $P_{PARIS} = 120$	$P_{PORTO} = 120$ $P_{PARIS} = 120$ $D = 0$ $P_R = 85.38$	$P_{PORTO} = 120$ $P_{PARIS} = 120$ $D = 0.55$ $P_R = 84.77$
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	$\boldsymbol{\pi_1 = 29400}$	$\boldsymbol{\pi_2 = 25500}$	$\boldsymbol{\pi_{3.1} = 29334.18}$	$\pi_{3.2,RESULT\ 1} = 25249.47$ $\pi_{3.2,RESULT\ 2} = 32089.47$ $\boldsymbol{\bar{\pi}_{3.2} = 28669.41}$(*)

(*) In expected terms.

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 3.11), 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.

Table 3. 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 € (*)	60.53 € (**)
Social welfare	29400 €	29571.43 €	30500 €	28712.02 € (***)	

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

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.

Table 3. 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	1,144	3,432	7,228	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	2,105	6,315	13,300	24,494
Total tourism expenditure (€)	465,173.28	1,395,519.84	2,939,049.36	5,412,925.44

3.4. Conclusions

This chapter studies the effects on consumers' purchase decisions, 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 chapter, 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.

Finally, we would like to highlight that, although this chapter 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.

3.5. Appendix 1

Table A.13. Level of competition in all routes offered by Eurowings through blind booking (*)

Route (direct flights)	Airlines
BERLIN - DÜSSELDORF	EUROWINGS
BERLIN - GRAN CANARIA	EUROWINGS, EASYJET, RYANAIR
BERLIN - GOTHENBURG	EUROWINGS
BERLIN - INSSBRUCK	EUROWINGS
BERLIN - COLOGNE-BONN	EUROWINGS
BERLIN - MALAGA	EUROWINGS, EASYJET, RYANAIR
BERLIN - FUERTEVENTURA	EUROWINGS, EASYJET, RYANAIR
BERLIN - GRAZ	EUROWINGS
BERLIN - HELSINKI	EUROWINGS, FINNAIR
BERLIN - COPENHAGEN	EUROWINGS, EASYJET, SAS, NORWEGIAN
BERLIN - LANZAROTE	EUROWINGS, EASYJET, RYANAIR
BERLIN - ROVANIEMI	EUROWINGS
BERLIN - STOCKHOLM	EUROWINGS, SAS, NORWEGIAN
BERLIN - TENERIFE	EUROWINGS, EASYJET, RYANAIR
BERLIN - PALMA DE MALLORCA	EUROWINGS, EASYJET, RYANAIR
BERLIN - SALZBURG	EUROWINGS
BERLIN - STUTTGART	EUROWINGS
BERLIN - TROMSø	EUROWINGS, NORWEGIAN
COLOGNE BONN - BARCELONA	EUROWINGS, RYANAIR
COLOGNE BONN - BOLOGNA	EUROWINGS, RYANAIR
COLOGNE BONN - EDINBURGH	EUROWINGS
COLOGNE BONN - LONDON	EUROWINGS, BRITISH AIRWAYS
COLOGNE BONN - MUNICH	EUROWINGS, LUFTHANSA
COLOGNE BONN - SALZBURG	EUROWINGS
COLOGNE BONN - BERLIN	EUROWINGS
COLOGNE BONN - BUDAPEST	EUROWINGS, WIZZ AIR
COLOGNE BONN - HAMBURG	EUROWINGS
COLOGNE BONN - MILAN	EUROWINGS
COLOGNE BONN - ROME	EUROWINGS, RYANAIR
COLOGNE BONN - VIENNA	EUROWINGS, RYANAIR, AUSTRIAN
COLOGNE BONN - ZÜRICH	EUROWINGS
COLOGNE BONN - SARAJEVO	EUROWINGS

Route (direct flights)	Airlines
DÜSSELDORF - ROVANIEMI	EUROWINGS
DÜSSELDORF - TROMSø	EUROWINGS
DÜSSELDORF - IVALO	EUROWINGS
DÜSSELDORF - KITTILÄ	EUROWINGS
DÜSSELDORF - REYKJAVIK	EUROWINGS, PLAY
DÜSSELDORF - STOCKHOLM	EUROWINGS, SAS
DÜSSELDORF - AGADIR	EUROWINGS, TUIFLY, CONDOR
DÜSSELDORF - FUNCHAL	EUROWINGS, TUIFLY, CONDOR
DÜSSELDORF - HURGHADA	EUROWINGS, CONDOR, TUIFLY, AIR CAIRO, CORENDON
DÜSSELDORF - MARRAKESCH	EUROWINGS
DÜSSELDORF - LARNACA	EUROWINGS, TUIFLY
HAMBURG - BUDAPEST	EUROWINGS
HAMBURG - GRAZ	EUROWINGS
HAMBURG - LONDON	EUROWINGS, BRITISH AIRWAYS
HAMBURG - MUNICH	EUROWINGS, CONDOR, LUFTHANSA
HAMBURG - PARIS	EUROWINGS, AIR FRANCE
HAMBURG - SALZBURG	EUROWINGS
HAMBURG - DÜSSELDORF	EUROWINGS
HAMBURG - COLOGNE (BONN)	EUROWINGS
HAMBURG - MILAN	EUROWINGS
HAMBURG - OSLO	EUROWINGS, NORWEGIAN, SAS
HAMBURG - ROME	EUROWINGS, WIZZ AIR, AIR MALTA
HAMBURG - ZÜRICH	EUROWINGS, SWISS
HAMBURG - STUTTGART	EUROWINGS
HAMBURG - AMSTERDAM	EUROWINGS, KLM
HAMBURG - LISSABON	EUROWINGS, TAP PORTUGAL
HAMBURG - VIENNA	EUROWINGS, AUSTRIAN, TUIFLY
HAMBURG - INSSBRUCK	EUROWINGS
HAMBURG - LONDON	EUROWINGS, BRITISH AIRWAYS
HAMBURG - NICE	EUROWINGS
HAMBURG - TROMSø	EUROWINGS
HAMBURG - BARCELONA	EUROWINGS, VUELING

COLOGNE BONN - ZAGREB	EUROWINGS
COLOGNE BONN - CATANIA	EUROWINGS
COLOGNE BONN - FUERTEVENTURA	EUROWINGS, CONDOR, RYANAIR
COLOGNE BONN - GRAN CANARIA	EUROWINGS, CONDOR, RYANAIR
COLOGNE BONN - LISBON	EUROWINGS, RYANAIR
COLOGNE BONN - PALMA DE MALLORCA	EUROWINGS, CONDOR, RYANAIR, LEAV AVIATION
COLOGNE BONN - TENERIFE	EUROWINGS, CONDOR, RYANAIR
COLOGNE BONN - FARO	EUROWINGS, RYANAIR
COLOGNE BONN - FUNCHAL	EUROWINGS
COLOGNE BONN - LANZAROTE	EUROWINGS, CONDOR, RYANAIR
COLOGNE BONN - MALAGA	EUROWINGS, RYANAIR
COLOGNE BONN - SPLIT	EUROWINGS
COLOGNE BONN - THESSALONIKI	EUROWINGS, AEGEAN
DÜSSELDORF - BUDAPEST	EUROWINGS
DÜSSELDORF - DRESDEN	EUROWINGS
DÜSSELDORF - SPLIT	EUROWINGS, CONDOR, CROATIA AIRLINES
DÜSSELDORF - ZAGREB	EUROWINGS
DÜSSELDORF - BUCHAREST	EUROWINGS
DÜSSELDORF - KRAKOW	EUROWINGS
DÜSSELDORF - PRISTINA	EUROWINGS, CONDOR, GP AVIATION
DÜSSELDORF - TIRANA	EUROWINGS
DÜSSELDORF - BERGEN	EUROWINGS
DÜSSELDORF - CATANIA	EUROWINGS
DÜSSELDORF - NAPLES	EUROWINGS
DÜSSELDORF - VENICE	EUROWINGS
DÜSSELDORF - BOLOGNA	EUROWINGS
DÜSSELDORF - MILAN	EUROWINGS
DÜSSELDORF - ROME	EUROWINGS
DÜSSELDORF - ALICANTE	EUROWINGS
DÜSSELDORF - BILBAO	EUROWINGS
DÜSSELDORF - GRAN CANARIA	EUROWINGS, TUIFLY, CONDOR, CORENDOR
DÜSSELDORF - JEREZ DE LA FRONTERA	EUROWINGS, TUIFLY, CONDOR
DÜSSELDORF - LANZAROTE	EUROWINGS, TUIFLY, CONDOR, CORENDOR
DÜSSELDORF - PALMA DE MALLORCA	EUROWINGS, TUIFLY, CONDOR, CORENDOR
DÜSSELDORF - BARCELONA	EUROWINGS, VUELING
DÜSSELDORF - FUERTEVENTURA	EUROWINGS, TUIFLY, CONDOR, CORENDOR
DÜSSELDORF - IBIZA	EUROWINGS, TUIFLY, CONDOR

HAMBURG - FUERTEVENTURA	EUROWINGS, CONDOR, NORWEGIAN
HAMBURG - GRAN CANARIA	EUROWINGS, CONDOR, NORWEGIAN
HAMBURG - LA PALMA	EUROWINGS, CONDOR
HAMBURG - MALAGA	EUROWINGS, NORWEGIAN, CONDOR, RYANAIR
HAMBURG - PALMA DE MALLORCA	EUROWINGS, CONDOR, RYANAIR
HAMBURG - FARO	EUROWINGS, NORWEGIAN
HAMBURG - FUNCHAL	EUROWINGS, CONDOR
HAMBURG - HURGHADA	EUROWINGS, CONDOR, CORENDON
HAMBURG - LANZAROTE	EUROWINGS, CONDOR, NORWEGIAN
HAMBURG - TENERIFE	EUROWINGS, CONDOR, NORWEGIAN
PRAG - BARCELONA	EUROWINGS, RYANAIR, VUELING
PRAG - FUNCHAL	EUROWINGS, SMARTWINGS
PRAG - COPENHAGEN	EUROWINGS, RYANAIR, SAS, NORWEGIAN
PRAG - ROME	EUROWINGS, RYANAIR, SKY EXPRESS, WIZZ AIR, AIR MALTA
PRAG - DÜSSELDORF	EUROWINGS
PRAG - GENEVA	EUROWINGS, EASYJET
PRAG - MALAGA	EUROWINGS, SMARTWINGS, RYANAIR
PRAG - STOCKHOLM	EUROWINGS, SAS, NORWEGIAN
SALZBURG - AMSTERDAM	EUROWINGS, EASYJET, TRANSAVIA
SALZBURG - DÜSSELDORF	EUROWINGS
SALZBURG - HAMBURG	EUROWINGS
SALZBURG - COLOGNE-BONN	EUROWINGS
SALZBURG - BERLIN	EUROWINGS
SALZBURG - GRAN CANARIA	EUROWINGS
SALZBURG - HURGHADA	EUROWINGS
SALZBURG - TENERIFE	EUROWINGS
STOCKHOLM - BERLIN	EUROWINGS, SAS, NORWEGIAN
STOCKHOLM - HAMBURG	EUROWINGS, SAS
STOCKHOLM - STUTTGART	EUROWINGS
STOCKHOLM - DÜSSELDORF	EUROWINGS, SAS
STOCKHOLM - PRAGUE	EUROWINGS, SAS, NORWEGIAN
STUTTGART - AMSTERDAM	EUROWINGS, KLM
STUTTGART - BERLIN	EUROWINGS
STUTTGART - HAMBURG	EUROWINGS
STUTTGART - LONDON	EUROWINGS, BRITISH AIRWAYS
STUTTGART - ROME	EUROWINGS
STUTTGART - VALENCIA	EUROWINGS

DÜSSELDORF - LA PALMA	EUROWINGS, CONDOR
DÜSSELDORF - MALAGA	EUROWINGS, CONDOR
DÜSSELDORF - VALENCIA	EUROWINGS
DÜSSELDORF - TENERIFE	EUROWINGS, TUIFLY, CONDOR, CORENDOR
DÜSSELDORF - ATHEN	EUROWINGS, AEGEAN, SKY EXPRESS
DÜSSELDORF - FARO	EUROWINGS, CONDOR, TUIFLY
DÜSSELDORF - LISBON	EUROWINGS, TAP PORTUGAL, NEOS
DÜSSELDORF - PORTO	EUROWINGS
DÜSSELDORF - WESTERLAND SYLT	EUROWINGS
DÜSSELDORF - BERLIN	EUROWINGS
DÜSSELDORF - NICE	EUROWINGS
DÜSSELDORF - VIENNA	EUROWINGS, AUSTRIAN
DÜSSELDORF - BIRMINGHAM	EUROWINGS
DÜSSELDORF - EDINBURGH	EUROWINGS
DÜSSELDORF - GRAZ	EUROWINGS
DÜSSELDORF - LONDON	EUROWINGS, BRITISH AIRWAYS
DÜSSELDORF - NEWCASTLE	EUROWINGS
DÜSSELDORF - SALZBURG	EUROWINGS
DÜSSELDORF - ZÜRICH	EUROWINGS, SWISS
DÜSSELDORF - DRESDEN	EUROWINGS
DÜSSELDORF - GENEVA	EUROWINGS
DÜSSELDORF - LYON	EUROWINGS
DÜSSELDORF - MANCHESTER	EUROWINGS
DÜSSELDORF - THESSALONIKI	EUROWINGS, AEGEAN
DÜSSELDORF - GOTHENBURG	EUROWINGS
DÜSSELDORF - KIRUNA	EUROWINGS
DÜSSELDORF - COPENHAGEN	EUROWINGS, SAS

