ECONOMIC EVALUATION OF TRANSPORT PROJECTS AND POLICIES: METHODOLOGY AND APPLICATIONS

Part 3:
Cost-benefit analysis of transfers to residents in air transport

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CONTENTS

1. INTRODUCTION

When, in opinion of governments, a minimum level of air connectivity in remote or with low demand regions is not guaranteed, there are different policies that the government may use in order to ensure an adequate level of air transport service, at affordable prices, and according to some pre-established air connectivity criteria.[1] This is especially relevant for residents in outermost territories, such as the Canary Islands, and, in general, for residents in non-peninsular territories. The different mechanisms that may be used to intervene produce different effects in the market and their suitability depends on the specific context in which they will be applied.

Within the menu of possible mechanisms, that ranges from restricted public service obligations to direct subsidies, in this report we focus on the effects of the discount for residents with an *ad valorem* subsidy, which in the territories of the Canary Islands, Balearic Islands, Ceuta and Melilla, now reaches 75% of the ticket price. In this document, we develop an economic model that will allows us to identify the key variables and economic agents that should be considered when evaluating this policy and its alternative. To this end, we present an original cost-benefit analysis (ACB) methodology for *ad valorem* subsidies, in order to evaluate the consequences that such a policy may have on the market, identifying winners and losers, and carefully analysing the key parameters that would allow the public policy to produce the desired effects on the market.

In our analysis, we consider two extreme situations regarding the market structure: either a situation in which there are so many airlines operating in the route that none of them has any market power (the perfect competition case), or a situation in which just one airline operates in the route and, thus, such an airline has the maximum market power (the monopoly case). Any other real situation that might be considered regarding the market structure is between these two extreme cases.

Throughout this document, we prove that the effectiveness of any policy aiming at increasing residents' air connectivity strongly depends on the particular characteristics of the route, such as the level of competition, the proportion of resident passengers, the shape of residents' and non-residents' demand functions, airlines' operating costs, etc. Thus, any CBA to evaluate the effects of transfers for residents has to be performed route by route, taking into account the particular characteristics of the route and the period of time. Empirical models that use aggregate data are not informative enough to distinguish the routes where the policy is being effective from those routes where the policy is producing important non-desirable effects in the market.

The rest of the document is organized as follows: In **Section 2**, we provide a review of different transport policies used worldwide and, more particularly in Spain, to ensure the mobility and air connectivity of people living in peripheral areas. The economic model for the CBA of transfers for residents is developed in **Section 3**. In **Section 4**, we compare the effects of an *ad valorem* and a specific subsidy for residents. In **Section 5**, we summarize the main conclusions of the economic model and suggest some transport policy recommendations. Finally, in **Section 6** we

[1] There are different definitions of air connectivity in the literature. Throughout this document we refer to an increase in residents' air connectivity as an increase in the number of flights departing from non-peninsular territories.

propose the empirical methodologies and procedures that can be used in practice to measure and quantify the effects of these policies.

2. REVIEW OF DIFFERENT POLICIES AIMED AT ENSURING AIR CONNECTIVITY OF RESIDENTS IN NON-PENINSULAR TERRITORIES

2.1. Review of existing worldwide transport policies

Several policies have been implemented around the world to increase air connectivity in remote regions. Among them, we can mainly distinguish the following ones:

(1) **Public Service Obligations (PSOs)**. PSOs are the most frequent instrument allowing to link remote areas worldwide. European legislation distinguishes between open and restricted PSOs. The open PSO establishes a set of conditions, such as maximum or reference prices, frequencies, time intervals and even the type of aircraft, allowing any airline that wants to enter the market to do so. The restricted PSO is established on those routes that are not commercially profitable in the absence of public intervention. Routes under PSOs are usually operated by a single airline that obtains the exclusiveness (and quite likely the corresponding economic compensation) after a competitive tendering process.

The legislation that allows member states in Europe to impose PSOs on air transport market is Regulation (EC) No 1008/2008 of the European Parliament and the Council of 24 September of 2008, on common rules for the operation of air services in the Community. The number of PSO declarations has been increasing over time and, according to the data available in the EC PSO-database on 18/09/2019, the current number of PSO routes in Europe is 176.[2]

It is worth highlighting that the European Commission considers PSOs as something exceptional, that makes sense when the market fails in solving accessibility problems, as it is the case of routes with low demand (less than 100,000 passenger-trips) or the case of outermost territories.

(2) **Subsidies to resident passengers**. Subsidies for resident passengers may take the form of either an *ad valorem* (percentage of discount on the ticket price) or a specific subsidy (fixed amount irrespective of the fare level). Examples of these kind of subsidies can be found in European countries such as France, Greece, Italy, Portugal, or Spain. While in Spain the subsidy for residents is *ad valorem,* in France and Italy the subsidy for residents takes the form of flat rates. In Portugal, the subsidy may take the form of a specific subsidy (such as the current fixed discount of 50 euros for residents in Madeira in flights to Porto Santo during the winter season) or a flat rate (such as the special rate for residents in Porto Santo of 20 euros in flights to Madeira).

[2] See https://ec.europa.eu/transport/sites/transport/files/pso_inventory_table.pdf

While in Spain the administrative procedure to receive the subsidy is done by airlines and resident passengers just pay the discounted ticket, in Portugal resident passengers pay the whole ticket price and then they make all the administrative steps to claim the amount of the subsidy back. In absence of administrative costs, granting the subsidy to airlines is equivalent to granting the subsidy to passengers, and both systems produce exactly the same effects in the market.

(3) **Subsidies to promote the start-up of new routes**. Some peripheral regions implement incentive programs to encourage the start-up of new routes to/from these regions. This is the case of United Kingdom (specifically in the North East, the North West and Wales) or the Canary Islands in Spain. In this latter case, some examples of new routes that have been subsidized are Lanzarote - Lyon, Fuerteventura - Paris Orly, Gran Canaria - Roma Fiumicino, o Tenerife South - Budapest.

(4) **Subsidies to airlines**. These policies correspond to the case of state-owned air carriers providing services to remote regions in order to ensure the operation of unprofitable routes. Although this is not a policy than can be applied in countries where privatization and deregulation of airlines have been implemented such as Europe, we can find some examples in countries like Bolivia, Colombia, Ecuador or Malaysia.

(5) **Subsidies to airports**. This type of policies takes the form of either discounts on airport charges paid by airlines that operate specific routes to remote areas, or direct (or cross) subsidies to airports located in remote or developing areas.

2.2. Review of existing transport policies in non-peninsular territories in Spain

The main policies aimed to promote air connectivity in non-peninsular territories in Spain, that is, the Balearic Islands, the Canary Islands and the cities of Ceuta and Melilla, are the following:

2.2.1. Public service obligations

PSO in Spain are set under a common European legal framework defined by the European Commission, although the Spanish Government has autonomy in the selection of protected regions, minimum frequency and service levels, reference fares and the amount of possible economic compensations.

PSO were first imposed in Spain for routes from/to the Canary and Balearic Islands in 1998. The objective was to compensate residents in these regions for the cost of the insularity and ensure an adequate level of connectivity. PSO for the Balearic and Canary Islands were revised in 2003 and 2006, respectively, in order to adequate the PSO conditions to the demand, establishing the minimum frequency, time of operations, minimum capacity, reference fare, etc. Airlines interested in operating these routes are asked to provide an annual program specifying for each route the capacity offered, frequency, time and days of operations, aircraft type, etc., and they have to commit to fulfil such a program during at least twelve consecutive months. Thus, the monopoly situation in PSO routes is in general not guaranteed for any airline though, undoubtedly, the annual program commitment imposes important costs of entry.

In 2011, for some thin routes in the Canary Islands, the PSO contract was modified in order to ensure an adequate level of connectivity for residents in exchange of an economic compensation and entry restrictions (monopoly situation guarantee) to the airline operating those routes.

Table 2.1 contains the routes that are subject to PSO regulation in the Canary and Balearic Islands. In the Canary Islands there are 13 interisland routes under PSOs, 4 of them with economic compensation and entry restrictions. As shown in the table, in most cases traffic levels are much higher than the threshold of 100,000 passenger-trips considered in the EU legislation. The Gran Canaria-Tenerife route had more than one million passenger-trips in 2018 (considering both Gran Canaria- Tenerife North and Gran Canaria-Tenerife South routes) and other million passenger-trips in the alternative maritime route (see **Table C.1** in **Annex C**). Thus, the Gran Canaria- Tenerife route has around 2.5 million passenger-trips, similar to some high demand continental routes. However, despite it is a route with high demand, the carriers willing to operate in this route have to fulfil all PSO requirements. The same happens with the route Gran Canaria-Lanzarote, with almost 800,000 passenger-trips; the route Tenerife North-La Palma with more than 720,000 passenger-trips, or the route Gran Canaria-Fuerteventura with almost 650,000 passenger-trips in 2018. As a consequence of the PSO regulation, the level of competition in the Canary Islands has been always very low even in those routes with high demand and, although there have been some entries and exits in the Canarian market over time, the airline Binter Canarias has traditionally enjoyed a high market share (see **Table C.1** in **Annex C**).

In the Balearic Islands, there are 3 interisland routes and one non-interisland domestic route subject to PSO regulation. It is remarkable that, although the route Mallorca-Ibiza has more than 500,000 passengers, the carriers willing to operate in this route have to fulfil all PSO requirements.

Table 2.1 summarizes the main PSO requirements for the Canary Islands (Agreement of the Council of Ministers in the 2nd of June of 2006 and the 7th of October of 2011) and the Balearic Islands (Agreement of the Council of Ministers in the 21st of November of 2003, the 15the of June of 2012 and the 21st of February of 2014, and Order of the Ministry of Transport in the 7th of April of 2008) regarding the period of the year in which the PSO applies, the minimum frequency and capacity to be offered by air transport operators, and the reference fare. The reference fares in **Table 2.1** are the ones in 2019. These reference fares are revised yearly.

Table 2.1. Routes with PSO in the Canary and Balearic Islands

Non-peninsular territory	Route	Number of passenger-trips (2018)	PSO				Economic compensation and restricted entry
			Period	Minimum frequency (per day)	Minimum capacity (seats)	Reference fare (one way)	
The Canary Islands	Gran Canaria - Tenerife North	987,118	All year	28 flights in winter/ 24 flights in summer	295,000 in winter/ 393,000 in summer	€63	NO
	Gran Canaria -Lanzarote	796,956	All year	22 flights in winter/ 28 flights in summer	240,000 in winter/ 378,000 in summer	€82	NO
	Tenerife North - La Palma	727,131	All year	26 flights in winter/ 28 flights in summer	274,000 in winter/ 402,000 in summer	€66	NO
	Gran Canaria -Fuerteventura	642,073	All year	26 flights in winter/ 28 flights in summer	274,000 in winter/ 402,000 in summer	€72	NO
	Tenerife North -Lanzarote	372,664	All year	10 flights in winter/ 14 flights in summer	108,000 in winter/ 180,000 in summer	€106	NO
	Tenerife North - Fuerteventura	281,139	All year	6 flights in winter/ 12 flights in summer	65,000 in winter/ 132,000 in summer	€101	NO
	Tenerife North - El Hierro	200,729	All year	6 flights in winter/ 8 flights in summer	60,000 in winter/ 100,000 in summer	€72	NO
	Gran Canaria- La Palma	151,601	All year	4 flights in winter/6 flights in summer	43,000 in winter/ 74,000 in summer	€100	NO
	Gran Canaria - Tenerife South	105,834	All year	2 flights	21,000 in winter/ 30,000 in summer	€72	YES
	Tenerife North - La Gomera	53,419	All year	4 flights	17,000 in winter/ 25,000 in summer	€72	YES
	Gran Canaria - El Hierro	45,883	All year	2 flights	10,000 in winter/ 26,000 in summer	€106	YES
	Gran Canaria - La Gomera	8,583	All year	4 flights	11,000 in winter/ 16,000 in summer	€100	YES
	La Palma - Lanzarote	362	July-September	6 flights	6,800	€106	NO
The Balearic Islands	Mallorca - Ibiza	522,694	All year	8 flights in winter/ 10 flights in summer	63,000 in winter/ 107,000 in summer	€90	NO
	Mallorca -Menorca	363,908	All year	8 flights in winter/ 10 flights in summer	71,000 in winter/ 110,000 in summer	€90	NO
	Menorca -Madrid	279,312	October-May	4 flights	90,000	€110	NO
	Menorca - Ibiza	7,441	All year	2 flights (through Mallorca)	-	€129	NO

2.2.2. The discount for residents

Passengers with residence in non-peninsular territories in Spain (the Canary Islands, the Balearic Islands and the cities of Ceuta and Melilla)[3] are nowadays entitled to receive a 75% discount (*ad valorem* subsidy) on the ticket price of all domestic flights departing/arriving to their place of residence. In order to enjoy the subsidy, passengers need to facilitate the relevant data to the airline, which in turn, will obtain the money corresponding to this subsidy directly from the Spanish Government on a yearly basis

The 75 percent discount applies to the standard fare charged by airlines in regular services, including luggage and other auxiliary services, taxes and fees, with the exception of the infrastructure use fee and the safety fee. The discount undoubtedly applies to the luggage in those cases in which the fare includes the carriage of luggage but it is not clear for the cases in which the fare does not include this possibility, which will in turn depends on each airline's luggage policy.