STUTTGART - BARCELONA	EUROWINGS, VUELING
STUTTGART - BREMEN	EUROWINGS
STUTTGART - LISBON	EUROWINGS
STUTTGART - MILAN	EUROWINGS
STUTTGART - STOCKHOLM	EUROWINGS
STUTTGART - BUDAPEST	EUROWINGS, WIZZ AIR
STUTTGART - PRISTINA	EUROWINGS, CONDOR, GP AVIATION
STUTTGART - SPLIT	EUROWINGS
STUTTGART - VIENNA	EUROWINGS, AUSTRIAN
STUTTGART - BUCHAREST	EUROWINGS
STUTTGART - SARAJEVO	EUROWINGS
STUTTGART - TIRANA	EUROWINGS
STUTTGART - ZAGREB	EUROWINGS
STUTTGART - ATHEN	EUROWINGS, AEGEAN
STUTTGART - FARO	EUROWINGS, TUIFLY
STUTTGART - FUNCHAL	EUROWINGS, TUIFLY, CONDOR
STUTTGART - HURGHADA	EUROWINGS, CONDOR, CORENDON, TUIFLY, AIR CAIR
STUTTGART - LANZAROTE	EUROWINGS, TUIFLY, NORWEGIAN
STUTTGART - NAPLES	EUROWINGS
STUTTGART - CATANIA	EUROWINGS
STUTTGART - FUERTEVENTURA	EUROWINGS, TUIFLY, NORWEGIAN, CONDOR
STUTTGART - GRAN CANARIA	EUROWINGS, TUIFLY, NORWEGIAN, CONDOR
STUTTGART - LA PALMA	EUROWINGS
STUTTGART - MALAGA	EUROWINGS
STUTTGART - TENERIFE	EUROWINGS, NORWEGIAN, TUIFLY, CONDOR
STUTTGART - PALMA DE MALLORCA	EUROWINGS, NORWEGIAN, CONDOR, TUIFLY
STUTTGART - THESSALONIKI	EUROWINGS, AEGEAN

(*) This information was consulted in February 2024.

3.6. Appendix 2

Table A.2. 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: 50; Paris: 120	Porto: 50; Paris: 120	Porto: 80; Paris: 140	Porto: 80; Paris: 140
	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
	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(**)

(*) 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.

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

CHAPTER 4.

OPAQUE PRODUCTS IN AIR TRANSPORT MARKETS: AN OPTIMAL STRATEGY FROM THE DEMAND AND SUPPLY SIDE

In this chapter, we analyse the optimality of opaque selling in the airline industry (blind booking) from the demand and supply side. First, we use a sentiment analysis to empirically test consumers' satisfaction when buying blind tickets. With more than 87% of positive reviews, results suggest that consumers like this kind of products. Once we have empirically verified that consumers like blind tickets, we develop a theoretical model in order to study its optimality for airlines, consumers, and overall society. Considering risk-averse consumers (something that most previous research has ignored), we prove that opaque selling enhances social welfare and airlines' profits. However, we warn about the importance of considering individuals' risk attitude, since ignoring consumers' risk aversion (and implementing opaque selling as if consumers were risk-neutral) may imply a profit loss for airlines.

4.1. The demand side: sentiment analysis

Google Maps is a popular online platform on which people can freely rate and share their experiences. In this empirical analysis, the database is composed of 2474 Google Maps reviews downloaded from five different companies that offer opaque products.[7] These firms are Drumwit, FlyKube, TheWonderTrip, Waynabox, and WowTrip. They offer surprise trips to different European cities and islands. During the purchasing process individuals specify their departure airport, the number of travellers, travel dates, and trip duration. After these specifications, consumers are given a set of possible destinations they may fly to. Most of these companies allow paying an extra fee in order to delete some destinations and, thus, reduce uncertainty. After payment, two or three days before the journey, consumers receive an email with all details of the trip.

From these initial reviews, 1875 include comments. Thus, some cleaning process was needed to analyse only the relevant information, as it is summarized in Table 4.1. Additionally, 99 reviews referred to cancelled flights because of COVID-19. These reviews were deleted since customers could not experience the blind ticket strategy. Thus, the final dataset contains 1776 reviews which were translated into English in order to make a homogenous analysis.

Table 4. 1. Data cleaning process

	Number of reviews
Initially downloaded	2474
With comments	1875
Referred to cancelled flights	99
Final dataset (with comments and non-referred to cancelled flights)	**1776**

From the total number of reviews, 1644 allow differentiating the gender of the reviewer, with 26.4 % from men and 73.6 % from women. This result supports the importance of taking into consideration risk aversion when implementing opaque selling since women tend to be more risk-averse than men. [8]

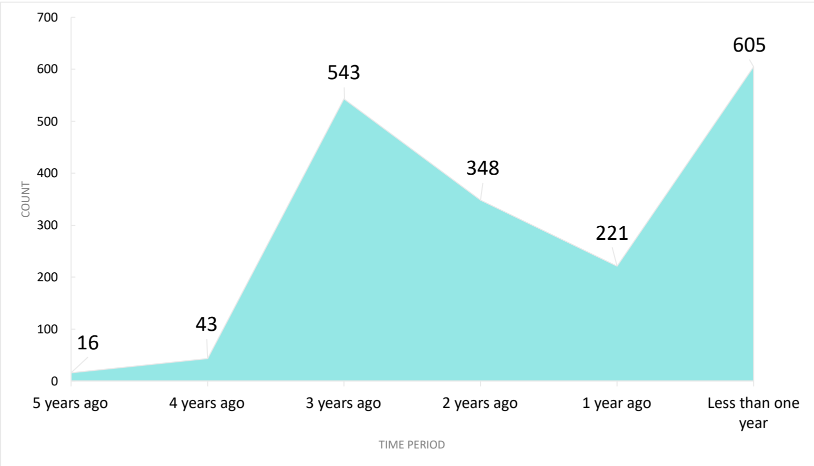
[7] The database includes all the reviews that were available since the origins of each company until mid-September 2022. The size of the data base is similar to the one used in other studies such as Yu et al. (2019), Mishra and Panada (2021), Leiras and Eusébio (2023), or Sangkaew et al. (2023).

[8] See, for instance, Byrnes et al. (1999), Cohen and Einav (2007), and Guenther et al. (2021).

Result 1: *Women contribute with a higher number of reviews compared to men. Since women are usually more risk-averse than men, this fact highlights the relevance of considering consumers' risk aversion when studying the optimality of blind tickets.*

Reviews were collected from 2017 until mid-September 2022. Figure 4.1 shows the distribution of the reviews based on when they were posted. Since its origin, the popularity of opaque selling has notably increased. However, in 2020 and 2021, the number of reviews drastically decreased due to both the global lockdown and travel restrictions that prevented companies from offering blind tickets. However, in the last months, the number of reviews has almost tripled in comparison with 2021, which stands out the actual popularity of trips with unknown destinations, and, therefore, the relevance of the present study.

Figure 4. 1. Time distribution of the reviews posted since companies started offering opaque selling until mid of September 2022



Result 2: *According to the number of reviews posted, opaque selling is nowadays a popular pricing strategy among customers with an average rate higher than 4.3 (maximum is 5).*

The average rating posted is higher than 4.3, which stands out the success of blind tickets among customers. However, it is important to study the content of each of the reviews independently of the rating. For instance, the following reviews have a rating of 4 stars. However, based on the content and words used, they do not mention any negative aspects and could imply a higher score.

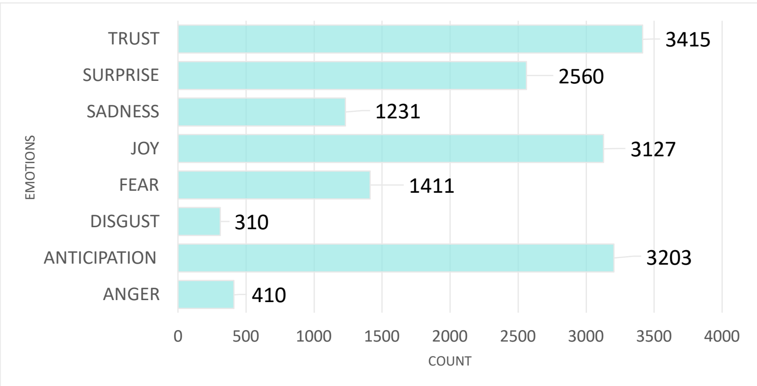
- "Highly recommended, accessible, and facilitated all the necessary requirements to fly in this Covid era."

- “Very good!!! Both for flights and the hotel.”

Thus, based on different natural language processing techniques, we calculate an objective score considering the content of each review. For this purpose, we use the packages Syuzhet (Jockers, 2017), Sentiment R (Rinker, 2019) and VADER (Hutto and Gilbert, 2014) in the software R.

The NRC lexicon (Mohammad and Turney, 2013) is composed of more than 10,000 words and consists of attributing each word to one of the eight basic emotions defined by Plutchik (1980). Regarding the polarity of the words, the NRC Lexicon assigns 3588 words as positive and 2192 words as negative. By adding the number of words assigned to each emotion, Figure 4.2 shows the frequencies. The most frequent emotions evoked by opaque products are trust, surprise, anticipation, and joy. Overall, they are positive emotions and suggest that when consumers buy opaque products, they get satisfied and like them.

Figure 4. 2. Emotion analysis of reviews following the NRC Lexicon using the Syuzhet package in R



Result 3: *Opaque selling is not only a popular pricing strategy, but also evokes positive emotions and feelings among customers.*

Taking into consideration valance shifters, such as negators, amplifiers, de-amplifiers, and downtowners and conjunctions, Sentiment R provides an overall score for each review. According to Rinker (2017), the mechanism is as follows. First, each review is decomposed into sentences and each sentence into words. Each word is assigned a score of +1 if it is positive and -1 if it is negative. Then, the score is recalculated considering the use of valance shifters by examining 5 and 2 words, before and after, respectively. Finally, each sentence gets a score, and an average is calculated to get a score per review.

Polarity suggests that as long as the score is lower (greater) than zero, the review is considered negative (positive). If it is equal to zero, then it is neutral. Table 4.2 summarizes the results, and it can be stated that on average, consumers value positively opaque selling. Regarding the polarity, more than 87 per cent of the reviews are positive. This stands out that opaque selling is a profitable and valuable pricing strategy for consumers for travelling to unknown destinations at lower prices.

Table 4. 2. Summary statistics of the methodologies used for the sentiment analysis of Google Maps reviews

	Average score (Standard Deviation)	*Polarity*		
		Positive	*Neutral*	*Negative*
Sentimentr	0.32 (0.2593)	87.41%	0.96%	11.63%
VADER	0.7 (0.4262)	87.04%	2.77%	10.19%

To contrast the results obtained, we make use of another package: The Valance Aware Dictionary for Sentiment Reasoning (VADER). VADER is an algorithm that takes into consideration punctuation, capitalization, degree modifiers, contrastive conjunctions and negations in addition to a large library of words (Mathayomchan et al., 2022). VADER categorize each review into positive negative or neutral emotions and calculates a score which ranges from -1 to 1. A positive (negative) review is considered when the score ranges from 0.05 (-0.05) to 1 (-1) while a neutral review has a score between -0.05 and 0.05. As it is shown in Table 2, the average score is equal to 0.7 which is near to a very positive review. Regarding the polarity, this algorithm also stands out in that more than 87 per cent of the reviews are positive.

Result 4: *The use of different methodologies to analyse the content of each review, results in that more than 87 per cent of customers like and enjoy travelling to surprise destinations.*

Regarding the nature of blind tickets, people highlight in their reviews that they end up travelling to places they would never visit and feel delighted with the destination and want to return. Thus, policymakers may be interested in contacting these companies to attract tourism demand and promote the destination. Some examples of reviews are attached below.

- "… Our destiny was Marseille, at first we thought that hopefully another destination would have touched us, but if it had been so, we would have lost to know an incredible city that has much to offer."
- "… In our case we got Brussels and totally delighted with the destination. Surely without knowing this method it would not be a city that I would have in mind to visit but it has been a very good experience and a good place to visit."

Result 5: *In line with the success of blind tickets among consumers, policymakers of low-demanded destinations may be interested in implementing this pricing strategy. Customers highlight in their reviews that they frequently travelled to initially undesired places but end up delighted with the destinations.*

Regarding prices, 115 reviews include comments about fares. The general perception is that people perceive a good relationship between price and quality. Some examples of reviews are the following:

- "Good experience at a good price."
- "Good price and the perfect flight schedules to fully enjoy your destination."
- "I love destiny… quality and price the best…wishing to travel again."

Result 6: *Customers highlight that blind tickets are an affordable way of travelling.*

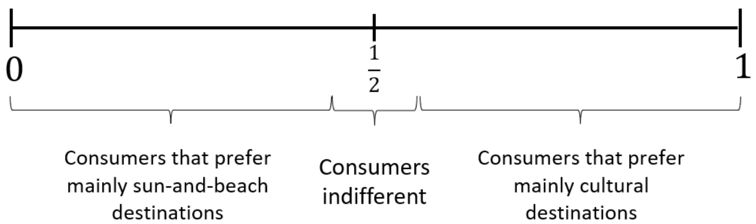
This section concludes that blind tickets are a very popular and successful pricing strategy among customers. Additionally, they may be also of interest to policymakers of underdeveloped tourist destinations since they suppose a channel for generating new demand. Thus, this empirical evidence supports that blind tickets are optimal for consumers and tourist destinations. Then, it is worth studying their optimality in terms of airlines' profits and social welfare.

4.2. The supply side: the optimality of blind tickets

Once we have empirically verified that consumers like blind tickets through a sentiment analysis, let us develop a theoretical model in order to study its optimality for airlines, consumers, and overall society. Suppose a monopolist airline offers two flights to two different types of destinations. [9] There may exist exclusively sun-and-beach destinations, such as Cuba, Cancun, Miami or Balearic Islands, while there may also exist purely cultural destinations like London, Paris, Madrid and Rome. In addition, the airline may decide to offer destinations with sun-and-beach and cultural attributes, such as Athens or Barcelona. Let's assume that the possible horizontally differentiated destinations are grouped into sun-and-beach, SB, and cultural, C. Marginal operating costs for all destinations are assumed to be constant and equal to c.

In such a market, there exists a mass of consumers with different preferences over destinations and unitary demand. Consumers are uniformly distributed among a line based on their preferences for each destination. Destinations may be represented across a line depending on their characteristics associated with sun-and-beach and cultural destinations. Those purely sun-and-beach destinations may be located near 0, while those exclusively cultural destinations may be located near 1. In the rest of the line, there may be located a continuum of destinations ordered based on their sun-and-beach and cultural attributes. Thus, those customers with strong preferences for a sun-and-beach destination are located at 0 and those for the cultural at 1, as shown in Figure 4.3. Notice that in the middle there may exist destinations that offer both beaches and cultural cities.

Figure 4. 3. Consumers' preferences over type of destinations



The consumers' utility function depends on the level of income I, the willingness to pay for each destination d (which is assumed to be the same for all types of destinations), the

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[9] The monopoly assumption is reasonable for destinations with low demand, as those usually considered by airlines when offering blind tickets. In Chapter 3, we analyse the case of Eurowings. They find that 47 per cent of the direct routes offered through blind tickets are operated only by Eurowings and that more than 70 per cent of these air routes are covered by a maximum of two airlines. 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 product differentiation, brand loyalty, or the existence of frequent flier programs.

ticket prices P_{SB} and P_C, consumers' destination preferences (consumers' location over the unit line) $x \in [0,1]$, and the transportation cost t. Thus, the utility functions for each destination are given by the following expressions:

$$U_{SB}(x) = I + d - tx - P_{SB}. \tag{4.1}$$

$$U_C(x) = I + d - t(1 - x) - P_C. \tag{4.2}$$

A consumer may travel to a sun-and-beach destination if $x < \frac{d}{t}$, and a cultural destination if $x > 1 - \frac{d}{t}$.

For the sake of simplicity, let us consider some initial assumptions. First, the transportation cost and the marginal operating cost are set equal to 1 and 0, respectively. Second, regarding the unit line, the maximum demand for both destinations is $\frac{1}{2}$ and $d > \frac{1}{2}$, which implies that consumers always prefer to fly to any destination rather than not buy any ticket. Third, in order to have the model well-defined, we assume that $I > \frac{1}{14}$. Fourth, we assume that all destinations aim to receive as many tourists as flight tickets offered.

The firm may adopt two different strategies: On the one hand, the airline may offer flights in a transparent market on which consumers can directly purchase a ticket to the sun-and-beach or the cultural destination. On the other hand, the airline may create a dual market on which it may sell tickets under both, certain and uncertain conditions. Under uncertain conditions, the only information consumers have is that they will travel to the sun-and-beach destination or the cultural destination. Then, this chapter aims to study the conditions and optimality of each of these two possible strategies.

All the notation of the chapter is summarized in Table 4.3.

Table 4. 3. Summary of chapter notation.

Notation	***Definition***
SB	Sun-and-beach destination
C	Cultural destination
I	Individual's income
d	Willingness to pay for both types of destinations
d_{SB}	Willingness to pay for the sun-and-beach destination
d_C	Willingness to pay for the cultural destination
t	Transportation cost
x	Consumers' preferences over each type of destination
P_{SB}	Ticket price of the sun-and-beach destination
P_{SB}'	Ticket price of the sun-and-beach destination when considering two different willingnesses to pay for each type of destination
P_C	Ticket price of the cultural destination
P_C'	Ticket price of the cultural destination when considering two different willingnesses to pay for each type of destination
$U_{SB}(x)$	Utility function of consumers when buying the sun and beach destination flight ticket
$U_{SB}(x)'$	Utility function of consumers when buying the sun-and-beach destination flight ticket in the case of different willingnesses to pay for each type of destination
$U_C(x)$	Utility function of consumers when buying the cultural destination flight ticket
$U_C(x)'$	Utility function of consumers when buying the cultural destination flight ticket in the case of different willingnesses to pay for each type of destination
λ_{SB}^{TM}	Marginal customer of the sun-and-beach destination in the transparent market
$\lambda_{SB}^{TM'}$	Marginal customer of the sun-and-beach destination in the transparent market when considering different willingnesses to pay for each type of destination
θ_C^{TM}	Marginal customer of the cultural destination in the transparent market
$\theta_C^{TM'}$	Marginal customer of the cultural destination in the transparent market when considering different willingnesses to pay for each type of destination
$\pi_{TM}(\cdot)$	Profits under transparent market strategy
$\pi_{TM}(\cdot)'$	Profits under transparent market strategy when considering different willingnesses to pay for each type of destination
$E[U_O(x)]$	Expected utility in the opaque market
$P_O(x)$	Price of the lottery in the opaque market
$P_O(x)'$	Price of the lottery in the opaque market when considering different willingnesses to pay for each type of destination
$\pi_{DM}(\cdot)$	Profits under dual market strategy
$\pi_{DM}(\cdot)'$	Profits under dual market strategy when considering different willingnesses to pay for each type of destination
x_{SB}^{DM*}	Marginal customer of the sun and beach destination in the dual market
$\pi_{RATIO\ 1}$	Profit ratio that represents optimal profits under dual market strategy over the profits under transparent market strategy
W_{TM}	Social welfare under transparent market strategy
W_{DM}	Social welfare under dual market strategy
$\bar{d}$	Maximum willingness to pay from which introducing the sale of opaque products does not imply an increase in social welfare
$\pi_{RATIO\ 2}$	Profit ratio that represents optimal profits under dual market strategy based on the myopic solution over the profits under transparent market strategy

4.2.1. The transparent market

A product is transparent when before purchasing it, customers are aware of all its characteristics and attributes. Therefore, in the transparent market consumers can buy a flight to any of the two possible destinations under certain conditions. Each destination is offered individually, and consumers choose the type of destination that maximizes their utilities, given their willingness to pay and the ticket price of each destination.

The airline may choose the optimal destination to offer for the sun-and-beach category and the cultural category. This is, the location across the unit line which depends on the marginal customers, denoted by λ_{SB}^{TM} and θ_C^{TM}, respectively to sun-and-beach and cultural destinations. Customers who are located below λ_{SB}^{TM}, this is $x < \lambda_{SB}^{TM}$, purchase the sun-and-beach flight ticket. Similarly, those who are located over θ_C^{TM} , $x > \theta_C^{TM}$ buy a ticket to the cultural destination. Therefore, the airline sells λ_{SB}^{TM} tickets of the sun-and-beach destination and $(1 - \theta_C^{TM})$ tickets of the cultural destination.

The ticket prices are also determined by the marginal individual. At the moment of purchase, marginal consumers are indifferent between buying or not the tickets, this is, $U_{SB}(x) = I$ and $U_C(x) = I$. Therefore, the prices of the flight tickets, under perfect information conditions are equal to:

$$P_{SB} = d - x. \tag{4.3}$$

$$P_C = d - (1 - x). \tag{4.4}$$

The firm's optimal location depends on its profit maximization with respect to λ_{SB}^{T} and θ_C^{T}, as shown in the following expression (given maximum demand):

$$\max_{\lambda_{SB}^{TM}, \theta_C^{TM}} \ \pi_{TM}(\cdot) = \lambda_{SB}^{TM}(d - \lambda_{SB}^{TM}) + (1 - \theta_C^{TM})(d - (1 - \theta_C^{TM}))$$
$$s.t.: \quad \lambda_{SB}^{TM} \leq \frac{1}{2} \qquad \theta_C^{TM} \geq \frac{1}{2} \tag{4.5}$$

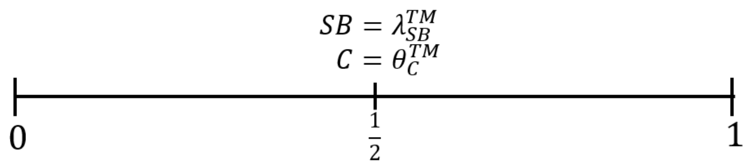
The solutions to the maximization problem imply that: $\lambda_{SB}^{TM} = \frac{d}{2}$ and $\theta_C^{TM} = 1 - \frac{d}{2}$.

Proposition 1: *Under perfect information conditions and if the willingness to pay is large enough, this is if* $d \geq 1$ *the airline sells all seats of the sun-and-beach and cultural flights at a price* $P_{SB} = P_C = d - \frac{1}{2}$, *achieving the maximum level of profits equal to* $d - \frac{1}{2}$. *Otherwise, if the willingness to pay is low,* $d < 1$, *the airline sells* $\frac{d}{2}$ *tickets of the sun-*

and-beach flight and $\frac{d}{2}$ *tickets of the cultural flight at a price* $P_{SB} = P_C = \frac{d}{2}$*, being its profits equal to* $\frac{d^2}{2}$.

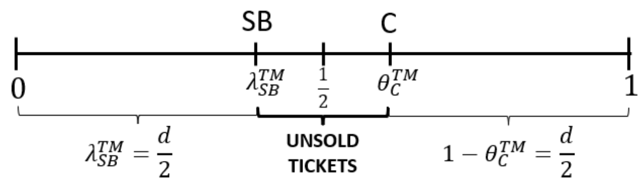
As reported above, the maximum demand for both flights is equal to $\frac{1}{2}$. Regarding the optimal solutions, if $d \geq 1$, the airline achieves a situation of sold out in both flights, that is $\lambda_{SB}^{T} = 1 - \theta_C^T = \frac{1}{2}$. The prices for both flights, P_{SB} and P_C, and its profits are equal to $d - \frac{1}{2}$. Importantly, as long as consumers' willingness to pay is larger than the transportation cost (normalized to 1), this is $d \geq 1$, all customers buy a ticket and are provided with their favourite destination category. Moreover, since the optimal location for both types of destinations is $\frac{1}{2}$, the airline offers two flights with similar characteristics in terms of sun-and-beach and cultural attributes. Figure 4.4 reports these results.

Figure 4. 4. Optimal destinations under perfect information conditions and $d \geq 1$.



Otherwise, when the willingness to pay is lower than the transportation cost, this is $d < 1$, the airline sells $\frac{d}{2}$ seats of the sun-and-beach flight and $\frac{d}{2}$ seats of the cultural flight. The prices, P_{SB} and P_C, are equal to $\frac{d}{2}$ and the profits are equal to $\frac{d^2}{2}$. Depending on the value of d the number of seats sold is closer or further from the maximum demand $\left(\frac{1}{2}\right)$. In this case, it is important to highlight that the airline does not serve all customers, although they have a positive willingness to pay. In addition, those non-served customers have a willingness to pay larger than the marginal cost. Figure 4.5 summarizes the results.

Figure 4. 5. Optimal destinations under perfect information conditions and $d < 1$.



4.2.2. The dual market

Under this strategy, the airline differentiates simultaneously two markets: the transparent market and the opaque market. Recall that in the transparent market, consumers can buy a flight to any of the two possible destinations under certain conditions. Therefore, each destination is offered individually, and consumers choose the type of destination that maximizes their utilities, given their willingness to pay and the ticket price of each destination. On the contrary, in the opaque market, consumers can pay a lower price for a blind ticket, that includes the two possible destinations, but they will not discover which of these two potential destinations is the final one until the end of the booking process.

Consumers may decide where to buy the tickets, in the transparent market or in the opaque one. It is expected that those price-insensitive customers buy in the transparent market and those price-sensitive end up purchasing in the opaque market at lower fares. Notice that this strategy supposes an additional source of demand since those customers that end up out of the market in the case of the transparent market strategy, now may enter into the market through opaque products.