The fare subject to the discount cannot be higher than the basic fare, meaning by basic fare the minimum fare applied to a fully flexible fare per round-trip registered by each airline according to the procedures established by the General Directorate of Civil Aviation. Therefore, business fares are fully subsidized if they are lower than the basic registered fare. If they are higher, the discount is limited to the 75% discount of the basic registered fare.

Although there is a limit on the fare subject to the discount, there is no limit on the number of tickets that each individual can buy per year. Moreover, apart from the place of residence, there is no other requirement to be fulfilled by the beneficiaries of the subsidy such as level of income or trip purpose.

Although airlines are not allowed to price discriminate due to passengers' place of residence, sometimes they apply different conditions to residents and non-residents. For example, Ryanair offers three different fares to non-residents- *standard*, *plus* and *flexiplus*- while residents can only choose the *standard* fare on the web. Norwegian offers to all passengers the *Lowfare*, which includes no hold baggage, and the *Lowfare+*, which implies paying 18 euros more and one hold baggage. However, the 75 percent discount for residents is not applied to these additional 18 euros. Finally, airlines may also try to price discriminate between residents and non-residents applying different prices for a round-trip depending on the origin airport. For example, they may charge a higher price for a round-trip from Gran Canaria to Madrid (that is likely to be bought by a resident passenger) than for a round-trip from Madrid to Gran Canaria (that is likely to be bought by a non-resident passenger).

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[3] Since Ceuta has no airport, passengers with residence in Ceuta that use both maritime and air transport to travel from/to Ceuta to/from other national destination are entitled to receive the 75% discount in flights from/to Málaga, Jérez or Seville.

Information about main routes with 75% discount for residents in Spain is provided in Annex C, including total number of passengers in 2018, proportion of resident passengers on the route, level of intramodal and intermodal competition, and the amount of the subsidy. Although currently the discount is 75%, its value has been evolving over time. **Table 2.2** summarizes the evolution of this *ad valorem* subsidy for residents from the initial 10% to the current 75%.

Table 2.2. Evolution of the *ad valorem* subsidy for residents in non-peninsular territories

***Ad valorem* subsidy for residents**	**Region and period**	
	The Balearic Islands	**The Canary Islands**
10%	From 1982 to 1998 in all interisland flights.	From 1988 to 1988 in all interisland flights.
25%	From 1982 to 1998 in all domestic non-interisland flights.	-
33%	From 1998 to 2005 in all domestic flights.	From 1988 to 1998 in all domestic flights non-interisland flights and from 1998 to 2005 in all domestic flights.
38%	From 2005 to 2006 in in all domestic flights.	
45%	From 2006 to 2007 in in all domestic flights.	
50%	From 2007 to 2017 in all interisland flights and from 2007 to 2018 in all domestic non-interisland flights.	
75%	From 2017 in all interisland flights and from 2018 in all domestic flights.	

2.2.3. Cross-subsidies and reduced fares applied in non-peninsular airports

Non-peninsular airports applied reduced fares to passengers in all interisland routes and all routes connecting with the mainland of Spain. This is shown in **Table 2.3** that includes the fees paid by passengers flying to the European Economic Area (EEA) and other international destinations, the PMR fee (fee for the mobility of passengers) and the safety fee applied in all Spanish airports. In contrast, **Table 2.4** and **Table 2.5** show the reduced charges applied in non-peninsular airports for all domestic flights to the mainland of Spain and all interisland flights, respectively.

Table 2.3. Passenger fees in flights to the EEA and other international destinations

Airports	Passengers		PMR	Safety
	EEA	International		
Madrid-Barajas	14.73	20.84	0.60	3.5
Barcelona	13.70	16.77		
Alicante, Gran Canaria, Tenerife South, Málaga, Palma de Mallorca	6.12	9.20		
Bilbao, Fuerteventura, Ibiza, Lanzarote, Menorca, Santiago, Sevilla, Tenerife North, Valencia	5.20	7.82		
Almería, Asturias, Coruña, Girona, Granada-Jaén, Jerez, La Palma, Murcia, Reus, Santander, Vigo, Zaragoza	3.73	5.6		
Albacete, Algeciras, Badajoz, Burgos, Ceuta, Córdoba, Madrid Cuatro Vientos, El Hierro, Huesca, La Gomera, León, Logroño, Melilla, Sabadell, Salamanca, San Sebastián, Son Bonet, Pamplona, Vitoria, Valladolid	2.44	3.67		

Source: AENA (2018).

Table 2.4. Reduced charges in non-peninsular airports for all domestic non-interisland flights

Airports	Passengers	PMR	Safety
Gran Canaria, Palma de Mallorca, Tenerife South	5,20	0,51	2,98
Fuerteventura, Ibiza, Lanzarote, Menorca, Tenerife North	4,42		
La Palma	3,17		
Ceuta, El Hierro, La Gomera, Melilla, Son Bonet	2,07		

Source: AENA (2018).

Similar reduced fares in non-peninsular airports for all domestic flights to the mainland of Spain and all interisland flights are applied to the landing fees paid by airlines (AENA, 2018). Recently and due to the Thomas Cook crisis, the Spanish Government has announced additional reductions in airport fees to be paid by airlines and passengers in all airports located in the Canary and Balearic Islands in 2020.[4]

Table 2.5. Reduced charges in non-peninsular airports for interisland flights

Airports	Passengers	PMR	Safety
Gran Canaria, Palma de Mallorca, Tenerife South	1,84	0,18	0,53
Fuerteventura, Ibiza, Lanzarote, Menorca, Tenerife North	1,56		
La Palma	1,12		
El Hierro, La Gomera, Son Bonet	0,73		

Source: AENA (2018).

On the other hand, the Spanish airport network configuration with a unique entity, AENA, that operates the whole network (46 airports and 2 heliports) allows cross-subsidies from large to small airports. **Figure 2.1** represents the earnings before interest, taxes, depreciation, and amortization (EBITDA) of Spanish airports in 2013. As shown in **Figure 2.1**, small non-peninsular airports, such as those in La Palma, Melilla, El Hierro, La Gomera, or Son Bonet are being subsidized by large airports in Spain.

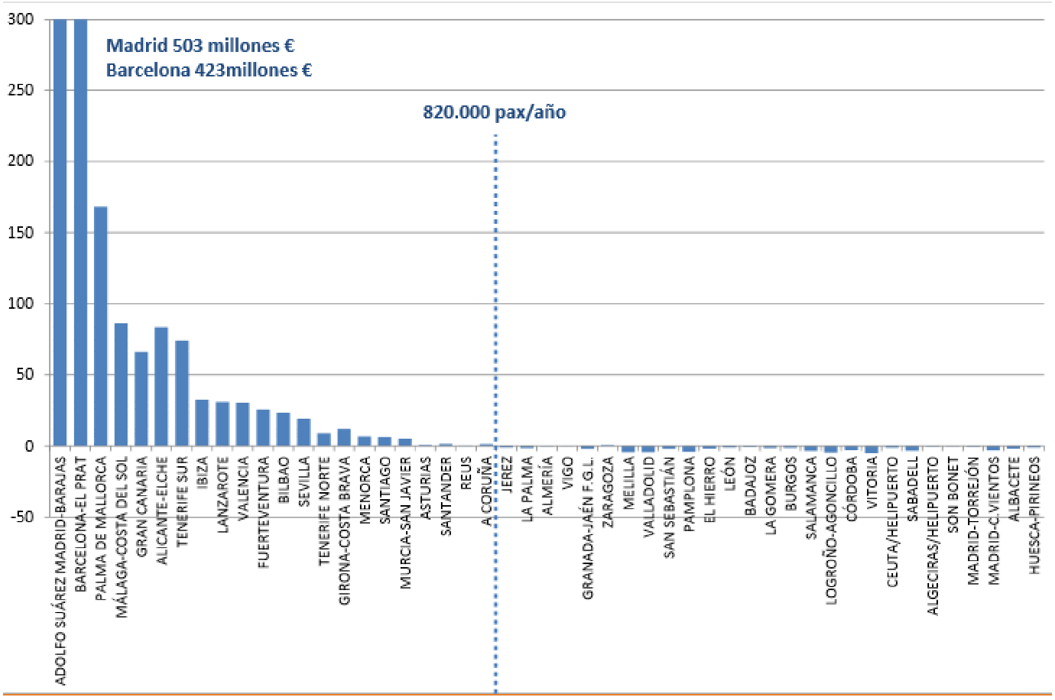
2.2.4. Incentive programs in non-peninsular territories

In addition to all the policies described in this section, there are also some incentives programs to promote air connectivity in non-peninsular territories. This is the case of the so-called Flight Development Fund, an incentive scheme designed to financially support the start-up of new regular direct air routes between Canary Islands airports and international airports.[5] The objective of this program is to encourage the development of the air connectivity of the Canary Islands with new tourist-generating markets or currently underserved regions.

[4] See for more information: https://www.mincotur.gob.es/es-es/crisis-thomas-cook/CookDocumentos/Medidas%20impulsadas%20ante%20la%20crisis/Plan%20de%20choque%20Thomas%20Cook.pdf

[5] For further details see: https://turismodeislascanarias.com/en/flight-development-fund/

Figure 2.1: EBITDA of Spanish airports in 2013 (in million euros)



Source: AENA (2014).

The incentive shall serve as support during the start-up period (normally 2 consecutive years). Applicant airlines are required to submit a formal application for the incentive, in addition to a business plan describing the details of the operation, promotion and marketing, as well as the expected financial results of the new route. The incentive is granted to one airline per route, and the beneficiary is the airline whose application obtains the highest score in the assessment procedure.

The duration of this Flight Development Programme in the territory of the Canary Islands Outermost Region for 2013-2017 has been extended to 31 December 2024 by virtue of European Commission Decision C (2017) 6546 final.

3. ECONOMIC MODEL FOR THE COST-BENEFIT ANALYSIS OF TRANSFERS FOR RESIDENTS

The CBA evaluation of any public intervention requires the comparison of the situations with and without intervention, identifying winners and losers, and carefully analysing the key parameters that would allow the public policy to induce the desired effects in the market. If we are interested in analysing the effects of a public policy aimed to reduce the price of air transport services paid by non-peninsular territories residents in order to increase their connectivity, without harming non-residents, we should first take into account the initial level of demand, the proportion of resident passengers in the route, and the level of competition in the situation without intervention and, then, analyse how the policy would affect social welfare under different assumptions.

In order to do so, in this section we develop an economic model that will allow us to identify the key variables and economic agents that should be considered when evaluating this kind of policies. In particular, we will focus on the effects of the *ad valorem* subsidy for residents, which is the policy currently used in Spain (with a 75% discount on the ticket price paid by resident passengers), and we will compare them with the effects of its alternative, a specific subsidy, fixed in each route, that may be different in different routes but that does not vary with the ticket price within the route. For the sake of simplicity, we will consider only two extreme situations regarding the level of competition: the perfect competition and the monopoly case. Any other real situation that might be considered is between these two extreme cases.

3.1. The basic model

Let us consider N consumers willing to travel from region *A* to region *B*, where region *A* is a non-peninsular territory and region *B* is located in the mainland of the country.[6]

Let $\alpha \in (0,1]$ represent the proportion of passengers residing in region *A* (resident passengers). All resident passengers are assumed to be identical in their travel preferences, each of them with a linear downward-sloping inverse demand given by: [7]

$$P_d^R = a_R - b_R x^R, \qquad \textbf{(3.1)}$$

[6] Region *B* may also represent another non-peninsular territory. If this is the case, both passengers living in region *A* and passengers living in region *B* are resident passengers. This is, for example, the case of interisland routes.

[7] For the sake of simplicity, we consider linear demand functions. However, the main results of this report also hold for non-linear demands, especially those related to the superiority of specific subsidies over *ad valorem* ones and how these differences may be mitigated when the subsidy is granted only to resident passengers.

where a_R and b_R are positive parameters representing the maximum willingness to pay and the slope of the inverse demand function of a resident passenger, respectively. P_d^R represents the ticket price paid by resident passengers, and x^R is the number of trips demanded by a representative resident passenger during a certain period of time. The higher is the value of b_R, the more price-inelastic is the demand function of the resident passenger.