The firm may optimally decide the number of seats to sell in each market maximizing its profits. The airline may sell some seats according to the marginal customer under perfect information conditions, and the rest through blind tickets. In the case of the opaque market, individuals are unaware of the real destination they are buying until they finish the purchasing process. They purchase under uncertain conditions, perceive it as a lottery, and behave as maximisers of their expected utility (Von Neumann-Morgenstern utility function). This is, the utility of each type of destination is combined in a multiplicative manner with the probabilities and are subsequently added (Schweinzer, 2004).

It is commonly accepted that most individuals are risk-averse. Thus, let us consider risk-averse individuals (concave utility function) [10] and that each destination has the same probability. Consumers' expected utility, $E[U_O(x)]$, is given by:

$$E[U_O(x)] = \frac{1}{2}(I + d - x - P_o)^{0.5} + \frac{1}{2}(I + d - (1 - x) - P_o)^{0.5}. \tag{4.6}$$

[10] Risk-averse individuals are the most restrictive ones. Considering risk-neutral or risk-loving individuals would reinforce even more our results.

The price of the lottery, P_o, is optimally calculated through the marginal individual, the one who, at the moment of purchase, gets the same expected utility that he obtains when he does not buy the lottery: $E[U_O(x)] = I^{0.5}$. Therefore, the optimal price of the lottery is equal to:

$$P_o(x) = d - \frac{1}{2} + \frac{x}{4I} - \frac{x^2}{4I} - \frac{1}{16I}. \quad (4.7)$$

Given the symmetry of the model, profits can be calculated by multiplying by two the prices and market shares of the sun-and-beach flight. The same results can be achieved when considering the cultural flight. Therefore, the airline's profits can be written as:

$$\pi_{DM}(\cdot) = 2\left[xP_{SB}(x) + \left(\frac{1}{2} - x\right)P_O(x)\right] = 2x(d-x) + (1-2x)\left(d - \frac{1}{2} + \frac{x}{4I} - \frac{x^2}{4I} - \frac{1}{16I}\right). \quad (4.8)$$

Denoting by x_{SB}^{DM} the marginal individual who is indifferent between purchasing in the transparent and the opaque market, the optimal market share is determined by maximizing the profits with respect to x_{SB}^{DM}.

$$\max_{x_{SB}^{DM}} \pi_{DM}(\cdot) = 2x_{SB}^{DM}(d - x_{SB}^{DM}) + (1 - 2x_{SB}^{DM})\left(d - \frac{1}{2} + \frac{x_{SB}^{DM}}{4I} - \frac{{x_{SB}^{DM}}^2}{4I} - \frac{1}{16I}\right)$$
$$s.t.: 0 \leq x_{SB}^{DM} \leq \frac{1}{2} \quad (9)$$

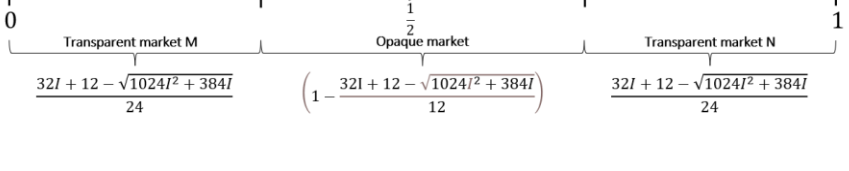
The purpose of introducing blind tickets is that the airline aims to deal with unsold tickets since the demand is lower than $\frac{1}{2}$. Thus, the solution of the problem under this condition ends up in that the constraint is going to be always fulfilled.

Given the first-order condition, the optimal market share is determined by the following expression:

$$x_{SB}^{DM*} = \frac{32I + 12 - \sqrt{1024I^2 + 384I}}{24}. \quad (10)$$

Figure 4.6 summarizes the market shares of each destination and the opaque product.

Figure 4. 6. Optimal destination when selling through both, the transparent and opaque market



Regarding the prices, in the transparent market the tickets are sold at $P_{SB} = P_C = d - \frac{32I+12-\sqrt{1024I^2+384I}}{24}$. In the case of the lottery, the price, P_O, is equal to $\frac{2\sqrt{2}\sqrt{8I^2+3I}-8I+9d-6}{9}$. Thus, the optimal profits, $\pi_{DM}(x_{SB}^{DM^*})$, under the dual market are given by the following expression:

$$\pi_{DM}(x_{SB}^{DM^*}) = \frac{4\sqrt{2}\sqrt{(8I^2+3I)^3}-128I^3-72I^2+27I(2d-1)}{54I}. \tag{4.11}$$

Regarding the profitability of the dual market strategy, remember that in the transparent market there are two different levels of profits, depending on the ratio between the willingness to pay and the transportation cost, this is $d \geq 1$ or $d < 1$. By comparing them with the profits under the dual market strategy, the following proposition can be stated.

Proposition 2: *As long as consumers' willingness to pay is larger than* 0.595938*, the dual market strategy will be more profitable for the airline. This is* $\pi_{DM}(x_M^{D^*}) - \pi_{TM} > 0$*. Thus, the airline can sell all tickets of both types of destinations in two different markets and charge consumers two different fares.*

Proof: See the Appendix (section 4.5.). ■

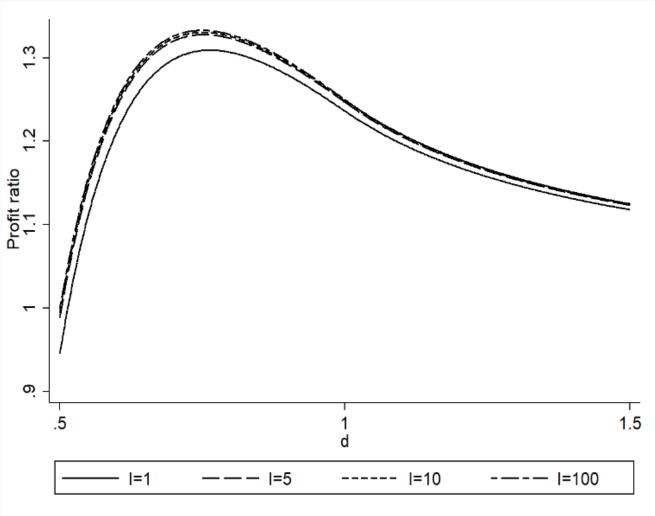
Notice that as it is stated in *Proposition 1*, when $d \geq 1$ the airline is able to sell all tickets in the transparent market. However, it can increase its profits by selling fewer tickets at higher prices in the transparent market and all unsold tickets as opaque products.

Let us define a profit ratio, $\pi_{RATIO\,1}$, composed of the optimal profits under the dual market strategy over the profits under the transparent market strategy to measure the increase in profits associated with blind tickets. As long as the profit ratio is greater (lower) than 1, the optimal pricing strategy is the dual (transparent) market strategy. Depending on consumers' willingness to pay, d, the profit ratio's expression is given by:

$$\pi_{RATIO\,1} \begin{cases} \frac{4\sqrt{2}(8I^2+3I)^{\frac{3}{2}}-128I^3-72I^2+27I(2d-1)}{27Id^2}, & if\ d < 1. \\ \frac{4\sqrt{2}(8I^2+3I)^{\frac{3}{2}}-128I^3-72I^2+27I(2d-1)}{27I(2d-1)}, & if\ d \geq 1. \end{cases} \tag{4.12}$$

As it is stated in the previous expression, the profit ratio depends on individuals' income. Figure 4.7 shows the profit ratio, $\pi_{RATIO\,1}$, for different levels of income, I_j, being $j = 1, 5, 10, 100$.

Figure 4. 7. Profit ratio composed by the profits under dual market strategy over the profits under transparent market strategy $\left(\pi_{RATIO\,1} = \frac{\pi_{DM}}{\pi_{TM}}\right)$



The graph suggests that for most values of the willingness to pay, d, the profit ratio is larger than 1. Moreover, the maximum increase in profits of the dual market over the transparent market strategy, $\bar{\pi}_{RATIO\,1}$, is given by expression (13). As it is shown in Figure 5, the dual market strategy may increase benefits at most by about 30 per cent.

$$\bar{\pi}_{RATIO\,1} = \frac{\left(I(128I^2+72I+27)-4\sqrt{2}\sqrt{I^3(8I+3)^3}\right)\left(4\sqrt{2}\sqrt{I^3(8I+3)^3}+128I^3+72I^2+27I\right)^2}{27I^3(192I^2+112I+27)^2}. \quad (4.13)$$

Corollary 1: *Under the dual market strategy, the airline is not only able to serve all customers in each destination, but also to increase its profits as long as the willingness to pay, d, is greater than* 0.595938. *The maximum increase in profits when introducing blind tickets is defined by $\bar{\pi}_{RATIO\,1}$.*

4.2.3. The effects on social welfare

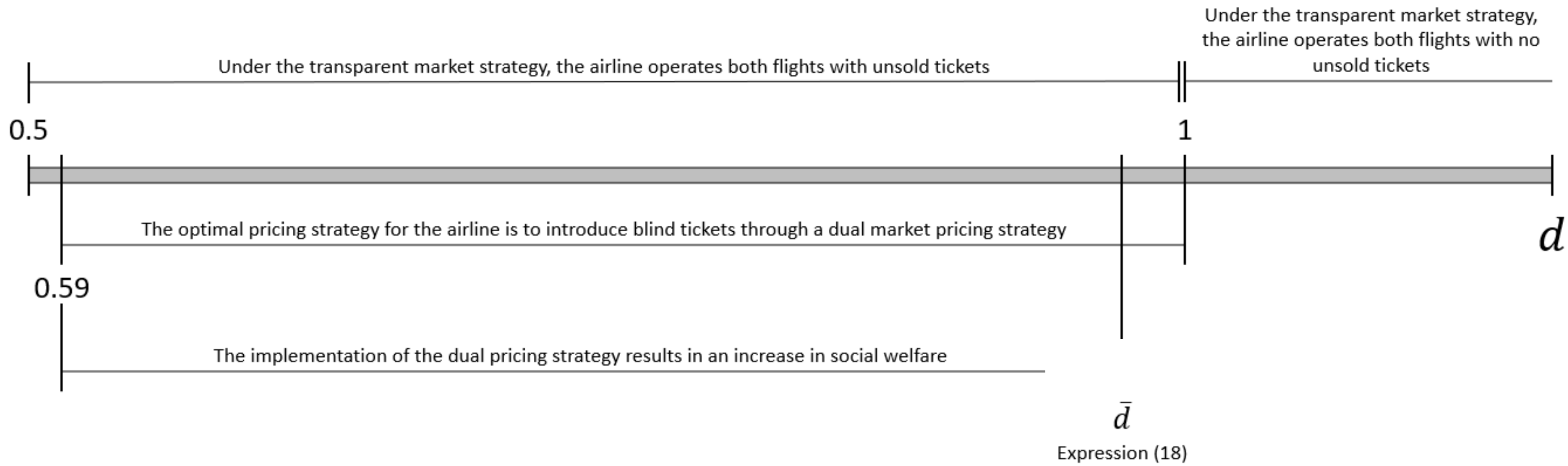
Knowing the optimal market shares and ticket prices, it is straightforward to determine and compare social welfare under the two different strategies.

Proposition 3: *As long as the ratio between the willingness to pay over the transportation cost is lower than $\bar{d}$, selling blind tickets through the dual market strategy is not only optimal for airlines, but also increases social welfare.*

Proof: See the Appendix (section 4.5.). ■

All the main results of the model and their implications are summarized in Figure 4.8.

Figure 4. 8. Summary of the results obtained in the base model, contingent upon the consumers' willingness to pay, d.



4.2.4. The importance of considering risk aversion

The optimality of the dual market strategy strongly depends on risk aversion. To show this, in this section, we compare our results with the ones obtained by Jiang (2007).

Jiang (2007) studies the optimality of opaque selling by considering two flights with different flight departure times. It departs from a monopolist airline that has infinite options of when to offer a morning and a night flight and a continuum of consumers with different preferences. This model and the one developed by Jiang (2007) are comparable in the sense that both have similar assumptions and make an application of the Hotelling model with two horizontally differentiated goods. Thus, it is straightforward to adapt Jiang's model to the scenario of an airline offering flights to two different types of destinations.

Jiang (2007) assumes risk-neutral consumers. However, it is commonly accepted that most consumers are risk-averse. Thus, if the firm acts in a myopic way and treats risk-averse consumers as if they were risk-neutral and uses the results proposed by Jiang (2007), in our model the marginal customer has no incentives to buy the lottery. Let us denote this situation as the myopic solution.

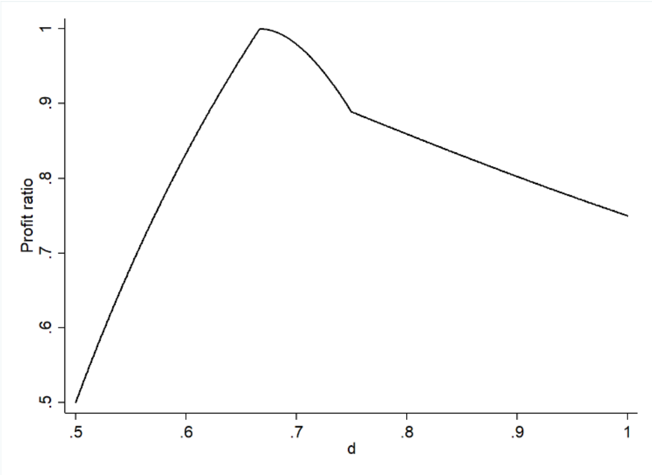
Lemma 1: *When implementing blind tickets, airlines have to take into consideration consumers' risk aversion. Defining optimal prices according to risk neutrality implies that risk-averse customers have no incentives to buy tickets in the opaque market.*

Proof: See the Appendix (section 4.5.). ■

As long as consumers do not have incentives to buy blind tickets, when airlines implement this pricing strategy, they will only sell flight tickets through traditional sales channels (the transparent market). Thus, is it still optimal for airlines to introduce the dual market strategy under the myopic solution?

If we focus on the scenario in which the willingness to pay is not large enough $(d < 1)$, implementing the transparent market or the dual market strategy according to the myopic solution results in excess capacity. Figure 4.9 shows a profit ratio, $\pi_{RATIO\,2}$, which represents the profits of the myopic solution, $\pi_{\text{MYOPIC SOLUTION}}$, over the profits under the transparent market when $d < 1$. For most values of d, the ratio is lower than 1 which means that despite both strategies remain with unsold tickets, profits are larger when selling only in the transparent market. Only when $d = \frac{2}{3}$, the airline obtains the same level of profits in both strategies. Additionally, the myopic solution may suppose a maximum loss of profits equal to 25 per cent.

Figure 4. 9. Profit ratio that represents the profits of the myopic solution over the profits under transparent market solution $\left(\pi_{RATIO\,2} = \frac{\pi_{MYOPIC\,SOLUTION}}{\pi_{TM}}\right)$



Proposition 4: *With the dual market strategy, treating risk-averse consumers as if they were risk-neutral has two consequences: First, individuals do not buy the lottery. Second, the profits are lower than when the airline sells only in the transparent market. Only if* $d = \frac{2}{3}$ *profits are the same. Thus, introducing opaque selling under the myopic solution is never better than selling only in the transparent market and leave unsold tickets.*

4.3. Beyond the base model: considering heterogeneous destinations

The base model considers that individuals have the same willingness to pay for sun-and-beach and cultural destinations. Different from previous research, let us consider different willingnesses to pay for each destination category.

Consider the same assumptions that in the base model except for the fact that now consumers have different willingnesses to pay for each type of destination: d_{SB} and d_C for the case of sun-and-beach and cultural destinations, respectively. In this case, utility functions are given by:

$$U_{SB}(x)' = I + d_{SB} - tx - P_{SB}. \qquad (4.14)$$

$$U_C(x)' = I + d_C - t(1-x) - P_C. \qquad (4.15)$$

Table 4.4 summarizes the main results of the transparent market strategy denoting by $\lambda_{SB}^{TM'}$ and $\left(1-\theta_C^{TM'}\right)$ the market shares of both types of destinations.

Table 4. 4. Main results of the transparent market strategy when considering consumers with different willingnesses to pay for both types of destinations

		Willingnesses to pay lower than 1 $\boldsymbol{d_{SB}, d_C < 1}$	***Willingnesses to pay greater or equal than 1*** $\boldsymbol{d_{SB}, d_C \geq 1}$
Optimal destinations	**SUN AND BEACH**	$\lambda_{SB}^{TM'} = \frac{d_{SB}}{2}$	$\lambda_{SB}^{TM'} = \frac{1}{2}$
	CULTURAL	$1-\theta_C^{TM'} = \frac{d_C}{2}$	$\theta_C^{TM'} = \frac{1}{2}$
Prices	**SUN AND BEACH**	$P_{SB}{}' = \frac{d_{SB}}{2}$	$P_{SB}{}' = d_{SB} - \frac{1}{2}$
	CULTURAL	$P_C{}' = \frac{d_C}{2}$	$P_C{}' = d_C - \frac{1}{2}$
Profits		$\pi_{TM}(\cdot)' = \frac{d_{SB}^2}{4} + \frac{d_C^2}{4}$	$\pi_{TM}(\cdot)' = \frac{d_{SB}+d_C-1}{2}$

Regarding the dual market strategy, the price of the lottery is optimally calculated according to the marginal individual ($E[U_O(x)] = I^{0.5}$). Thus, the price is equal to:

$$P_O(x)' = \frac{d_{SB}}{2} + \frac{d_C}{2} - \frac{1}{2} - \frac{d_{SB}^2}{16I} + \frac{d_{SB}d_C}{8I} + \frac{d_{SB}x}{4I} - \frac{d_{SB}}{8I} - \frac{d_C^2}{16I} - \frac{d_Cx}{4I} + \frac{d_C}{8I} - \frac{x^2}{4I} + \frac{x}{4I} - \frac{1}{16I}\,. \quad (4.16)$$

The airline's profits can be written as follows, denoting by μ_{SB} and φ_C the optimal sun-and-beach and cultural destinations offered by the airline in the case of the dual market strategy. Contrary to the base model, since customers have different willingness to pay for each destination category, the profit maximization problem must be solved independently for each destination.

$$\pi_{DM}(\cdot)' = \mu_{SB}(d_{SB} - \mu_{SB}) + \left(\frac{1}{2} - \mu_{SB}\right)P_O(\mu_{SB}) + (1-\varphi_C)\big(d_C - (1-\varphi_C)\big) + \left(\varphi_C - \frac{1}{2}\right)P_O(\varphi_C) \quad (4.17)$$

Table 4.5 shows the results of the profit maximization problem.

Table 4. 5. Main results of the dual market strategy when considering consumers with different willingnesses to pay for both type of destinations

Optimal destinations	SUN AND BEACH: $\mu_{SB} = \frac{8I+3+2d_{SB}-2d_C-\sqrt{d_C^2-2d_c(d_{SB}+4I)+d_{SB}^2+8d_{SB}I+64I^2+24I}}{6}$ CULTURAL: $\varphi_C = \frac{2d_{SB}-2d_C-8I+3+\sqrt{d_C^2+2d_C(4I-d_{SB})+d_{SB}^2-8d_{SB}I+64I^2+24I}}{6}$
Number of tickets to be sold through blind tickets	$\varphi_C - \mu_{SB} = \frac{\sqrt{d_C^2+2d_C(4I-d_{SB})+d_{SB}^2-8d_{SB}I+64I^2+24I} + \sqrt{d_C^2-2d_C(d_{SB}+4I)+d_{SB}^2+8d_{SB}I+64I^2+24I} - 16I}{6}$
Prices (Transparent market)	SUN AND BEACH: $P_{SB} = d_{SB} - \mu_{SB}$ CULTURAL: $P_C = d_C - 1 + \varphi_C$
Price of the blind ticket	$P_o(x)' = \begin{cases} \frac{2d_c(d_{SB}+16L)-d_C^2-d_{SB}^2+8L(5d_{SB}-2(4L+3))+(d_C-d_{SB}+8L)\sqrt{d_C^2-2d_C(d_{SB}+4L)+d_{SB}^2+8d_{SB}L+64L^2+24L}}{72L} & if\ x = \mu \\ \frac{2d_c(d_{SB}+20L)-d_C^2-d_{SB}^2+32d_{SB}L-16L(4L+3)-(d_C-d_{SB}-8L)\sqrt{d_C^2+2d_C(4L-d_{SB})+d_{SB}^2-8d_{SB}L+64L^2+24L}}{72L} & if\ x = \varphi \end{cases}$
Profits	$\pi_{DM,2} = \mu_{SB}(d_{SB} - \mu_{SB}) + (1 - \varphi_C)(d_C - 1 + \varphi_C) + (\varphi_C - \mu_{SB})P_O(x)'$

Notice that, as long as both willingnesses to pay are equal, results are similar to the ones obtained in section 4.2.2. (the dual market strategy).

In this context, because of the asymmetry of the model, the price of the lottery may have two possible values depending on the marginal customers of each type of destination. Thus, depending on each marginal customer, the price of the lottery varies. Airlines may have different prices to choose. First, airlines could ask consumers what their dream travel would be. For example, Eurowings asks individuals to choose the type of trip they would like to do and whether they prefer to travel to a surprise island ("Happiness Comes in Waves") or a city ("Adventure in the City"). Both mechanisms help airlines face the adverse selection problem and charge each customer the optimal price. Second, the airline may implement the minimum price. This scenario, on the one hand, guarantees that all consumers who purchase the lottery have incentives to buy it, but on the other hand, there may be individuals who deviate from the transparent market given, that the expected utility is higher than the utility under transparent conditions.

To illustrate these results, Table 4.6 shows a numerical example. Consider that the willingness to pay for the sun-and-beach and cultural destination is equal to 0.8 and 0.6, respectively. Additionally, the level of income is equal to 1. Notice that in the case of the cultural destination, the result shown in the table is the market share. Thus, for instance, the optimal location for the cultural destination in the transparent market is 0.7.

Table 4. 6. Numerical illustrations for the optimality of the dual market strategy considering two scenarios with different willingness to pay for each type of destination

<table>
<tr><th rowspan="3"></th><th colspan="4">$d_{SB} = 0.8,\ d_C = 0.6,\ I = 1$</th></tr>
<tr><th colspan="2">CASE 1: AIRLINES ASK CUSTOMERS THEIR FAVOURITE DESTINATION TO TRAVEL</th><th colspan="2">CASE 2: AIRLINES IMPLEMENT BLIND TICKETS AT THE MINIMUM PRICE</th></tr>
<tr><th>Transparent market</th><th>Dual market</th><th>Transparent market</th><th>Dual market</th></tr>
<tr><td>Optimal destinations</td><td>$\mu_{SB}^{TM} = 0.4$
$1-\theta_C^{TM} = 0.3$</td><td>$\mu_{SB}^{DM} = 0.32$
$1-\varphi_C^{DM} = 1-0.78$</td><td>$\mu_{SB}^{TM} = 0.4$
$1-\theta_C^{TM} = 0.3$</td><td>$\mu_{SB}^{DM} = 0.32$
$1-\varphi_C^{DM} = 1-0.78$</td></tr>
<tr><td>Number of tickets sold under perfect information conditions</td><td>$SB: 0.4$
$C: 0.3$</td><td>$SB: 0.32$
$C: 0.22$</td><td>$SB: 0.4$
$C: 0.3$</td><td>$SB: 0.32$
$C: 0.12$</td></tr>
<tr><td>Number of tickets sold through blind tickets</td><td>-</td><td>$SB: 0.18$
$C: 0.28$</td><td>-</td><td>$SB: 0.18$
$C: 0.38$</td></tr>
<tr><td>Prices (Transparent market)</td><td>$P_{SB}^{TM} = 0.4$
$P_C^{TM} = 0.3$</td><td>$P_{SB} = 0.48$
$P_C = 0.38$</td><td>$P_{SB}^{TM} = 0.4$
$P_C^{TM} = 0.3$</td><td>$P_{SB} = 0.48$
$P_C = 0.38$</td></tr>
<tr><td>Price of the blind tickets</td><td>-</td><td>$SB: 0.18$
$C: 0.19$</td><td>-</td><td>0.18</td></tr>
<tr><td>Profits</td><td>$\pi'_{TM} = 0.25$</td><td>$\pi'_{DM} = 0.32$</td><td>$\pi'_{TM} = 0.25$</td><td>$\pi'_{DM} = 0.3$</td></tr>
</table>

In this numerical illustration travellers have a high willingness to pay for sun-and-beach destinations. If the airline only sells tickets through transparent mechanisms, both flights are operated, but with 0.3 unsold tickets. Regarding the implementation of blind tickets, airlines may choose among two possible prices, depending on the market shares of each destination. In this case, the optimal price of the lottery according to the marginal customer of the sun-and-beach destination is equal to 0.18, while the cultural destination is equal to 0.19. Airlines may apply different mechanisms in order to set the price of the lottery.

Under the dual market strategy, the firm sells each type of destination at its optimal price in the transparent market. Because of different willingness to pay, blind tickets can be sold at two different prices. In *Case 1*, the airline can ask customers, before showing the price and purchasing, their preferred destination and, thus, charge the corresponding price. Under this case, there exists a high risk of cannibalization. Thus, the airline may assign blind tickets strategically. This is, if a customer prefers the sun-and-beach destination, he may be assigned the cultural one in order to avoid anticipation and cannibalization. Under this case, the implementation of blind tickets allows airlines to sell all tickets and increase profits by 28 per cent.

In *Case 2*, in order to avoid cannibalization, the airline may implement blind tickets at the minimum optimal price, which is 0.18. At this price, some individuals who prefer to travel to the cultural destination deviate to the opaque market, since their expected utility in the opaque market is larger than the utility of purchasing directly the flight in the transparent one. Specifically, these individuals are the ones located between 0.78 and 0.88. Therefore, the airline loses this market share in the transparent market but attends them through blind tickets. Despite the deviation of customers and that the airline is not in an optimal situation according to marginal customers, all demand is attended in both destinations and profits are higher than selling only in the transparent market. Specifically, profits are increased by 20 per cent.

4.4. Conclusions

This chapter studies, from the demand and supply side, the optimality of a popular pricing strategy introduced by tourist firms to cope with demand uncertainty and leftover inventory. Opaque selling consists of hiding some products' attributes, such as the travel destination, during the purchase process by lowering prices.