Non-resident passengers are also assumed to be identical, each of them with a linear down-sloping inverse demand given by:

$$P_d^{NR} = a_{NR} - b_{NR} x^{NR}, \qquad \textbf{(3.2)}$$

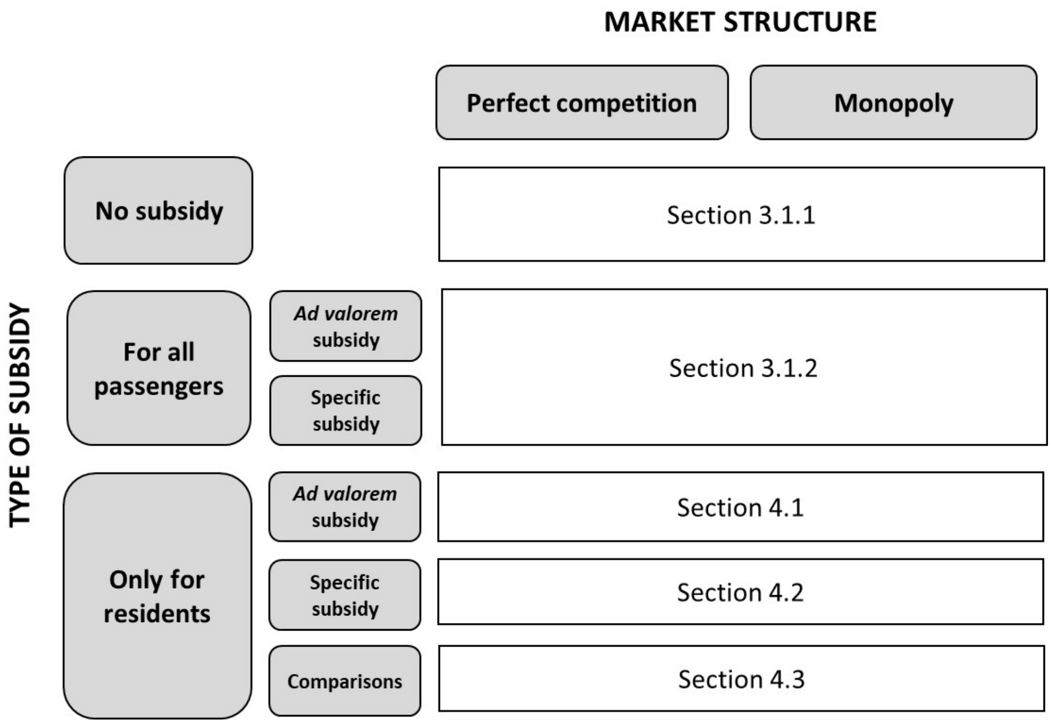
where a_{NR} and b_{NR} are positive parameters representing the maximum willingness to pay and the slope of the inverse demand function of a non-resident passenger, respectively. P_d^{NR} represents the ticket price paid by non-resident passengers, and x^{NR} is the number of trips demanded by a representative non-resident passenger during a certain period of time. The higher is the value of b_{NR}, the more price-inelastic is the demand function of the non-resident passenger.

Notice that the maximum willingness to pay of the representative resident passenger may be higher, lower or equal than the maximum willingness to pay of the representative non-resident passenger. Similarly, the demand function of the representative resident passenger may be more or less price-inelastic than the demand function of the representative non-resident passenger. Although in the economic model we do not assume any specific value to these parameters, for consistency in all figures of this document we represent a resident passenger with higher maximum willingness to pay and more price-inelastic demand function than the one of the non-resident passenger. This is only due to exposition purposes and, as already highlighted, it does not correspond to any assumption or constraint on the values that can take these parameters.

In order to maintain the basic model as simple and intuitive as possible, we will consider only two extreme situations regarding the market structure: either a situation in which there are so many airlines operating in route *AB* that none of them has any market power (the perfect competition case), or a situation in which just one airline operates in route *AB* and, thus, such an airline has the maximum market power (the monopoly case). Any other real situation that might be considered regarding the market structure is between these two extreme cases. For the sake of simplicity, marginal operating costs in all cases are assumed to be constant and equal to c, with $c \geq 0$.[8]

Figure 3.1 summarizes the structure of the basic model used to assess the effects of subsidies for resident passengers. As a benchmark, we start analysing the equilibrium in absence of public subsidies, both in a perfect competition and a monopoly situation. Second, in order to understand the main differences between *ad valorem* and specific subsidies, we analyse the effects of such subsidies when they are granted to all passengers on the route. Finally, **Section 4** is devoted to the CBA of the effects of *ad valorem* and specific subsidies only for resident passengers.

Figure 3.1. The basic model structure



[8] The assumption of constant marginal operating costs in air transport is quite common in the economic literature. However, if there is an expected increase of the demand, airlines might face increasing marginal operating costs in the short run. We discuss this possibility in **Section 3.3**.

3.1.1. Equilibrium in absence of public subsidies

The perfect competition case:

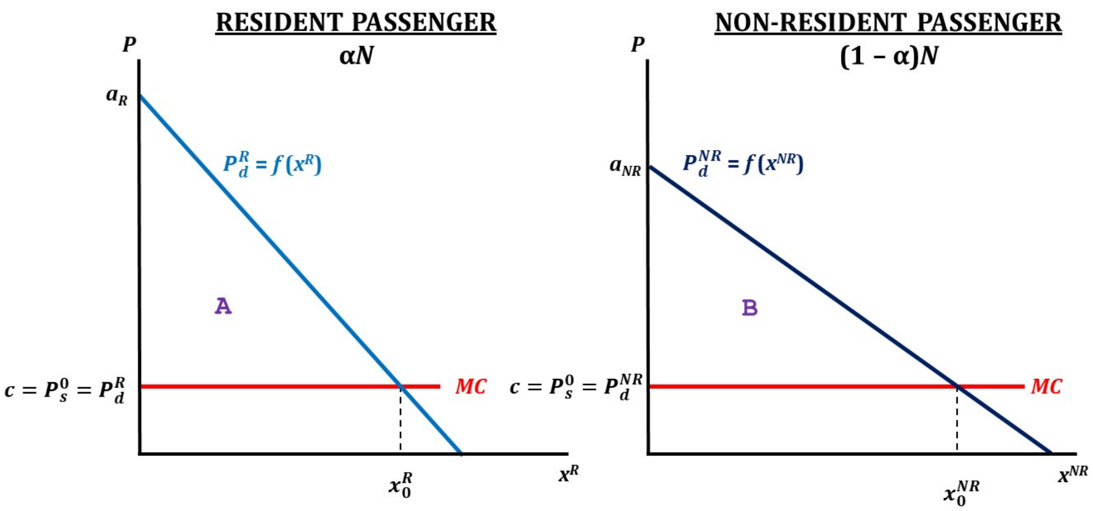
In absence of any public intervention and perfect competition in the air transport market, the ticket price paid by consumers coincides with the ticket price charged by airlines, P_S^0, which in equilibrium is equal to the marginal operating cost, that is, $P_d^R = P_d^{NR} = P_S^0 = c$. By substituting the equilibrium prices in expressions **(3.1)** and **(3.2)**, we can obtain the quantities demanded by each resident and non-resident passenger in the equilibrium without subsidies, which are given by:

$$x_0^R = \frac{a_R - c}{b_R};\; x_0^{NR} = \frac{a_{NR} - c}{b_{NR}}. \tag{3.3}$$

Figure 3.2 illustrates the market equilibrium for the perfect competition case in absence of any public intervention. When the ticket price is set equal to the marginal operating cost, producers' surplus is equal to zero, and resident consumers' surplus (CS^R) and non-resident consumers' surplus (CS^{NR}) are given by **areas A** and **B**, respectively, multiplied by the corresponding number of passengers:

$$\begin{aligned} CS^R &= \alpha NA = \frac{1}{2}\alpha N(a_R - c)x_0^R, \\ CS^{NR} &= (1-\alpha)NB = \frac{1}{2}(1-\alpha)N(a_{NR} - c)x_0^{NR}. \end{aligned} \tag{3.4}$$

Figure 3.2. Market equilibrium in absence of public subsidies: The perfect competition case



The monopoly case:

In absence of any public intervention, the ticket price paid by consumers coincides with the ticket price charged by the airline. In this case, the monopoly carrier chooses the ticket price P_S that maximizes his profits. Notice that this price is the same for residents and non-residents, since the monopolist is not allowed to price discriminate according to passengers' place of residence. In other words, the monopolist solves the following maximization program:

$$\underset{P_s}{Max} \ \ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S - c)x^{NR}, \qquad \textbf{(3.5)}$$

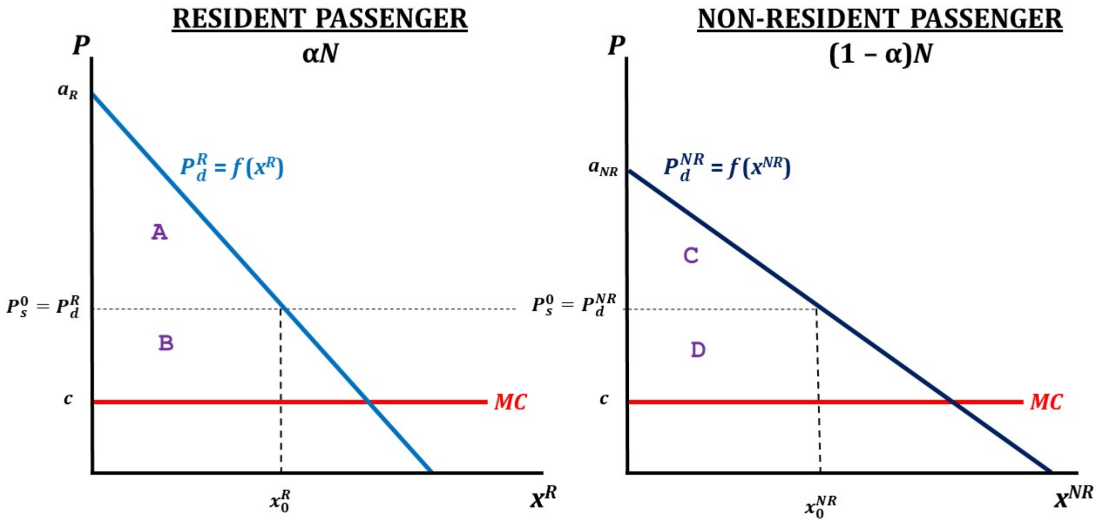
where x^R and x^{NR} are the number of trips demanded by residents and non-residents given by expressions **(3.1)** and **(3.2)**, respectively, with $P_d^R = P_d^{NR} = P_S$.

The first-order condition of the above maximization program yields the optimal ticket price charged by the airline, P_S^0. By substituting such an optimal ticket price P_S^0 in the demand functions given by expressions **(3.1)** and **(3.2)**, and taking into account that in absence of any public intervention $P_d^R = P_d^{NR} = P_S$, we can obtain the corresponding optimal quantities demanded by residents, x_0^R, and by non-residents, x_0^{NR} (mathematical expressions are given in **Annex A**).

Figure 3.3 illustrates the market equilibrium for the monopoly case in absence of any public intervention. When the monopoly sets the ticket price equal to P_S^0, resident consumers' surplus (CS^R), non-resident consumers' surplus (CS^{NR}), and producer's surplus (PS) are given by the following areas represented in **Figure 3.3**, where each area is multiplied by the corresponding number of passengers

$$\begin{aligned} CS^R &= \alpha NA = \frac{1}{2}\alpha N(a_R - P_S^0)x_0^R, \\ CS^{NR} &= (1-\alpha)NC = \frac{1}{2}(1-\alpha)N(a_{NR} - P_S^0)x_0^{NR}, \\ PS &= \alpha NB + (1-\alpha)ND = \alpha N(P_S^0 - c)x_0^R + (1-\alpha)N(P_S^0 - c)x_0^{NR}. \end{aligned} \qquad \textbf{(3.6)}$$

Figure 3.3. Market equilibrium in absence of public subsidies: The monopoly case



3.1.2. Equilibrium with public subsidies to all passengers

Let us compare the effects on the ticket price and government's expenditure of two possible subsidies: *ad valorem* and specific subsidies. Let us start assuming that the subsidy is granted to all passengers in the route, that is, it is granted both to residents and non-resident passengers.

An *ad valorem* subsidy is a discount on the ticket price while a specific subsidy consists of granting a fixed amount per trip, independently on the ticket price. Let us denote by $\sigma \in (0,1)$ the proportion of the ticket price that is subsidized when the subsidy takes an *ad valorem* form, and by s the fixed amount granted when the subsidy is specific. Obviously, this fixed amount should be lower than the maximum willingness to pay and, hence, we assume that $0 < s < a_R$ and $0 < s < a_{NR}$.

Let us now compare the effects of both kinds of subsidies on the ticket price, airlines' profits, and taxpayers' surplus.

<u>The perfect competition case:</u>

With perfect competition, the ticket price charged by airlines in equilibrium with subsidies is equal to the marginal operating cost, that is, $P_S^1 = P_S^0 = c$. Thus, the ticket price charged by airlines is exactly the same that before the subsidy.