Regarding the demand side, to the best of our knowledge, this chapter is the first one to develop a demand study of opaque products by analysing online reviews of customers who have already experienced these products. We make use of different natural language processing techniques and algorithms to evaluate how customers perceive opaque products based on the reviews' content. Results of the demand analysis suggest that more than 87 per cent of the reviews are positive and consolidate opaque products as a popular pricing strategy on which consumers like and enjoy travelling to surprise destinations. Most reviews highlight that individuals frequently travel to initially undesired destinations but end up delighted with them. Therefore, we show that it is an optimal pricing strategy for consumers and low-demanded or less desired destinations, since it generates a new source of demand.

Once we have used a sentiment analysis to empirically evaluate consumers' preferences over blind tickets, we develop a theoretical model in order to study its optimality for airlines and social welfare. We apply the Expected Utility Theory to the case of risk-averse individuals. Even though with this product consumers purchase under uncertain conditions, little attention has been paid to consider risk aversion when evaluating its optimality.

We show that consumers' willingness to pay and transportation costs determine whether opaque selling is the first-best alternative for airlines. As long as airlines face excess capacity, opaque selling may increase their profits by up to 30 per cent and, in most scenarios, also social welfare. However, ignoring risk aversion or considering risk neutrality when consumers are risk-averse may end up with two important consequences. First, risk-averse individuals have no incentives to purchase surprise trips. Second, a profit loss can amount to up to 25 per cent.

Finally, we would like to highlight that, although opaque selling in this chapter is applied to the case of airlines, results can be extended to any tourist firm that deals with demand uncertainty and non-storable goods or services.

4.5. Appendix

Proof of Proposition 2: Given the different levels of profits depending on the values of d in the transparent market *(Proposition 1)* and the profits under the dual market strategy- expression (11)- the comparison is as follows.

Table A1. Comparison of profits among strategies

	$\pi_{DM}(x_{SB}^{DM^*}) - \pi_{TM}(d)$
$d < 1$	$\frac{4\sqrt{2}(8I^2+3I)^{\frac{3}{2}}-128I^3-72I^2-27I(d^2-2d+1)}{54I}$
$d \geq 1$	$\frac{2\sqrt{2}\left((8I^2+3I)^{\frac{3}{2}}-16\sqrt{2}I^3-9\sqrt{2}I^2\right)}{27I}$

First, in the case of $d < 1$, the difference in profits is increasing in I. Thus, considering the minimum value of the income, $\frac{1}{14}$, it can be proved that, if $d > 0.595938$, the profits are larger in the dual market than in the regular market. Similarly, when $d \geq 1$, the difference in profits is increasing in I and positive in the minimum value of income.

Therefore, as the willingness to pay is larger than 0.595938, the dual market strategy is more profitable for the airline.

This completes the proof. ■

Proof of Proposition 3: Social welfare can be defined as the price integral taking into consideration market shares. In the case of the transparent market, expressions (A.1) and (A.2) show social welfare if the willingness to pay is lower and greater than 1, respectively. Expression (A.3) defines social welfare under the dual market strategy.

$$W_{TM,d<1} = 2\int_0^{\lambda_{SB}^{TM}} d - x\, dx = \frac{3d^2}{4} \tag{A.1}$$

$$W_{TM,d\geq 1} = 2\int_0^{\lambda_{SB}^{TM}} d - x\, dx = d - \frac{1}{4} \tag{A.2}$$

$$W_{DM} = 2\left[\int_0^{x_{SB}^{DM*}} d - x\, dx + \int_{x_{SB}^{DM*}}^{\frac{1}{2}} P_O(x)dx\right] = \frac{32\sqrt{2}(8I^2+3I)^{\frac{3}{2}} - 12\sqrt{2}(8I^2+9I)\sqrt{8I^2+3I} + 324dI - 640I^3 - 72I^2 - 81I}{324I} \tag{A.3}$$

Comparing expressions (A.1) and (A.2) with expression (A.3), we can obtain the conditions under which the dual market strategy supposes an increase in social welfare. If $d < 1$ there is a maximum threshold, $\bar{d}$, from which social welfare is larger under the strategy of the transparent market. In addition, as long as $d \geq 1$, the social welfare is larger in the case of selling only in the transparent market.

$$\bar{d} = \frac{\sqrt{3}\left(\sqrt{32\sqrt{2}(8I^2+3I)^{\frac{3}{2}} - 12\sqrt{2}(8I^2+9I)\sqrt{8I^2+3I} - 640I^3 - 72I^2 + 27I}\right)}{27\sqrt{I}}. \tag{A.4}$$

Therefore, as the willingness to pay is larger than $\bar{d}$, the dual market strategy generates an increase in social welfare.

This completes the proof. ■

Proof of Lemma 1: According to the results proposed by Jiang (2007), depending on the willingness to pay, d, market shares and optimal prices differ. Regarding the expected utility defined in expression (6), let us study whether individuals have or not to buy opaque products.

Table A2. Risk-averse consumers incentives to purchase blind tickets when they are designed according to risk-neutral individuals.

	Marginal customer	**Price of the lottery**	**Critical values of d that determines the indifference between purchasing the lottery and not purchasing it**
$2-\sqrt{2}<d<\frac{2}{3}$	$\frac{d}{2}$	$d-\frac{1}{2}$	$\frac{1}{2}\left(I-\frac{d}{2}+\frac{1}{2}\right)^{0.5}+\frac{1}{2}\left(I+\frac{d}{2}-\frac{1}{2}\right)^{0.5}=I^{0.5}$ if $d=1$
$\frac{2}{3}<d<\frac{3}{4}$	$1-d$	$d-\frac{1}{2}$	$\frac{1}{2}\left(I+d-\frac{1}{2}\right)^{0.5}+\frac{1}{2}\left(I-d+\frac{1}{2}\right)^{0.5}=I^{0.5}$ if $d=0.5$
$d>\frac{3}{4}$	$\frac{1}{4}$	$d-\frac{1}{2}$	$\frac{1}{2}\left(I+\frac{1}{4}\right)^{0.5}+\frac{1}{2}\left(I-\frac{1}{4}\right)^{0.5}\neq I^{0.5}\ \forall d$

For any value of d, it can be demonstrated that if individuals are risk-averse, they do not have incentives to buy the lottery. Thus, although the airline implements the dual market strategy, it will only sell the tickets in the transparent market.

This completes the proof. ■

CHAPTER 5.

BLIND TICKETS TO SOLVE THE INEFFICIENCES OF SUBSIDIES FOR RESIDENTS IN AIR TRANSPORT MARKETS

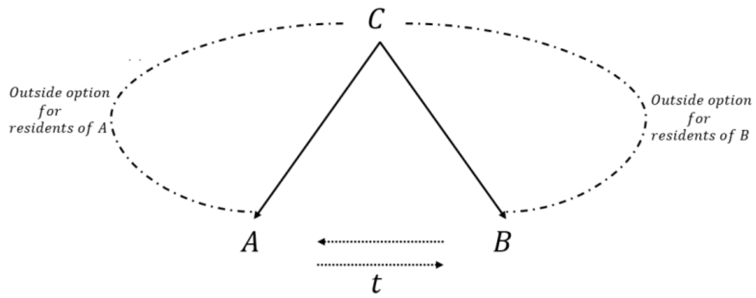
Subsidies for passengers living in islands or remote regions are common in European air transport markets. The existing literature highlights their inefficiencies since they may imply increases in fares and non-residents' exclusion. This chapter proposes an economic model to analyse the optimality of blind tickets in order to manage those inefficiencies. Blind tickets consist of purchasing cheap surprise flight tickets without knowing the destination. This pricing strategy allows airlines to discriminate between resident and non-resident passengers creating two different markets, the transparent and the opaque market. Our results suggest that blind tickets are a socially optimal pricing strategy. While resident passengers may be better off because of additional discounts, non-residents, that were excluded from the market, are now able to fly purchasing blind tickets. This chapter has different policy implications and provides an alternative pricing strategy that may coexist with subsidies, mitigating their inefficiencies and enhancing social welfare.

5.1. 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. 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 in an alternative transport mode involves a transportation cost for the resident passenger. Let us denote this transportation cost by t, and it includes the ticket price of the alternative transport mode, waiting time, travel time, etc. Second, they may travel to their homes considering other non-direct routes, different from the one described above. We refer to these other non-direct alternatives as an outside option. Figure 5.1 summarizes the structure of the network situation and possible alternatives.

Figure 5. 1. Network structure



Let us define by H and L the willingness to pay for travelling 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:

$$U_A^R = (I + H - P_A)^\alpha, \quad U_A^{NR} = (I + L - P_A)^\beta. \tag{5.1}$$

$$U_B^R = (I + H - P_B)^\alpha, \quad U_B^{NR} = (I + L - P_B)^\beta, \tag{5.2}$$

where I represents the level of income, and P_A and P_B the prices charge on destinations A and B. Similarly, the utility for resident passengers of purchasing the outside option is:

$$U_A^R = U_B^R = a^\alpha. \tag{5.3}$$

For the sake of simplicity, let us assume that the airline has a constant marginal cost per passenger equal to 0. In order to define properly the model, we consider that the difference between non-residents' willingness to pay, L, and the price of the outside option is negative: Thus, they do not have incentives to purchase the outside option. Moreover, the surplus of purchasing the outside option, a, is lower than $H - L$.

Table 5.1 summarizes the main notation of the chapter.

Table 5. 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	Travel cost between destinations A and B
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 of residents of destination A
$CS_{RES.\ B}$	Consumer surplus of residents of destination B
$CS_{NON\text{-}RES.}$	Consumer surplus of non-residents
PS	Producer surplus
GS	Government surplus
SW	Social welfare

5.1.1. 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 $H - a$, 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 $H - a$, it may only sell $N\theta_B$ 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 selling the tickets of destination B at a price equal to $H - a$.

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

Table 5.2 shows optimal prices and profits for different cases, depending on the proportion of residents willing to travel in both routes.

Table 5. 2. Optimal prices, quantities and profits in a benchmark situation depending on the proportion of resident and non-residents passengers

		Prices	Tickets sold in 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	

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*, the airline serves all customers.

Note that, while all cases ensure that resident passengers are accommodated, only in *Case 4* 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 5.3 shows the social welfare (SW) of each case. Producer surplus (PS) coincides with airline's profits. Consumer surplus (CS) is the difference between consumers' willingness to pay and the price they are charged.

Table 5. 3. Social welfare analysis of 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 RES.A	$N\theta_A a$	$N\theta_A a$	$N\theta_A(H-L)$	$N\theta_A(H-L)$
CS RES. B	$N\theta_B a$	$N\theta_B(H-L)$	$N\theta_B a$	$N\theta_B(H-L)$
CS NON-RES.	0	0	0	0
SW	$N(\theta_A+\theta_B)H$	$N\theta_A H+NL+N\theta_B(H-L)$	$N\theta_B H+NL+N\theta_A(H-L)$	$2NL+\ N(\theta_A+\theta_B)(H-L)$

While residents are always better off in *Case 4*, the optimality for the airline depends on the ratio of residents and non-resident passengers. Notice that the consumers surplus of non-resident passengers is always 0, for two main 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*.

5.1.2. 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 $\tau\in(0,1)$, that 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 es 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 in any destination is larger than $\frac{L(1-\tau)}{H-a}$, *the optimal price in such destination is* $\frac{H-a}{1-\tau}$. *Otherwise, the optimal price is L.*

Table 5.4 shows the optimal prices, number of sold tickets and profits depending on the ratio of resident passengers in both routes.

Table 5. 4. Optimal prices, quantities and profits when the government introduces an ad valorem subsidy only for residents

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

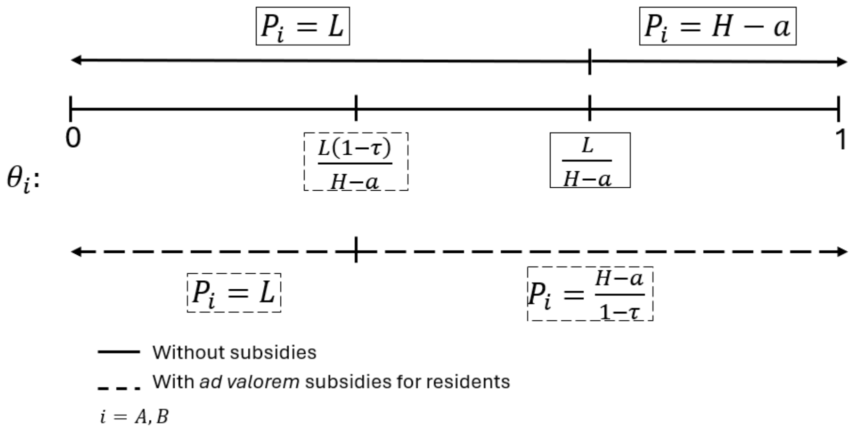
While in *Case 4*, the airline gets the same profits than in the *benchmark case*, in the rest of the cases profits (*Case 1*, *Case 2* and *Case 3*) are always larger. Table 5.5 shows the social welfare analysis when the government introduces an *ad valorem* subsidy only for residents. Notice that now we also need to take into consideration the government surplus.