With an *ad valorem subsidy*, residents and non-residents pay a ticket price equal to the ticket price charged by airlines minus the discount, that is, $P_d^R = P_d^{NR} = (1-\sigma)c$. Substituting in the corresponding demand functions we have that:

$$x_1^R = \frac{a_R - c(1-\sigma)}{b_R};\ x_1^{NR} = \frac{a_{NR} - c(1-\sigma)}{b_{NR}}. \quad \textbf{(3.7)}$$

With an *ad valorem* subsidy, taxpayers' surplus is then given by:

$$GS = -(\alpha N \sigma c x_1^R + (1-\alpha) N \sigma c x_1^{NR}), \quad \textbf{(3.8)}$$

where the values of x_1^R and x_1^{NR} are given by expression **(3.7)**.

On the contrary, with a specific subsidy, residents and non-residents pay a ticket price equal to the ticket price charged by airlines minus the subsidy, that is, $P_d^R = P_d^{NR} = c - s.$ Substituting in the corresponding demand functions we have that:

$$x_1^R = \frac{a_R - (c-s)}{b_R};\ x_1^{NR} = \frac{a_{NR} - (c-s)}{b_{NR}}. \quad \textbf{(3.9)}$$

With a specific subsidy, taxpayers' surplus is then given by:

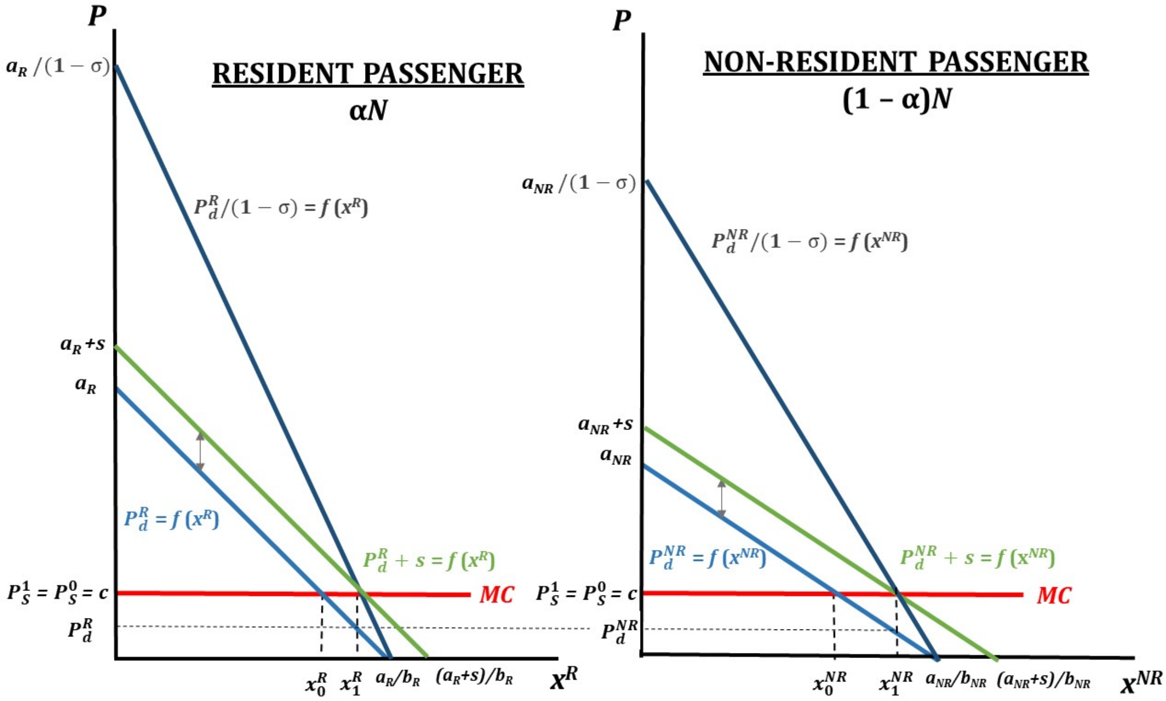
$$GS = -(\alpha N s x_1^R + (1-\alpha) N s x_1^{NR}), \quad \textbf{(3.10)}$$

where the values of x_1^R and x_1^{NR} are given by expression **(3.9)**.

Figure 3.4 represents the specific subsidy that leads to the same results that the *ad valorem* subsidy in terms of the ticket price charged by airlines, $P_S^1 = P_S^0 = c,$ the price finally paid by residents and non-residents, P_d^R and P_d^{NR}, and the quantity demanded by each resident passenger and each non-resident passenger, x_1^R and x_1^{NR}.

It is easy to show that by setting $s = c\sigma$, expressions **(3.7)** and **(3.9)** coincide, and the same happens with expressions **(3.8)** and **(3.10)**. In other words, with perfect competition a specific subsidy equal to $s = c\sigma$ leads exactly to the same results that an *ad valorem* subsidy equal to σ in terms of consumers' surplus, airlines' profits (zero profits), and the government's expenditure.

Figure 3.4. Equilibrium with subsidies to all passengers: The perfect competition case



<u>The monopoly case:</u>

In order to explain the intuition behind the different effects of *ad valorem* and specific subsidies in the monopoly case, let us start assuming that $\alpha = 1$, that is, there are only resident passengers in this route. The profits of the monopolist airline are, then, given by:

$$\Pi = N(P_S - c)x^R. \tag{3.11}$$

With a specific subsidy, the price finally paid by residents is given by $P_d^R = P_S - s$, and, thus, the price charged by the airline is $P_S = P_d^R + s$. Therefore, the profits of the monopolist can be rewritten as:

$$\Pi = N(P_d^R + s - c)x^R = N(P_d^R - (c - s)x^R. \tag{3.12}$$

The last term in expression **(3.12)** shows that the specific subsidy implies a reduction of the marginal operating cost.

With an *ad valorem* subsidy, the price finally paid by residents is given by $P_d^R = P_S(1-\sigma)$, and, thus, the price charged by the airline is $P_S = \frac{P_d^R}{1-\sigma}$. Therefore, the profits of the monopolist can be rewritten as:

$$\Pi = N(\frac{P_d^R}{1-\sigma} - c)x^R = N(\frac{P_d^R - c + c\sigma)}{1-\sigma})x^R = N(\frac{P_d^R + s_a - c)}{1-\sigma}x^R \ . \qquad \textbf{(3.13)}$$

The first term in expression **(3.13)** shows that the *ad valorem* subsidy implies an increase in the marginal revenue. However, it has another implication. Indeed, the last term in expression **(3.13)** shows that the *ad valorem* subsidy is equivalent to the combined use of a specific subsidy of value $s_a = c\sigma$ plus a profit subsidy. Hence, an specific subsidy $s = c\sigma$ leads to the same price for residents P_d^R as the *ad valorem* subsidy, but the *ad valorem* subsidy increases the monopolist's market power and, thus, implies that the airline charges a higher price P_S, resulting in higher profits for the airline, and higher government's expenditure.

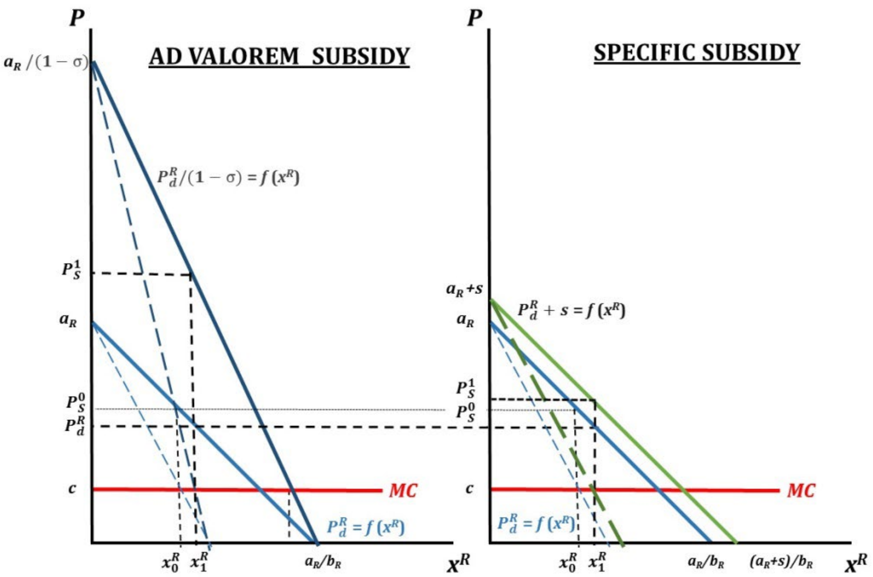
Figure 3.5 compares the results in the market when an *ad valorem* versus specific subsidy is introduced. When there is only one market ($\alpha = 1$), the monopolist charges the price P_S that equals the marginal revenue to the marginal cost, which is equal to P_S^0 in absence of subsidies and P_S^1 when a subsidy is introduced. As shown in **Figure 3.5**, the specific subsidy that implies the same price for residents (P_d^R) that the *ad valorem* one, implies a lower price charged by the airline and, thus, lower profits for the airline and lower public expenditure.

The same results hold for the case $\alpha \in (0,1]$. In this case, when an *ad valorem* subsidy for all passengers is introduced, the airline solves the following maximization program:

$$\underset{P_S}{Max} \ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S - c)x^{NR}, \qquad \textbf{(3.14)}$$

where x^R and x^{NR} represents, the quantity demanded by a representative resident passenger and a representative non-resident passenger, respectively, with $x^R = \frac{a_R - (1-\sigma)P_S}{b_R}$ and $x^{NR} = \frac{a_{NR} - (1-\sigma)P_S}{b_{NR}}$.

Figure 3.5. Equilibrium with subsidies to all passengers ($\alpha = 1$): The monopoly case



On the contrary, when a specific subsidy for all passengers is introduced, the airline solves the maximization program given by expression **(3.14)**, but taking into account that the quantity demanded by a representative resident passenger and a representative non-resident passenger is now given by: $x^R = \dfrac{a_R - P_S + s}{b_R}$ and $x^{NR} = \dfrac{a_{NR} - P_S + s}{b_{NR}}$.

By setting a specific subsidy $s = c\sigma$, the equilibrium yields the same price paid for residents and non-residents that the *ad valorem* one, but the *ad valorem* subsidy increases the monopolist's market power and, thus, implies that the airline charges a higher price P_S, resulting in higher profits for the airline, and higher government's expenditure (see **Annex A** for all mathematical expressions and formal proof of this result).

3.2. Cost-benefit analysis of policies aimed at ensuring air connectivity of residents in non-peninsular territories

The CBA of any policy aiming at ensuring an adequate level of air connectivity and mobility of residents in non-peninsular territories requires measuring the change in social welfare due to the policy. The change in social welfare can be defined as the weighted sum of the change in consumers' surplus (including resident and non-resident passengers), producers' surplus, taxpayers' surplus and the rest of society's surplus, that is:

$$\Delta SW = \beta_R \Delta CS^R + \beta_{NR} \Delta CS^{NR} + \beta_p \Delta PS + \beta_G \Delta GS + \beta_E \Delta RS, \qquad \textbf{(3.15)}$$

where β_R, β_{NR}, β_p, β_G, and β_E represent the weight in social welfare of resident consumers' surplus, non-resident consumers' surplus, producers' surplus, taxpayers' surplus, and the rest of the society's surplus, respectively. The change in the rest of the society's surplus includes all possible (positive and/or negative) externalities that the policy may produce in the economy.

When income distribution is optimal, or the society has at its disposal means for unlimited and costless redistributions, the weights in the social welfare described in expression **(3.15)** can be set equal to one $(\beta_R = \beta_{NR} = \beta_P = \beta_G = 1)$ and, thus, monetary gains and losses can be summed across individuals. However, redistribution is not necessarily costless since, for example, it might affect incentives in a negative way. In this case, the actual income distribution may not be far from the constrained optimal one. This means that the actual situation represents a kind of constrained optimum and possibly we can just sum gains and losses across individuals. This is also sufficient if relative prices are left more or less unchanged.[9]

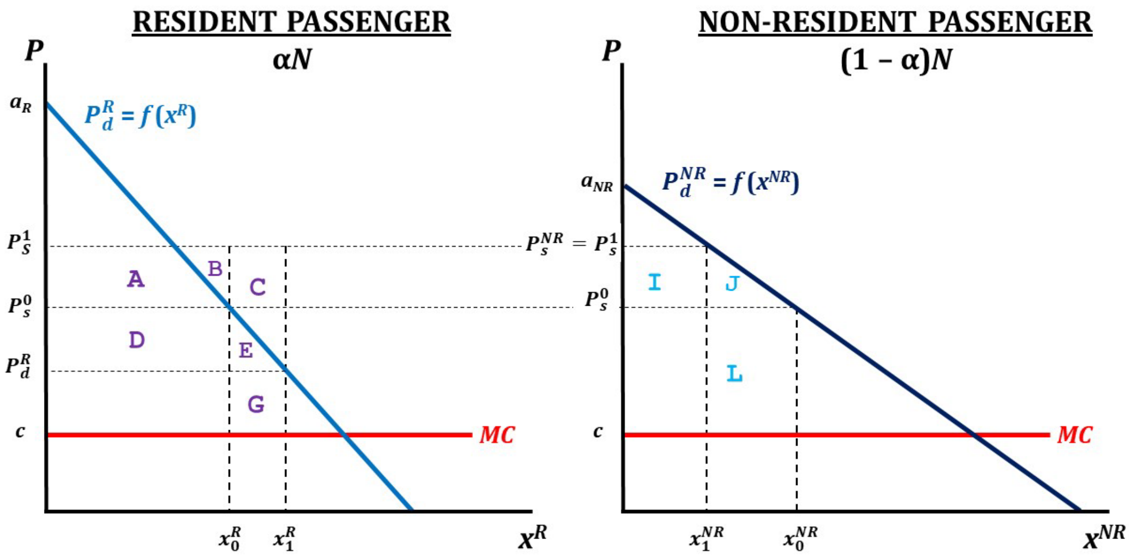
Another possibility is simply to report the unweighted sum of gains and losses and allow the decision maker with the possibility to insert his own weights in the social welfare function. This is the approach we follow in this report. Taking into account that our purpose is to evaluate policies aimed at ensuring an adequate level of air connectivity and mobility of residents, considering the weights in the social welfare function that would support such an objective would reinforce even more our conclusions.