Table 5. 5. Social welfare analysis of the introduction of an ad valorem subsidy for resident passengers

	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 RES.A	$N\theta_A a$	$N\theta_A a$	$N\theta_A\big(H - L(1-\tau)\big)$	$N\theta_A\big(H - L(1-\tau)\big)$
CS RES. B	$N\theta_B a$	$N\theta_B\big(H - L(1-\tau)\big)$	$N\theta_B a$	$N\theta_B\big(H - L(1-\tau)\big)$
CS NON-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	$N(\theta_A+\theta_B)H$	$N\theta_A H + NL + N\theta_B(H-L)$	$N\theta_B H + NL + N\theta_A(H-L)$	$2NL + N(\theta_A+\theta_B)(H-L)$

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. Figure 5.2 shows these thresholds.

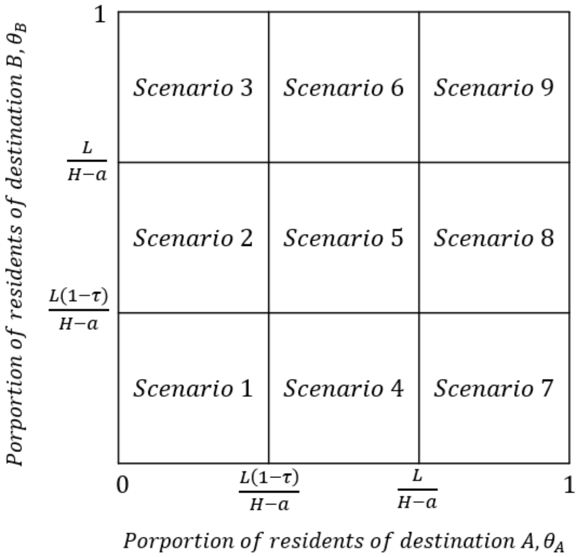
Figure 5. 2. Thresholds for the percentage of residents for destinations A and B in which the airline may implement the highest prices once the ad valorem subsidy only for residents is introduced



As it is shown in Figure 5.2, 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 corresponding 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. While in the b*enchmark 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 implementation of the subsidy results in higher fares and the exclusion of the market of non-resident passengers. This situation corresponds to *Scenario 5* in Table 5.7. Even though the change in consumer surplus of 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's 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.

Depending on the proportion of residents and non-residents, we can distinguish nine different scenarios, as it is shown in the Figure 5.3.

Figure 5. 3 Definition of different scenarios depending on the proportion of residents in each destination, $\boldsymbol{\theta_A}$ and $\boldsymbol{\theta_B}$



In Table 5.6, 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.

Table 5. 6. Economic and social consequences of implementing an ad valorem subsidy for resident passengers for any value of θ_A and θ_B

	Scenario 1: $\theta_A, \theta_B < \frac{L(1-\tau)}{H-a}$	***Scenario 2:*** $\theta_A < \frac{L(1-\tau)}{H-a}$ $\frac{L(1-\tau)}{H-a} \leq \theta_B < \frac{L}{H-a}$	***Scenario 3:*** $\theta_A < \frac{L(1-\tau)}{H-a}$ $\theta_B \geq \frac{L}{H-a}$	***Scenario 4:*** $\frac{L(1-\tau)}{H-a} \leq \theta_A < \frac{L}{H-a}$ $\theta_B < \frac{L(1-\tau)}{H-a}$	***Scenario 5:*** $\frac{L(1-\tau)}{H-a} \leq \theta_A < \frac{L}{H-a}$ $\frac{L(1-\tau)}{H-a} \leq \theta_B < \frac{L}{H-a}$	***Scenario 6:*** $\frac{L(1-\tau)}{H-a} \leq \theta_A < \frac{L}{H-a}$ $\theta_B \geq \frac{L}{H-a}$	***Scenario 7:*** $\theta_A \geq \frac{L}{H-a}$ $\theta_B < \frac{L(1-\tau)}{H-a}$	***Scenario 8:*** $\theta_A \geq \frac{L}{H-a}$ $\frac{L(1-\tau)}{H-a} \leq \theta_B < \frac{L}{H-a}$	***Scenario 9:*** $\theta_A \geq \frac{L}{H-a}$ $\theta_B \geq \frac{L}{H-a}$
Benchmark case:									
P_A	L	L	L	L	L	L	$H-a$	$H-a$	$H-a$
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:**									
P_A	L	L	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$
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	$2NL$	$NL + N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$NL + N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$NL + N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$NL + N\theta_A\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$
Changes in Social Welfare (Ad valorem subsidy – Benchmark case):									
ΔPS	0	$NL + N\theta_B\left(\frac{H-a}{1-\tau}\right)$	$N\theta_B\left(\frac{H-a}{1-\tau}\right)\tau$	$N\theta_A\left(\frac{H-a}{1-\tau}\right) - NL$	$2NL - N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$NL + N\theta_B(H-a) - N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)$	$N\theta_A\frac{H-a}{1-\tau}\tau$	$N\theta_A\left(\frac{H-a}{1-\tau}\right)\left(\frac{\tau}{1-\tau}\right) + N\theta_B\left(\frac{H-a}{1-\tau}\right) - NL$	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\left(\frac{\tau}{1-\tau}\right)$
$\Delta CS_{RES.\ A}$	$N\theta_A L\tau$	$N\theta_A L\tau$	$N\theta_A L\tau$	$-N\theta_A(H-L-a)$	$-N\theta_A(H-L-a)$	$-N\theta_A(H-L-a)$	0	0	0
$\Delta CS_{RES.\ B}$	$N\theta_B L\tau$	$-N\theta_B(H-L-a)$	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
$\Delta CS_{NON\text{-}RES.}$	0	0	0	0	0	0	0	0	0
ΔGS	$-N(\theta_A+\theta_B)L\tau$	$-N\theta_A L\tau - N\theta_B\left(\frac{H-a}{1-\tau}\right)\tau$	$-N\theta_A L\tau - N\theta_B\left(\frac{H-a}{1-\tau}\right)\tau$	$-N\theta_A\left(\frac{H-a}{1-\tau}\right)\tau - N\theta_B L\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$	$-N\theta_A\left(\frac{H-a}{1-\tau}\right)\tau - N\theta_B L\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$	$-N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}\right)\tau$
ΔSW	$\mathbf{0}$	$\boldsymbol{NL(\theta_B - 1) < 0}$	$\mathbf{0}$	$\boldsymbol{NL(\theta_A - 1) < 0}$	$\boldsymbol{NL(-2 + \theta_A + \theta_B) < 0}$	$\boldsymbol{NL(\theta_A - 1) < 0}$	$\mathbf{0}$	$\boldsymbol{NL(\theta_B - 1) < 0}$	$\mathbf{0}$

In all scenarios, the introduction of the *ad valorem* subsidy 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 of 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 some residents are 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 of both destinations are worse off while all non-residents are excluded from the market. Only in *Scenario 9*, consumers' welfare does 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 in 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 motivate the implementation of other pricing strategies that might mitigate the aforementioned undesirable effects of subsidies for resident passengers.

5.1.3. Managing the inefficiencies of an *ad valorem* subsidy through blind tickets

As it is previously mentioned, in most scenarios non-resident passengers are excluded from the market. However, the airline may be interested in accommodating these passengers, 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 destination A or destination B. Once they pay, will discover the final destination.

This pricing strategy aims to (re)introduce non-resident passengers in 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 in at least one destination. Blind tickets may allow the airline to discriminate among passengers, avoiding the cannibalization effect. To do so, the airline should create two different markets (the transparent market and the opaque market) 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.

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 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 (5.1), (5.2) and (5.3), α and β represent resident and non-resident passengers' risk attitudes, respectively. [11] 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.

Similar to previous chapters we need to define the participation and incentive 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.

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[11] 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).

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:

$$\frac{1}{2}(I + L - P_{BT})^{\beta} + \frac{1}{2}(I + L - P_{BT})^{\beta} = I^{\beta}. \quad (5.4)$$

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, this 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.

According to resident passengers, since they are residents in one of the destinations offered through blind tickets, the airline has to apply the discount when selling a blind ticket. However, with this discounted 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 degrees 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 by x such a discount. 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).

$$\frac{1}{2}\big(I + H - L(1-\tau)\big)^{\alpha} + \frac{1}{2}(I + L - L(1-\tau) - t)^{\alpha} = \left(I + H - \left(\frac{H-a}{1-\tau} - x\right)(1-\tau)\right)^{\alpha}. \quad (5.5)$$

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

$$x = \frac{\left[\frac{1}{2}\big(I+H-L(1-\tau)\big)^{\alpha} + \frac{1}{2}(I+L\tau-t)^{\alpha}\right]^{\frac{1}{\alpha}} - I - a}{(1-\tau)}. \quad (5.6)$$

Consumers' willingness to pay, the surplus associated with the outside option, income, the amount of the subsidy, transportation costs and individuals' 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).*

Expressions (5.7), (5.8) and (5.9) shows 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 traveling between destinations A and B, t.

$$\frac{\partial x}{\partial H} = \frac{2^{\frac{-1}{\alpha}}\left(I+H-L(1-\tau)\right)^{\alpha-1}\left[\left(I+H-L(1-\tau)\right)^{\alpha}+(I-t+L\tau)^{\alpha}\right]^{\frac{1-\alpha}{\alpha}}}{1-\tau} > 0. \tag{5.7}$$

$$\frac{\partial x}{\partial a} = \frac{1}{\tau-1} < 0 \tag{5.8}$$

$$\frac{\partial x}{\partial t} = \frac{2^{\frac{-1}{\alpha}}\left[\left(I+H-L(1-\tau)\right)^{\alpha}+(I-t+L\tau)^{\alpha}\right]^{\frac{1-\alpha}{\alpha}}(I-t+L\tau)^{\alpha-1}}{\tau-1} < 0. \tag{5.9}$$

The greater the willingness to pay for 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 higher 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 prices. Table 5.7 and 5.8 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.

Table 5. 7. Economic consequences of implementing blind tickets 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:***
P_A	L	L	$H-a$	$H-a$
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:***
P_A	L	L	L	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$	$\frac{H-a}{1-\tau}$
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)

P_A	$\frac{H-a}{1-\tau}-x$	**PS**	$N(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-x\right)+NL(2-\theta_A-\theta_B)$
P_B	$\frac{H-a}{1-\tau}-x$	**$CS_{RES. A}$**	$N\theta_A\big(a+x(1-\tau)\big)$
P_{BT}	L	**$CS_{RES. B}$**	$N\theta_B\big(a+x(1-\tau)\big)$
Sold tickets dest. A	N	**$CS_{NON-RES.}$**	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**	$NH(\theta_A+\theta_B)+NL(2-\theta_A-\theta_B)$

Table 5. 8. Social consequences of implementing blind tickets 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	$\left(\frac{H-a}{1-\tau}\right)-x>L$	$L+\theta_A\left(\frac{H-a}{1-\tau}-x-L\right)+\theta_B\left(\frac{H-a}{1-\tau}-x+H-a-L\right)>0$	$L+\theta_A\left(\frac{H-a}{1-\tau}-x-H+a-L\right)+\theta_B\left(\frac{H-a}{1-\tau}-x-L\right)>0$	$(\theta_A+\theta_B)\left(\frac{H-a}{1-\tau}-H-a-x-L\right)+2L>0$
ΔCS$_{RES.\,A}$	$N\theta_A(L+a+x(1-\tau)-H)$	$N\theta_A(a+x(1-\tau)-H+L)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$
ΔCS$_{RES.\,B}$	$N\theta_B(L+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$	$N\theta_B(a+x(1-\tau)-H+L)$	$N\theta_B x(1-\tau)$
ΔCS$_{NON\text{-}RES.}$	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	**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	$x<\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{\theta_A}{\theta_A+\theta_B}\right)\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{\theta_B}{\theta_A+\theta_B}\right)\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{2-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{\theta_B}{\theta_A+\theta_B}\right)\left(\frac{H-a}{1-\tau}\right)+\left(\frac{1-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$	$x<\left(\frac{2-\theta_A-\theta_B}{\theta_A+\theta_B}\right)L$
ΔCS$_{RES.\,A}$	$N\theta_A(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_A(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$	$N\theta_A x(1-\tau)$
ΔCS$_{RES.\,B}$	$N\theta_B(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$	$N\theta_B(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$	$N\theta_B(L(1-\tau)+a+x(1-\tau)-H)$	$N\theta_B x(1-\tau)$
ΔCS$_{NON\text{-}RES.}$	0	0	0	0	0	0
ΔGS	- $N(\theta_A+\theta_B)\tau\left(\frac{H-a}{1-\tau}-x-L\right)$	$-N\theta_A\tau\left(\frac{H-a}{1-\tau}-x-L\right)+N\theta_B x\tau$	$N\theta_A x\tau \quad -N\theta_B\tau\left(\frac{H-a}{1-\tau}-x-L\right)$	$N(\theta_A+\theta_B)x\tau$	$N\theta_A x\tau \quad -N\theta_B\tau\left(\frac{H-a}{1-\tau}-x-L\right)$	$N(\theta_A+\theta_B)x\tau$
ΔSW	**0**	$\boldsymbol{NL(1-\theta_B)>0}$	$\boldsymbol{N\theta_B L+NL(1-\theta_A-\theta_B)>0}$	$\boldsymbol{NL(2-\theta_A-\theta_B)>0}$	$\boldsymbol{N\theta_B L+NL(1-\theta_A-\theta_B)>0}$	$\boldsymbol{NL(2-\theta_A-\theta_B)>0}$

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 it is shown in Table 5.8, only when the proportion of residents of both destinations is low, implementing blind tickets results in the same level of social welfare with respect to the case in which the government introduces a subsidy for residents. However, in the rest of the cases, implementing blind tickets increases social welfare.