Let us assume in this subsection that the policy only affects consumers' surplus, producers' surplus, and taxpayers' surplus. The change in consumers' surplus, producers' surplus, and taxpayers' surplus due to the policy can be obtained by considering the prices and quantities before and after implementing the policy. In order to exemplify how to do so, let us analyse the situation illustrated in **Figure 3.6**. The optimal ticket price and quantities demanded by residents and non-residents in absence of any public intervention are given by P_S^0, x_0^R and x_0^{NR}, respectively. Suppose now that the government introduces a discount for residents and the ticket price increases till P_S^1. Residents pay the ticket price minus the discount, that is, $P_d^R < P_S^1$, while non-residents pay the whole ticket price, that is, $P_d^{NR} = P_S^1$. The government pays the difference between the ticket price charged by the airline, P_S^1, and

[9] See Johansson and Kriström (2016) for a detailed explanation of the aggregation problems that may arise and the practical approaches.

the price finally paid by residents, P_d^R. How do resident consumers' surplus, non-resident consumers' surplus, producers' surplus and taxpayers' surplus change due to this policy?

Figure 3.6. The change in consumers' surplus, producers' surplus, and taxpayers' surplus due to the policy



The change in resident consumers' surplus, non-resident consumers' surplus, producers' surplus and taxpayers' surplus due to this policy is computed taken into account the areas in **Figure 3.6**, multiplied by the corresponding number of resident and non-resident passengers in the route.

Let us denote by TS the total surplus, which is defined as the sum of consumers' surplus, producers' surplus and taxpayers' surplus. Notice that the change in total surplus coincides with the change in social welfare when all the weights in the social welfare function described in expression **(3.15)** are equal to one, that is, $\beta_R = \beta_{NR} = \beta_P = \beta_G = 1$. The change in all surpluses due to this policy are then given by:

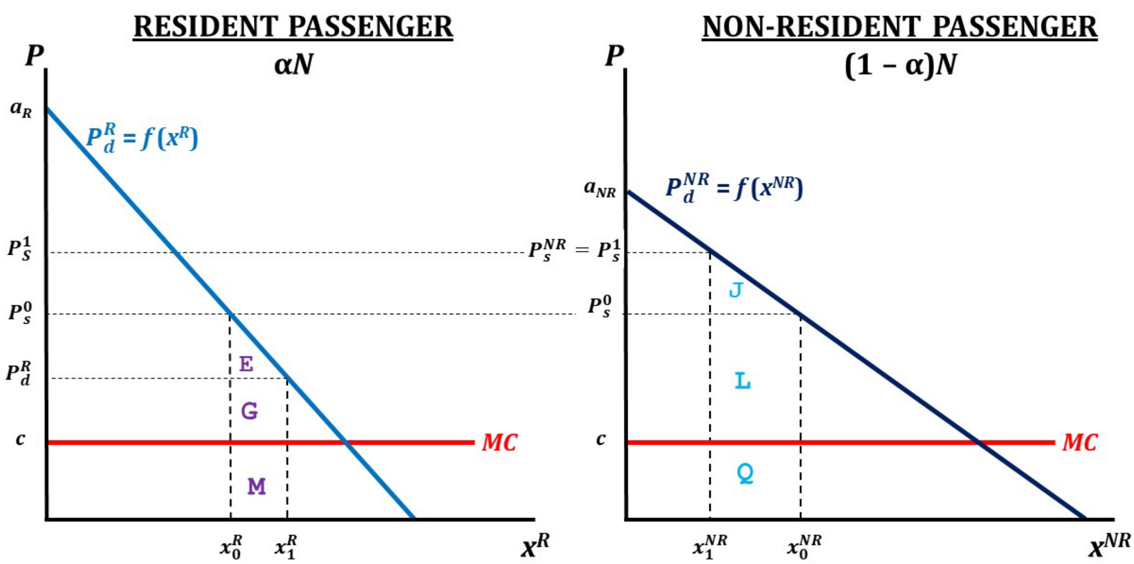
$$\begin{aligned}
&\Delta CS^R = \alpha N(D+E),\\
&\Delta CS^{NR} = -(1-\alpha)N(I+J),\\
&\Delta PS = \alpha N(A+B+C+E+G)+(1-\alpha)N(I-L),\\
&\Delta GS = -\alpha N(A+B+C+D+E),\\
&\Delta TS = \alpha N(E+G)-(1-\alpha)N(J+L).
\end{aligned} \qquad \textbf{(3.16)}$$

The change in the total surplus can be also obtained as the difference between the change in willingness to pay and the change in the use of the resources. This is shown in **Figure 3.7.** The policy implies an increase in the number of trips from x_0^R to x_1^R for a resident passenger, and from x_0^{NR} to x_1^{NR} for a non-resident passenger, which implies an increase in the willingness to pay of **areas E**, **G** and **M** for a resident passenger and **J**, **L** and **Q** for a non-resident passenger. To these areas, we have to subtract the change in the use of resources, which is given by the cost of operating the new trips, that is, the **area M** for a resident passenger and the **area Q** for a non-resident passenger. Finally, we have to multiply the areas by the corresponding number of passengers of each type, αN residents and $(1-\alpha)N$ non-residents:

$$\begin{aligned}\Delta TS &= \alpha N(E+G+M-M)-(1-\alpha)N(J+L+Q-Q)= \\ &= \alpha N(E+G)-(1-\alpha)N(J+L).\end{aligned} \tag{3.17}$$

Although the total surplus given by expressions **(3.16)** and **(3.17)** coincide, in order to evaluate a policy aimed to residents, we have to clearly identify winners and losers and carefully analyse the key parameters that would allow the public policy to induce the desired effects in the market. For these purposes, the approximation given by the sum of surpluses seems more appropriate and, therefore, it is the one that we will use throughout the rest of this document.

Figure 3.7. The change in social surplus as the difference between the change in willingness to pay and the use of resources



3.3. Additional effects that could be taken into account in the cost-benefit analysis

Although in order to evaluate the effects of transfers to residents, we will focus on the analysis of the change that such a policy implies on consumers' surplus, producers' surplus and taxpayers' surplus in the direct market, there might be additional effects in other markets and/or externalities that might be considered in a sound CBA.

First, public funds are usually obtained through distortionary taxation and, thus, the economic cost of public funds should be considered in the CBA. The economic cost of public funds refers to the distortions created in the economy when raising taxes to finance the public policy. There are several papers in the literature estimating the cost of public funds. For instance, Ballard *et al*. (1985) find that the welfare loss due to 1% increase in all distortionary tax rates is between 17% and 56% per dollar. More generally, it seems that the shadow cost of public funds lies in the range of 15% to 50% in countries with a developed efficient tax-collection system (Gagnepain and Ivaldi, 2002).

Second, an increase in the number of passengers and/or flights due to the policy may produce more queues, delays and/or congestion in airports. On the contrary, an increase in the number of flights due to the policy may produce a positive effect: the impact on the so-called "schedule delay". Passengers have a preferred departure time and dislike the "schedule delay", which is the difference between the actual and preferred departure time. An increase in the numbers of flights (frequency) reduces the "schedule delay" and, hence, the consumers' generalized price.

Third, an increase in the number of flights may produce a negative environmental impact in terms of noise and air pollution. The negative environmental impact due to an increase in air traffic may depend on a set of variables such as the type of aircraft used by airlines, the existence of population living near the airport, etc., and thus it should be analysed case by case.

Fourth, the policy may produce gains in productivity, since residents increase their flights to the mainland. However, the policy may also produce losses in productivity or negative agglomeration effects since the policy may also imply a decrease of the number of flights of non-residents to the non-peninsular territories.

Fifth, the policy may have indirect effects in other markets related to tourism. For example, if the policy deviates resident passengers to national destinations that in absence of public subsidies would travel to alternative international destinations, the CBA should consider the positive effects that such deviated passengers produce in the national economy. On the contrary, if the policy deviates non-resident passengers to international destinations that in absence of subsidies for residents would travel to those non-peninsular territories, the CBA should consider the negative effects that such deviated passengers produce in the national economy.

Sixth, the policy may affect airlines' operating costs, either due to the need to attend the increased demand in the short run, or because the policy affects airlines' incentives to be cost efficient. On the one hand, marginal operating costs may be increasing in the short run. Since the policy may imply an increase in the number of flights to be operated by airlines, the airlines may face an increase in their operating costs to attend such an increased demand in the short run (more and more costly aircraft, more and more costly crew, etc.). On the other hand, if due to the policy, airlines lose their incentives to be cost efficient and increase their operating costs, such a negative effect should be also considered in the CBA.

Finally, the policy may have a positive impact on the level of competition. The policy may have a positive effect in incumbents' profits that may attract new entrants to the market. If that is the case, the CBA should consider the new market structure when evaluating the situation with the policy in comparison with the situation without the policy. Moreover, not only intramodal competition should be considered but also intermodal competition. When talking about competition in the route we refer not only to the number of airlines operating the route but also other transport modes that passengers may use to move from region *A* to region *B* (e.g. maritime transport).

4. COMPARISON OF DIFFERENT POLICIES AIMED AT ENSURING AIR CONNECTIVITY OF RESIDENTS IN NON-PENINSULAR TERRITORIES

4.1. *Ad valorem* subsidies only for residents

An *ad valorem* subsidy for resident passengers is a subsidy based on the ticket price paid by passengers living in non-peninsular territories (region *A*). Let us denote by $\sigma \in (0,1)$ the proportion of the ticket price that is subsidized. Since resident passengers are entitled to receive the subsidy, the ticket price finally paid by those passengers is equal to the ticket price charged by the carrier minus the *ad valorem* subsidy, that is, $P_d^R = (1-\sigma)P_S$. On the contrary, the ticket price paid by non-residents is just the ticket price charged by the carrier, that is, $P_d^{NR} = P_S$.

<u>The perfect competition case:</u>

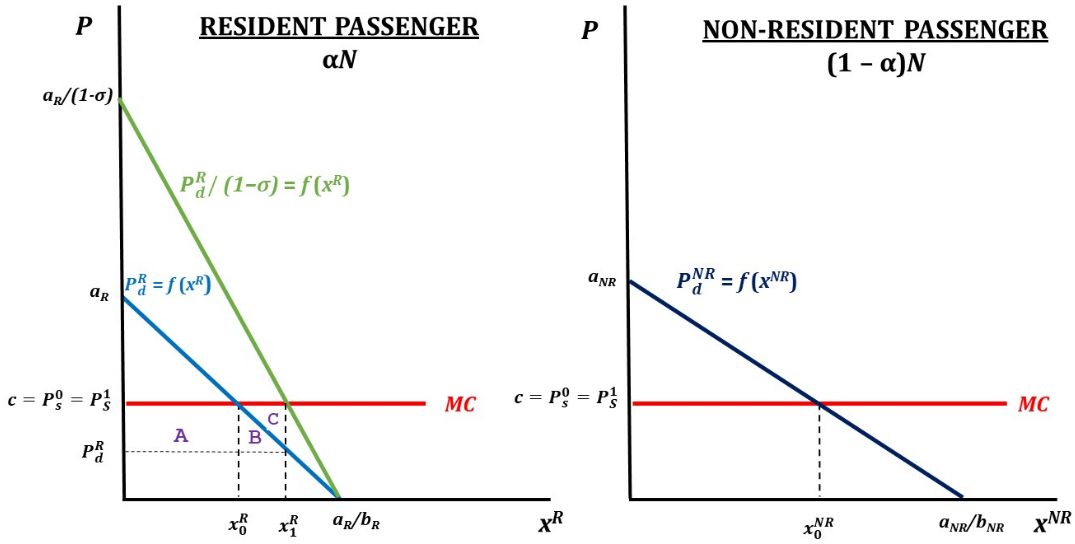
With perfect competition, the ticket price charged by airlines in equilibrium is equal to the marginal operating cost, that is, $P_S^1 = P_S^0 = c$. Thus, the ticket price charged by airlines is exactly the same that before the subsidy. Since residents pay a ticket price equal to the ticket price charged by airlines minus the discount, $P_d^R = (1-\sigma)P_S$, they finally pay a lower price than before the subsidy, $P_d^R = (1-\sigma)c$, and demanding more. On the contrary, non-residents end up paying exactly the same ticket price that before the subsidy, $P_d^{NR} = P_S^1 = P_S^0 = c$, and demanding the same amount:

$$x_1^R = \frac{a_R - c(1-\sigma)}{b_R};\ x_1^{NR} = x_0^{NR} = \frac{a_{NR} - c}{b_{NR}}. \quad \textbf{(4.1)}$$

In perfect competition, the ticket-price charged by airlines is set equal to the marginal operating cost and, thus, producers' surplus is zero. Since the ticket-price charged by airlines is unaltered and non-residents receive no subsidy, the change in non-resident consumers' surplus is zero. The change in resident consumers' surplus, and taxpayers' surplus due to this policy are given by the areas in **Figure 4.1**, multiplied by the corresponding number of resident and non-resident passengers in the route. With perfect competition, the change in total surplus is negative and equal to **area C**, multiplied by the number of residents:

$$\begin{aligned} \Delta CS^R &= \alpha N(A+B), \\ \Delta GS &= -\alpha N(A+B+C), \\ \Delta TS &= -\alpha NC. \end{aligned} \quad \textbf{(4.2)}$$

Figure 4.1. The change in consumers' surplus, producers' surplus, and taxpayers' surplus due to an *ad valorem* subsidy for residents: the perfect competition case



The subsidy for residents implies an efficiency loss equal to αNC representing that for the new trips, $\alpha N(x_1^R - x_0^R)$, residents are willing to pay less than the cost of operating those additional trips.