***Proposition 5*:** *An ad valorem subsidy for resident passengers combined with blind tickets never decreases social welfare. Moreover, in almost all cases, blind tickets increase social welfare in subsidised air transport markets. Only when the proportion of residents is low enough (Scenario 1),* $\theta_A, \theta_B < \frac{L(1-\tau)}{H-a}$ *, blind tickets in subsidised markets produce the same social welfare.*

Table 5.8 includes a profitability constraint which 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 non-resident passengers travel to both destinations, but also residents 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. Indeed, even if the necessary discount is so high that introducing blind tickets is not profitable 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 shows 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 not be profitable 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.

5.2. Some numerical illustrations

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 also in interisland 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).

Currently, one airline is covering the air routes Vigo - Gran Canaria and Vigo – Tenerife through direct flights. Let us consider Gran Canaria as destination A and Tenerife as destination B. According to de Rus and Socorro (2022) and based on data from July 2018 to June 2019, the percentage of residents in the route Vigo – Gran Canaria is 78.69% while in Vigo – Tenerife is 55.1%. 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 160€, 40€ and 50€, respectively. The rest of the data is summarized as follows:

Numerical example 1: $H - a = 120$; $H = 160$; $a = 40$; $t = 100$; $L = 50$; $N = 136$; $\tau = 0.75$; $I = 1000$; $\theta_A = 0.786$; $\theta_B = 0.551$; $N\theta_A = 107$; $N\theta_B = 75$; *Risk attitude of resident passengers:* $\alpha = 1.4$

Table 5.9 shows the main results of the benchmark case, the case of the *ad valorem* subsidy for resident passengers and the case the case of the *ad valorem* subsidy for resident passengers combined with blind tickets. Notice that the analysis is made for one specific flight.

Table 5. 9. Main results of *Numerical example 1*

	Benchmark case	***Ad valorem* subsidy for resident passengers**	**Blind tickets**
Case / Scenario	*Case 1*	*Scenario 9*	*Scenario 9*
P_A	120 €	480 €	461.54 €
P_B	120 €	480 €	461.54 €
P_{BT}	–	–	50 €
x	–	–	18.46 €
Tickets sold dest. A	107	107	107
Tickets sold dest. B	75	75	75
Tickets sold BLIND TICKETS	–	–	90
PS	21840 €	87360 €	88500.28 €
$CS_{RES.\ A}$	4280 €	4280 €	4773.27 €
$CS_{RES.\ B}$	3000 €	3000 €	3346.13 €
$CS_{NON\text{-}RES.}$	0	0	0
GS	0	−65520 €	−63000.21 €
SW	29120 €	29120 €	33619.09 €

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 only for resident passengers, the airline increases proportionally the prices and only resident passengers continue travelling to both destinations. In both routes, non-residents do not travel to any destination with or without the *ad valorem* subsidy only for residents. The implementation of the *ad valorem* subsidy supposes more than 65000€ of additional revenues for the airline.

When implementing blind tickets in the subsidised market, all non-resident passengers are introduced in this market and 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. Overall, this numerical example shows that implementing blind tickets in a subsidised market enhances social welfare by more than 15 per cent with respect to the *benchmark* case resulting in a better social equilibrium.

Table 5.10 shows the changes in social welfare, as well as in producer, consumers and government surpluses under the three different cases. The second column shows the changes derived from implementing the subsidy with respect to the benchmark case. The third column shows the changes resulting from introducing blind tickets in subsidised market.

Table 5. 10. Changes in social welfare under different cases 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**
ΔPS	65520 €	1140.28 €	66660.28 €
$\Delta CS_{RES.\ A}$	0 €	493.27 €	493.27 €
$\Delta CS_{RES.\ B}$	0 €	346.13 €	345.75 €
$\Delta CS_{NON\text{-}RES.}$	0	0	0
ΔGS	−65520€	2519.79 €	−63000.21 €
ΔSW	0 €	4500 €	4499.09 €

According to previous research and as it is shown in this chapter, the introduction of the subsidy increases the market power of the airline. 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 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 in the latter case, they do travel, paying a price equal to their willingness to pay.

This numerical example illustrates a situation on which with the implementation of blind tickets, both the airline and resident passengers are better off, non-resident passengers are introduced in the market and the public expenditure is reduced. Moreover, when comparing the surpluses of blind tickets in subsidised air markets with respect to the benchmark case, see that both the airlines and resident passengers are better off while non-residents travel. Overall, blind tickets increase social welfare.

This numerical example shows the main results of this chapter. Notice that, because of the number of passengers, this data may correspond to one flight. Therefore, the increase in social welfare would be much higher if we consider yearly data.

In order to show the robustness of the results and analyse other scenarios, let us consider another two routes: Malaga – Fuerteventura and Malaga – Tenerife. Both of them are currently operated by just one airline. Let us consider Fuerteventura as destination A and Tenerife as destination B. The proportion of residents in 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 travelling 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. As follows is the rest of the data for this second example called Numerical example 2.

Numerical example 2: $H - a = 100$; $H = 160$; $a = 60$; $t = 55$; $L = 35$; $N = 150$; $\tau = 0.75$; $I = 1000$; $\theta_A = 0.337$; $\theta_B = 0.378$; $N\theta_A = 51$; $N\theta_B = 57$; *Risk attitude of resident passengers:* $\alpha = 1.5$

Table 5.11 shows the main results associated with each case, depending on whether exist or not the *ad valorem* subsidy and blind tickets. Similar to the previous example, according to the number of passengers willing to travel in each route, we can assume that the analysis is just for one flight.

Table 5. 11. Main results of Numerical example 2

	Benchmark case	***Ad valorem* subsidy for resident passengers**	**Blind tickets**
Case / Scenario	*Case 3*	*Scenario 6*	*Scenario 6*
P_A	35 €	400 €	387.37 €
P_B	100 €	400 €	387.37 €
P_{BT}	–	–	35
x	–	–	12.63 €
Tickets sold dest. A	51	51	51
Tickets sold dest. B	57	57	57
Tickets sold BLIND TICKETS	–	–	192
PS	10950 €	43200 €	48555.96 €
$CS_{RES.\ A}$	6375 €	3060 €	3221.16 €
$CS_{RES.\ B}$	3420 €	3420 €	3600.12 €
$CS_{NON\text{-}RES.}$	0	0	0
GS	0	−32400 €	−31376.97 €
SW	20745 €	17280 €	24000.27 €

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

When implementing the *ad valorem* subsidy, the proportion of residents of both Fuerteventura and Tenerife exceeds the minimum threshold from which the airline may apply the high price, $\frac{H-a}{1-\tau}$. Thus, all non-resident passengers do not fly to any of the destinations. As it is shown in Table 5.11, notice that in the case of the Malaga-Fuerteventura route prices quadrupled, while in the case of Malaga-Tenerife the increase is even greater, from 35€ to 400€.

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

In order to evaluate the changes in all surpluses and social welfare, Table 5.12 provides a comparison of the different cases.

Table 5. 12. Changes in social welfare under different cases 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**
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 €

As it is 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 are reintroduced on both routes, although there is no change in their surplus since they are charged their maximum willingness to pay for travelling. Residents benefit from blind tickets since they pay lower fares for travelling to their homes. In addition, the reduction in the price of the tickets in the transparent market produces a decrease in 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. Despite this fact, all agents are better off and there is an increase in social welfare. Thus, governments may compensate or create another policy that benefits these passengers considering the social implications of implementing blind tickets.

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. Thus, these results may be of interest to both airlines and policymakers.

5.3 Conclusions

Despite the liberalization of most air transport markets in the world, market inefficiencies or equity reasons justify public interventions. For instance, in the case of Spain, residents of the Canary Islands, Balearic Islands, Ceuta and Melilla benefit from an *ad valorem* subsidy of 75 per cent over the ticket price of domestic flights. The subsidy is justified due to the peripheral situation of these areas with respect to the rest of the country.

Although this policy aims to increase and facilitate air connectivity in disadvantaged areas, literature highlights its 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 might imply important inefficiencies and undesirable effects.

This chapter develops an economic model to analyse and mitigate the inefficiencies associated with subsidies to resident passengers. First, we analyse the conditions and importance of those market inefficiencies. Second, we analyse the optimality of introducing blind tickets in subsidised markets. Blind tickets consist of surprise flights on 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. Third, in order to illustrate the main results of the model, we use some numerical examples based on real data.

Prior research on blind tickets highlights their profitability for airlines and their success among customers. In this chapter, we show that they might be also a socially optimal pricing strategy to solve the inefficiencies derived from *ad valorem* subsidies in air transport markets. This pricing strategy may increase airline's profits by creating two different markets and discriminating between resident and non-resident passengers. Additionally, this pricing strategy may improve travellers' welfare. On the one hand, residents may benefit from travelling at lower rates. On the other hand, blind tickets reintroduce non-resident passengers into the market.

To the best of our knowledge, this chapter is the first one to provide an alternative pricing strategy that may coexist with the discount for residents, mitigating the inefficiencies associated with subsidies and enhancing social welfare. Thus, the results of this chapter have different policy implications. First, it manages to solve the two main inefficiencies derived from the subsidy: the increase in ticket prices and the exclusion of non-residents. Second, it does not require any additional public funds for its implementation since it 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, it may lead to additional tourist expenditure and, therefore, to the growth and development of tourism economies.

CHAPTER 6.

CONCLUSIONS

Consumers' heterogeneity, market fluctuations and the very perishable nature of seats make the setting of prices a complex decision for airlines (Alderighi et al., 2022 P1). This Ph. D. thesis dissertation provides an economic analysis from the demand and supply side of an ingenious pricing strategy introduced in the tourism and travel industries based on the so-called opaque products or blind tickets.

Hotels, restaurants, airlines and rent-a-car companies are examples of tourism industries that have introduced this original pricing strategy. In the airline industry, blind tickets consist of non-refundable tickets on which customers purchase flight tickets without knowing the destination they are flying to. The only information they have during the purchasing process is the set of possible destinations, and it is only after the payment is made that the final destination is revealed.

In this Ph. D. thesis dissertation, we develop different economic models in order to evaluate the optimality of this new pricing strategy. In line with the objectives of this Ph. D. thesis dissertation, we contribute to the existing literature on revenue management techniques in providing the main conditions and market characteristics to optimally implement this pricing strategy in air transport markets. Additionally, we evaluate how tourist demand influences the setting of opaque products, considering the behaviour of both firms and individuals as profit and utility maximising agents, respectively.

Even though with opaque products consumers purchase under uncertain conditions, previous research has paid little attention to considering individuals' degree of risk aversion when evaluating their optimality. In this Ph. D. thesis dissertation, we apply the Expected Utility Theory to model individuals' risk attitudes and demonstrate that blind tickets suppose a channel on which airlines can manage distressed inventory (unsold tickets), generating additional revenues from a new source of demand.

For airlines, we show that blind tickets are an optimal pricing strategy which does not require the presence of any intermediary for its implementation. Indeed, blind tickets suppose an additional source of demand which may increase profits by up to 30 per cent. However, airlines should take into consideration that most individuals are risk-averse, since implementing blind tickets assuming risk neutrality or treating risk-averse individuals as risk-neutral may produce important losses for airlines. In Chapter 4, we demonstrate that it is better for the airline to have unsold seats than implementing blind tickets ignoring individuals' risk aversion.

Regarding consumers, we empirically show that blind tickets are a popular pricing strategy and a cheap way of travelling. Even though price-sensitive individuals can travel at lower rates with blind tickets, we demonstrate that existing travellers may also benefit from additional discounts. Thus, overall, both existing and new passengers may end up travelling at lower fares.

As far as tourist destinations are concerned, we show that blind tickets may suppose a way of attracting new demand for low-demanded or less-known destinations. In Chapter 3, we numerically illustrate the main economic impacts of introducing blind tickets for these destinations. Additionally, in Chapter 4 we support these findings with a demand analysis in which individuals highlight that thanks to blind tickets, they have travelled to destinations they had never consider before and ended up delighted with these new experiences.

Regarding governments and policymakers, we demonstrate that blind tickets are optimal not only for airlines and consumers, but they are also an optimal pricing strategy for solving the inefficiencies derived from *ad valorem* subsidies to resident passengers. In particular, in Chapter 5, we show that, thanks to blind tickets, resident passengers may enjoy additional discounts, while guaranteeing the (re)introduction of non-residents in subsidised air transport markets. Moreover, it does not require any additional public funds for its implementation, and, in some cases, it may even decrease the public expenditure.

Summarising, in this Ph. D. thesis dissertation, we prove that blind tickets are an optimal pricing strategy for airlines, consumers, tourist destinations and policymakers.

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