It is worth highlighting that, though **areas** **A** and **B** are transfers from taxpayers to each resident passenger and, thus, they are cancelled in the computation of the change in total surplus, they might be multiplied by different weights in the social welfare function. This means that from the social point of view **areas** **A** and **B** might not be treated as mere transfers, and if $\beta_R > \beta_G$ the change in social welfare might be positive, even though the change in total surplus is undoubtedly negative.

<u>The monopoly case:</u>

When the route is operated by a monopolist and an *ad valorem* subsidy only for residents is introduced, the airline solves the following maximization program:

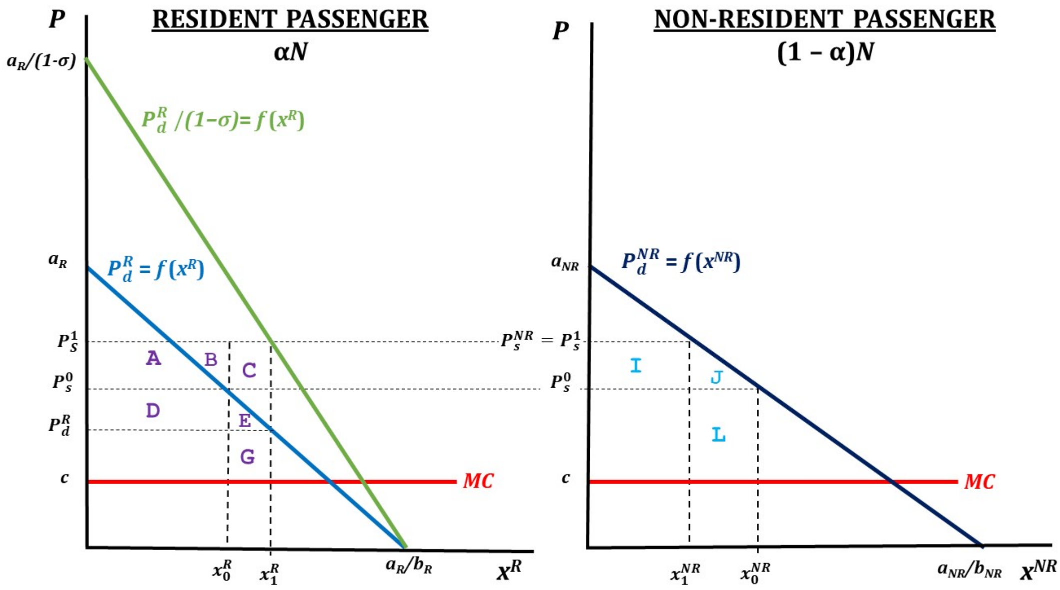
$$\underset{P_S}{Max}\ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S - c)x^{NR}, \qquad \textbf{(4.3)}$$

where x^R and x^{NR} represents, given the price that they finally pay, the quantity demanded by residents and non-residents, respectively. Thus: $x^R = \frac{a_R - (1-\sigma)P_S}{b_R}$ and $x^{NR} = \frac{a_{NR} - P_S}{b_{NR}}$.

The first-order condition of the above maximization program yields the optimal ticket price charged by the airline, P_S^1. By substituting such an optimal ticket price P_S^1 in the corresponding demand functions, we can obtain optimal quantities demanded by residents, x_1^R, and by non-residents, x_1^{NR} (see all mathematical expressions in **Annex A**).

Figure 4.2 summarizes the effects of an *ad valorem* subsidy for residents for the monopoly case. An *ad valorem* subsidy affects the slope of the residents' demand function. This fact is taken into account by the monopolist that faces the trade-off between increasing the ticket price to appropriate as much as possible of the residents' subsidy while losing non-residents demand, or maintaining the ticket price close to the case in which there is no public intervention. The degree in which the ticket price charged by the airline is increased, $P_S^1 - P_S^0$, will strongly depend on the proportion of resident passengers in the route, α, the amount of the *ad valorem* subsidy, σ, the maximum willingness to pay of residents and non-residents, a_R and a_{NR}, and the slope of residents' and non-residents' inverse demand functions, b_R and b_{NR} (mathematical expressions can be found in **Annex A**). The higher the maximum willingness to pay of non-residents a_{NR} is, the higher the difference between $P_S^1 - P_S^0$ is. Similarly, the higher the proportion of resident passengers in the route α is, the higher the difference between $P_S^1 - P_S^0$ is. Thus, the size and the proportion of non-residents in the route are elements that undoubtedly mitigate the non-desirable effects in the market of the *ad valorem* subsidy for residents.

Figure 4.2. The change in consumers' surplus, producers' surplus, and taxpayers' surplus due to an *ad valorem* subsidy for residents: the monopoly case



The change in resident consumers' surplus, non-resident consumers' surplus, producers' surplus and taxpayers' surplus due to this policy are given by the areas in **Figure 4.2**, multiplied by the corresponding number of resident and non-resident passengers in the route:

$$\begin{aligned}
&\Delta CS^R = \alpha N(D+E),\\
&\Delta CS^{NR} = -(1-\alpha)N(I+J),\\
&\Delta PS = \alpha N(A+B+C+E+G)+(1-\alpha)N(I-L),\\
&\Delta GS = -\alpha N(A+B+C+D+E),\\
&\Delta TS = \alpha N(E+G)-(1-\alpha)N(J+L).
\end{aligned} \tag{4.4}$$

The change in total surplus reflects the efficiency of the *ad valorem* subsidy only for residents, meaning that the policy is efficient if the increase in the willingness to pay minus the resources used for the increase in the number of trips of residents compensates the decrease in the willingness to pay plus the saving in resources caused by the decrease in the number of trips of non-residents.

Again, it is worth highlighting that, though **areas *A, B, C, D, E***, and ***I*** are transfers from one agent to the other and, thus, they are cancelled in the computation of the change in total surplus, they might be multiplied by different weights in the social welfare function. This means that the value and sign of the change in social welfare might be different than the value and sign of the change in total surplus.

4.2. Specific subsidies only for residents

A specific subsidy only for residents consists of granting a fixed amount s to all passengers living in non-peninsular region A, independently on the ticket price. Obviously, this fixed amount should be lower than the maximum ticket price and, hence, we assume that $0 < s < a_R$. Since resident passengers are entitled to receive the subsidy, the ticket price finally paid by those passengers is equal to the ticket price charged by the carrier minus the specific subsidy, that is, $P_d^R = P_S - s$.

<u>The perfect competition case:</u>

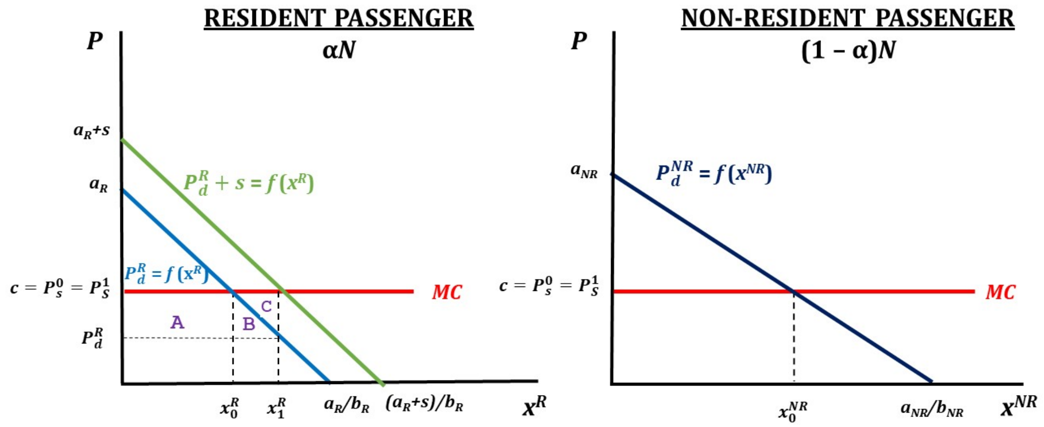
With perfect competition, the ticket price charged by airlines in equilibrium is equal to the marginal operating cost, that is, $P_S^1 = P_S^0 = c$. Thus, the ticket price charged by airlines is exactly the same that before the subsidy. Since residents pay a ticket price equal to the ticket price charged by airlines minus the discount, $P_d^R = P_S - s$, they end paying a lower price than before the subsidy, $P_d^R = c - s$, and demanding more. On the contrary, non-residents end up paying exactly the same ticket price that before the subsidy and demanding the same amount:

$$x_1^R = \frac{a_R - c + s}{b_R}; \; x_1^{NR} = x_0^{NR} = \frac{a_{NR} - c}{b_{NR}}. \qquad \textbf{(4.5)}$$

With perfect competition, the ticket-price charged by airlines is set equal to the marginal operating cost and, thus, producers' surplus is zero. Since the ticket-price charged by airlines is unaltered and non-residents receive no subsidy, the change in non-resident consumers' surplus is zero. The change in resident consumers' surplus and taxpayers' surplus due to this policy are given by the areas in **Figure 4.3**, multiplied by the corresponding number of resident and non-resident passengers in the route:

$$\begin{aligned} \Delta CS^R &= \alpha N(A+B), \\ \Delta GS &= -\alpha N(A+B+C), \\ \Delta TS &= -\alpha NC. \end{aligned} \qquad \textbf{(4.6)}$$

Figure 4.3. The change in consumers' surplus, producers' surplus, and taxpayers' surplus due to a specific subsidy for residents: the perfect competition case



The subsidy for residents implies a efficiency loss equal to αNC representing that for the new trips, $\alpha N(x_1^R - x_0^R)$, residents are willing to pay less than the cost of operating those additional trips.

Similar to the *ad valorem* case, though **areas A** and **B** are transfers from taxpayers to each resident passenger and, thus, they are cancelled in the computation of the change in total surplus, they might be multiplied by different weights in the social welfare function. This means that from the social point of view **areas A** and **B** might not be treated as mere transfers.

The monopoly case:

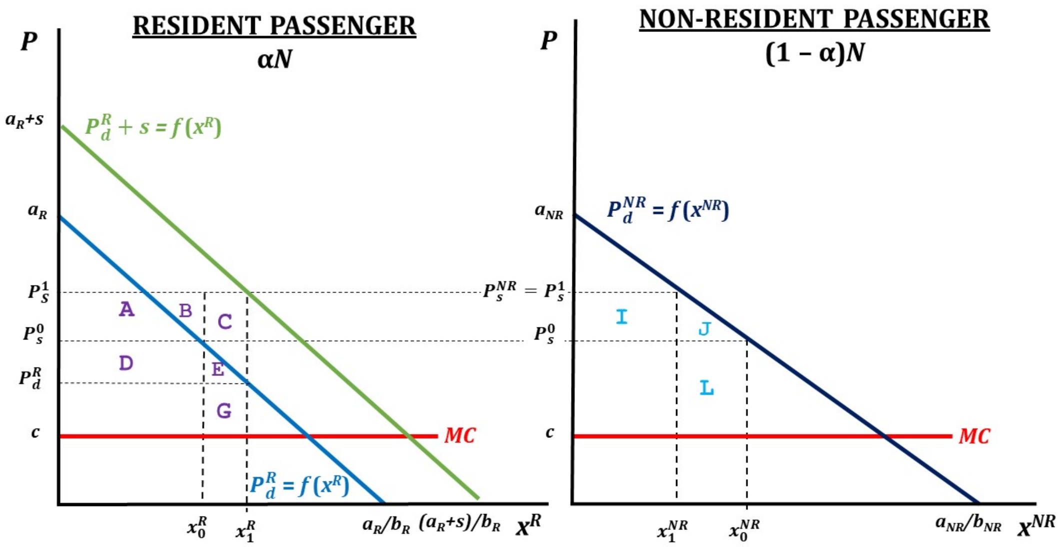
When the route is operated by a monopolist and a specific subsidy only for residents is introduced, the airline solves the following maximization program:

$$\underset{P_S}{Max}\ \ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S - c)x^{NR}, \qquad \textbf{(4.7)}$$

where x^R and x^{NR} represents, given the price that they finally pay, the quantity demanded by residents and non-residents, respectively. Thus: $x^R = \dfrac{a_R - P_S + s}{b_R}$ and $x^{NR} = \dfrac{a_{NR} - P_S}{b_{NR}}$.

The first-order condition of the above maximization program yields the optimal ticket price charged by the airline, P_S^1. By substituting such an optimal ticket price P_S^1 in the corresponding demand functions, we can obtain optimal quantities demanded by residents, x_1^R, and by non-residents, x_1^{NR} (see all mathematical expressions in **Annex A**).

Figure 4.4. The change in consumers' surplus, producers' surplus, and taxpayers' surplus due to a specific subsidy for residents: the monopoly case



The change in resident consumers' surplus, non-resident consumers' surplus, producers' surplus and taxpayers' surplus due to this policy the areas in **Figure 4.4**, multiplied by the corresponding number of resident and non-resident passengers in the route:

$$\begin{aligned}
&\Delta CS^R = \alpha N(D+E), \\
&\Delta CS^{NR} = -(1-\alpha)N(I+J), \\
&\Delta PS = \alpha N(A+B+C+E+G)+(1-\alpha)N(I-L), \\
&\Delta GS = -\alpha N(A+B+C+D+E), \\
&\Delta TS = \alpha N(E+G)-(1-\alpha)N(J+L).
\end{aligned} \qquad \textbf{(4.8)}$$

The interpretation of these results is similar to the one of the *ad valorem* subsidy only for residents.

4.3. *Ad valorem* versus specific subsidies only for residents

4.3.1. The effects on prices and all agents' surpluses

<u>The perfect competition case:</u>

With perfect competition, the price charged by airlines is equal to the marginal operating cost both with the *ad valorem* and specific subsidy granted only for residents. Since the price charged by airlines is unaltered, the quantity demanded by non-residents is the same that before the subsidy, no matter if the subsidy takes an *ad valorem* or a specific form:

$$x_1^{NR} = x_0^{NR} = \frac{a_{NR} - c}{b_{NR}}. \tag{4.9}$$

However, with an *ad valorem* subsidy residents pay a price equal to $c(1-\sigma)$ while with a specific subsidy the price becomes $c - s$. Therefore, by setting a specific subsidy equal to $s = c\sigma$ the price finally paid by residents is exactly the same that the one paid by residents and an *ad valorem* subsidy, where the quantity demanded by a representative resident passenger with any of these subsidies is given by:

$$x_1^{R} = \frac{a_R - c + c\sigma}{b_R}. \tag{4.10}$$

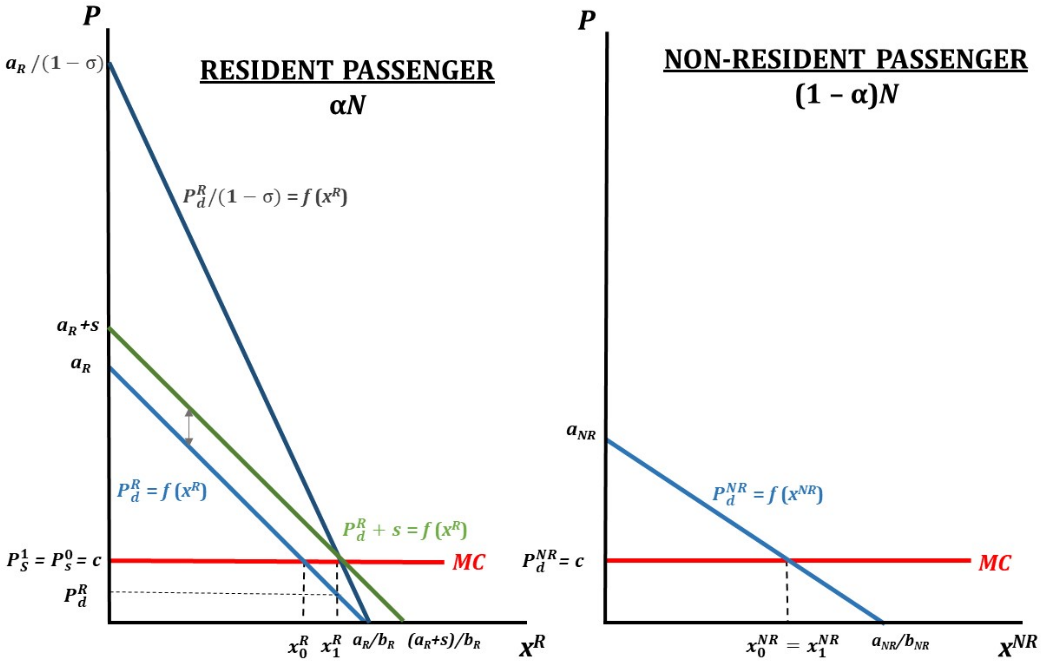
With such a specific subsidy, resident consumers' surplus, non-resident consumers' surplus, producers' surplus and the government's expenditure are identical than the corresponding surpluses obtained with an *ad valorem* subsidy, which are given by:

$$\begin{aligned}
&CS^R = \frac{1}{2}\alpha N(a_R - c + c\sigma))x_1^R, \\
&CS^{NR} = \frac{1}{2}(1-\alpha)N(a_{NR} - c)x_1^{NR}, \\
&PS = 0 \\
&GS = -\alpha N c\sigma x_1^R,
\end{aligned} \tag{4.11}$$

where x_1^R and x_1^{NR} are given by expressions **(4.10)** and **(4.9)**, respectively.

Figure 4.5 represents the specific subsidy granted only for residents that yields exactly the same results that the corresponding *ad valorem* one when the market is under perfect competition: $s = c\sigma$.

Figure 4.5: Comparison of ad valorem and specific subsidy for residents: The perfect competition case



The monopoly case:

Let us denote by $(P_S^1)^{AV}$ the ticket price charged by the airline when an *ad valorem* subsidy only for residents is introduced, that is, the price that solves the maximization program given by expression **(4.3)**. Let $(P_S^1)^s$ represent the ticket price charged by the airline when a specific subsidy only for residents is introduced, that is, the price that solves the maximization program given by expression **(4.7)** (all mathematical expressions are in **Annex A**).

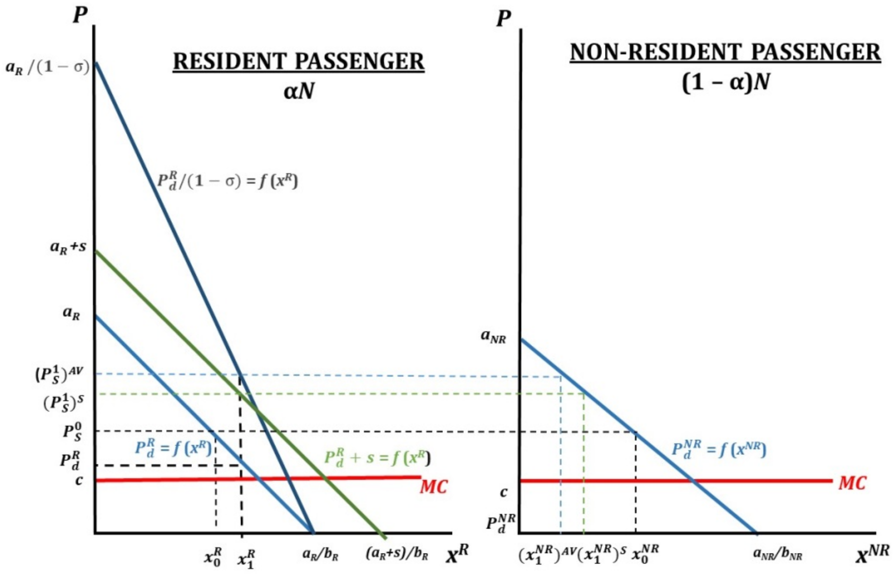
Then, the specific subsidy s^* that allows resident passengers to pay exactly the same price that they would pay with an *ad valorem* subsidy of value σ is given by solving (see the mathematical expression in **Annex A**):

$$(P_d^R)^{AV} = (P_S^1)^{AV}(1-\sigma) = (P_S^1)^s - s^* = (P_d^R)^s = P_d^R. \qquad \textbf{(4.12)}$$

As shown in **Figure 4.6**, for such a specific subsidy s^* the ticket price charged by the airline with an *ad valorem* subsidy is higher than the ticket price charged with the specific subsidy, $(P_S^1)^{AV} > (P_S^1)^s$. Since non-residents are not entitled to receive the subsidy and $(P_S^1)^{AV} > (P_S^1)^s$, the quantity demanded by non-residents is higher with the specific subsidy: $(x_1^{NR})^s > (x_1^{NR})^{AV}$

As a consequence, with a specific subsidy s^* residents are equal, non-residents are better off, and airline's profits and the government's expenditure are lower than with the *ad valorem* subsidy.

Figure 4.6: Comparison of *ad valorem* and specific subsidy for residents: The monopoly case



4.3.2. Some numerical illustrations

As shown in previous sections, under perfect competition, by setting a specific subsidy equal to $s = c\sigma$ the government obtains exactly the same results that with an *ad valorem* subsidy equal to σ. However, this is not the case if airlines have market power. Therefore, in this subsection we will focus on the monopoly case and compare the results obtained, under different scenarios, with the *ad valorem* subsidy and the equivalent specific subsidy that yields the same price to be paid for residents than the former.

<u>Numerical example 1: The monopoly case</u>

Let us consider the following values for the parameters of the economic model developed in **Section 3**:

$$a_R = 100;\ b_R = 1;\ a_{NR} = 165;\ b_{NR} = 0.8;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.1;\ N = 10{,}000.$$

In this first example, we are considering the case in which non-residents have a demand function with similar price-elasticity than residents, but non-resident's maximum willingness to pay is higher. Moreover, the proportion of resident passengers in the route is very low and equal to 10%. Thus, the non-residents' market is very important for the airline. In this context, how does a subsidy only for residents affect the ticket price, the total number of trips, and the surplus of all agents in the economy?

Table 4.1 represents the equilibrium prices, total number of trips and all economic agents' surpluses in absence of public intervention, when the subsidy (either *ad valorem* or specific) is granted to all passengers independently of their place of residence, and when the subsidy (either *ad valorem* or specific) is given only to residents. The equivalent subsidy is computed in order to imply either the same price paid by residents that the *ad valorem* one (specific subsidy (1)), or alternatively the same public expenditure that the ad valorem one (specific subsidy (2)).

When the subsidy is granted to all passengers on the route, the gap between the price charged by the airline with an *ad valorem* subsidy and the price charged by the airline with the equivalent specific subsidy - that is, the specific subsidy that implies the same price paid by residents and non-residents (or alternatively the same public expenditure) - is very large: 324.39 euros versus 88.6 euros (or alternatively, 152.12 euros). The reason is that, as explained in **Subsection 3.1.2**, the *ad valorem* subsidy is equivalent to the combined use of a specific subsidy of value $s = c\sigma = 7.5$ plus a profit subsidy. Hence, a specific subsidy $s = 7.5$ leads to the same price for residents P_d^R as the *ad valorem* one, but the *ad valorem* subsidy increases the monopolist's market power and, thus, implies that the airline charges a higher price P_S, resulting in higher profits for the airline (302.70 million euros versus 75.68 million euros), and higher government's expenditure (234.24 million euros versus 7.22 million euros). Notice that, even though the total surplus is identical for the *ad valorem* and the specific subsidy (1), the social welfare associated with the *ad valorem* subsidy to all passengers may be completely different than the social welfare associated with the specific subsidy (1), since from the social point of view €1 in the airline's hands has not the same weight in the social welfare function that €1 in taxpayers' hands. Moreover, notice that for the sake of simplicity we are not considering any economic cost of public funds. However, public funds are usually obtained through distortionary taxation and, thus, each €1 of public expenditure costs €$1+\lambda$ to the society. If we consider the economic cost of public funds, the social welfare associated with the *ad valorem* subsidy to all passengers (with 234.24 million euros of public expenditure) may be completely different than the social welfare associated with the specific subsidy (1) (with only 7.22 million euros of public expenditure).

Alternatively, if we compare the *ad valorem* subsidy with the specific subsidy that implies the same public expenditure- specific subsidy (2) - the *ad valorem* subsidy increases the monopolist's market power and, thus, implies that the airline charges a higher price P_S, resulting in higher prices paid for residents and non-residents (81.10

euros versus 17.57 euros), and higher profits for the airline (302.70 million euros versus 247.43 million euros).

Contrary to what happens in the case in which subsidies are granted to all passengers on the route, when the subsidy is granted only to residents, the difference between the price charged by the airline without subsidies and the price charged with subsidies is small. Moreover, the gap between the price charged by the airline with an *ad valorem* subsidy and the price charged with the equivalent specific subsidy- that is, the specific subsidy that implies the same price paid by residents (or alternatively the specific subsidy that implies the same public expenditure) is very small: 90.05 euros versus 87.5 euros (or alternatively, 87.56 euros). The reason is that the monopolist faces the trade-off between increasing the ticket price to capture as much as possible of residents' subsidy while losing non-residents' demand and maintaining the ticket price as before the subsidy. Since, in this first example non-residents market is very important for the airline (high willingness to pay of non-residents compared with residents', and low proportion of residents in the route), the increase in the ticket price charged by the airline is small both with an *ad valorem* or a specific subsidy for residents. With the specific subsidy (1) (or alternatively, with specific subsidy (2)), non-residents and taxpayers are better-off (or alternatively, residents and non-residents are better-off), while airlines' profits are lower, leading to higher total surplus than the *ad valorem* one though, as mentioned above, these differences are relatively small due to the importance of non-residents' market for the airline. The total number of trips demanded by non-residents is also higher with the specific subsidy for residents. Finally, the social welfare associated with the specific subsidy for residents is also expected to be higher since the weight assigned to non-residents' surplus and taxpayers' surplus are likely to be higher than the weight assigned to airline's profits in the corresponding social welfare function.

Table 4.1. ***Ad valorem*** **versus specific subsidies: numerical example 1**

$$a_R = 100;\ b_R = 1;\ a_{NR} = 165;\ b_{NR} = 0.8;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.1;\ N = 10,000$$

	No public intervention	Subsidy for ALL			Subsidy only for residents		
		Ad valorem	Specific (1) $s = 7.5$	Specific (2) $s = 134.55$	*Ad valorem*	Specific (1) $s = 64.99$	Specific (2) $s = 66.39$
Ticket price charged by the airline (in euros): P_S	84.85	324.39	88.60	152.12	90.05	87.50	87.56
Ticket price paid by each resident passenger (in euros): P_d^R	84.85	81.10	81.10	17.57	22.51	22.51	21.17
Ticket price paid by each non-resident passenger (in euros): P_d^{NR}	84.85	81.10	81.10	17.57	90.05	87.50	87.56
Total number of trips demanded by residents: $\alpha N x^R$	15,000	19,000	19,000	82,000	77,000	77,000	79,000
Total number of trips demanded by non-residents: $(1-\alpha)N x^{NR}$	900,000	945,000	945,000	1,656,000	846,000	873,000	873,000
Total number of trips in the route: $\alpha N x^R + (1-\alpha)N x^{NR}$	915,000	964,000	964,000	1,738,000	923,000	950,000	952,000
Consumers surplus for residents (in million euros): CS^R	0.11	0.17	0.17	3.40	3.00	3.00	3.12
Consumers surplus for non-residents (in million euros): CS^{NR}	36.14	39.60	39.60	122.26	31.59	33.79	33.73
Airline's profits (in million euros): PS	68.62	302.70	75.68	247.43	73.70	73.57	73.68
Taxpayers' surplus (in million euros): GS	0	-234.24	-7.22	-234.24	-5.23	-5.03	-5.23
Total surplus (in million euros): TS	104.87	108.23	108.23	138.85	103.06	105.33	105.30

Specific (1): The specific subsidy that yields the same price for residents, P_d^R, that the *ad valorem* one.

Specific (2): The specific subsidy that yields the same government's expenditure, *GS*, that the *ad valorem* one.

Numerical example 2: Monopoly case

Consider now the following values for the parameters:

$$a_R = 100;\ b_R = 1;\ a_{NR} = 165;\ b_{NR} = 0.8;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.5;\ N = 10,000\,.$$

In this second example we are considering exactly the same values that in *Numerical example 1* except for the proportion of resident passengers in the route, that now is 50%. How does this increase in the proportion of resident passengers affect the monopoly incentives to increase the ticket price when a subsidy only for residents is introduced?

Table 4.2 represents the equilibrium prices, total number of trips and all economic agents' surpluses in absence of public intervention, when the subsidy (either *ad valorem* or specific) is granted to all passengers independently of their place of residence, and when the subsidy (either *ad valorem* or specific) is given only to residents. The equivalent subsidy is computed in order to imply the same price paid by residents that the *ad valorem* one (specific subsidy (1)), or alternatively to imply the same public expenditure that the *ad valorem* one (specific subsidy (2)).

Again, when the subsidy is granted to all passengers on the route, the distance between the price charged by the airline with an *ad valorem* subsidy and the price charged with the equivalent specific subsidy is very large: 277.22 euros versus 76.80 euros (or alternatively, 130.63 euros). The reason is that the *ad valorem* subsidy increases the monopolist's market power and, thus, implies that the airline charges a higher price P_S than with specific subsidy (1), resulting in higher profits for the airline (200.83 million euros versus 50.21 million euros), and higher government's expenditure (156.26 million euros versus 5.64 million euros). Alternatively, if we compare the *ad valorem* subsidy with specific subsidy (2) - the *ad valorem* subsidy implies that the airline charges a higher price P_S, resulting in higher prices paid for residents and non-residents and higher profits for the airline.

Is the increase in the monopolist's market power due the *ad valorem* subsidy attenuated when the subsidy is granted only to residents? When the subsidy is granted only to residents, the distance between the price charged by the airline without subsidies and the price charged with subsidies is higher than in *Numerical example 1*. Moreover, the distance between the price charged by the airline with an *ad valorem* subsidy and the price charged with the equivalent specific subsidy is now significant: 107.08 euros versus 86.28 euros (or alternatively, 88.91 euros). The same result applies to the comparison of non-residents' surplus, airline's profits, and the government's expenditure (or alternatively, residents' surplus if we are considering specific subsidy (2)). Now the distance between the results obtained with an *ad* *valorem* subsidy and the results obtained with a specific subsidy are higher than in the *Numerical example 1*, with the latter producing higher total surplus. The reason for these results is that now the non-residents market is not so important for the airline, since the proportion of resident passengers is higher than in *Numerical example 1*. Thus, the airline is now more willing to increase the ticket price to capture part of residents' subsidy despite this increase implies losing part of non-residents' demand. Since the *ad valorem* subsidy increases the monopolist's market power, the negative impact on the ticket price charged by the airline is higher with the *ad valorem* subsidy for residents that with the specific one.

Table 4.2. Ad valorem versus specific subsidies: numerical example 2

$a_R = 100;\ b_R = 1;\ a_{NR} = 165;\ b_{NR} = 0.8;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.5;\ N = 10,000$

	No public intervention	Subsidy for ALL			Subsidy only for residents		
		Ad valorem	**Specific (1)** $s = 7.5$	**Specific (2)** $s = 115.15$	***Ad valorem***	**Specific (1)** $s = 59.51$	**Specific (2)** $s = 71.34$
Ticket price charged by the airline (in euros): P_S	73.06	277.22	76.80	130.63	107.08	86.28	88.91
Ticket price paid by each resident passenger (in euros): P_d^R	73.06	69.30	69.30	15.48	26.77	26.77	17.56
Ticket price paid by each non-resident passenger (in euros): P_d^{NR}	73.06	69.30	69.30	15.48	107.08	86.28	88.91
Total number of trips demanded by residents: $\alpha N x^R$	135,000	155,000	155,000	422,500	365,000	365,000	412,500
Total number of trips demanded by non-residents: $(1-\alpha)Nx^{NR}$	575,000	600,000	600,000	935,000	360,000	490,000	475,000
Total number of trips in the route: $\alpha N x^R + (1-\alpha)Nx^{NR}$	710,000	755,000	755,000	1,357,500	725,000	855,000	887,500
Consumers surplus for residents (in million euros): CS^R	1.81	2.35	2.35	17.86	13.40	13.40	16.98
Consumers surplus for non-residents (in million euros): CS^{NR}	26.42	28.62	28.62	69.86	10.48	19.36	18.09
Airline's profits (in million euros): PS	44.73	200.83	50.21	163.71	70.69	65.46	70.05
Taxpayers' surplus (in million euros): GS	0	-156.26	-5.64	-156.26	-29.41	-21.79	-29.41
Total surplus (in million euros): TS	72.96	75.54	75.54	95.17	65.16	76.43	75.71

Specific (1): The specific subsidy that yields the same price for residents, P_d^R, that the *ad valorem* one.

Specific (2): The specific subsidy that yields the same government's expenditure, GS, that the *ad valorem* one.

Numerical example 3: Monopoly case

Consider now the following values for the parameters:

$$a_R = 100;\ b_R = 1;\ a_{NR} = 165;\ b_{NR} = 0.8;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.9;\ N = 10{,}000.$$

In this third example we are considering exactly the same values that in *Numerical example 1* and *Numerical example 2* except for the proportion of resident passengers in the route, that now is 90%. This implies that the non-residents market is insignificant for the airline, compared with the residents' market. How does this increase in the proportion of resident passengers affect the monopoly incentives to increase the ticket price when a subsidy only for residents is introduced?

Table 4.3 represents the equilibrium prices, total number of trips and all economic agents' surpluses in absence of public intervention, when the subsidy (either *ad valorem* or specific) is granted to all passengers independently of their place of residence, and when the subsidy (either *ad valorem* or specific) is given only to residents. The equivalent subsidy is computed in order to imply the same price paid by residents that the *ad valorem* one (specific subsidy (1)), or alternatively to imply the same public expenditure that the *ad valorem* one (specific subsidy (2)).

Again, when the subsidy is granted to all passengers on the route, the distance between the price charged by the airline with an *ad valorem* subsidy and the price charged with the equivalent specific subsidy is very large: 220.85 euros versus 62.71 euros (or alternatively, 104.94 euros). As already explained, the reason is that the *ad valorem* subsidy increases the monopolist's market power and, thus, implies that the airline charges a higher price P_S, resulting in higher profits for the airline, and higher government's expenditure (or alternatively, the same public expenditure but higher residents' surplus).

When the subsidy is granted only to residents, the distance between the price charged by the airline with an *ad valorem* subsidy and the price charged by the airline with the equivalent specific subsidy is still very large: 163.04 euros versus 73.21 euros (or alternatively, 95.31 euros). The same result applies to the comparison of non-residents' surplus, airline's profits and the government's expenditure. Now the distance between the results obtained with an *ad valorem* subsidy and the results obtained with the specific subsidy (either specific subsidy (1) or specific subsidy (2)) are higher than in the *Numerical example 1* and *Numerical example 2*, with the latter producing higher total surplus and much higher social welfare, since from the social point of view €1 in the airline's hands has not the same weight in the social welfare function that €1 in taxpayers' hands (or alternatively, in residents' hands) and public funds may be obtained through distortionary taxation.

In this case, the fact of granting the subsidy only to residents does not attenuate the increase in the monopolist's market power produced by the *ad valorem* subsidy and the negative effects of the subsidy are much larger with the *ad valorem* subsidy for residents than with the equivalent specific one.

Table 4.3. ***Ad valorem*** **versus specific subsidies: numerical example 3**

$$a_R = 100;\ b_R = 1;\ a_{NR} = 165;\ b_{NR} = 0.8;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.9;\ N = 10,000$$

	No public intervention	Subsidy for ALL			Subsidy only for residents		
		Ad valorem	**Specific (1)** $s = 7.5$	**Specific (2)** $s = 91.96$	***Ad valorem***	**Specific (1)** $s = 32.45$	**Specific (2)** $s = 82.8$
Ticket price charged by the airline (in euros): P_S	58.96	220.85	62.71	104.94	163.04	73.21	95.31
Ticket price paid by each resident passenger (in euros): P_d^R	58.96	55.21	55.21	12.98	40.76	40.76	12.51
Ticket price paid by each non-resident passenger (in euros): P_d^{NR}	58.96	55.21	55.21	12.98	163.04	73.21	95.31
Total number of trips demanded by residents: $\alpha N x^R$	369,000	405,000	405,000	783,000	531,000	531,000	787,500
Total number of trips demanded by non-residents: $(1-\alpha)Nx^{NR}$	132,000	137,000	137,000	190,000	2,000	115,000	87,000
Total number of trips in the route: $\alpha N x^R + (1-\alpha)Nx^{NR}$	501,000	542,000	542,000	973,000	533,000	646,000	874,500
Consumers surplus for residents (in million euros): CS^R	7.58	9.03	9.03	34,07	15.79	15.79	34.44
Consumers surplus for non-residents (in million euros): CS^{NR}	7.03	7.53	7.53	14.44	0.002	5.26	3.03
Airline's profits (in million euros): PS	24.57	113.93	28.48	92.40	81.97	40.95	74.61
Taxpayers' surplus (in million euros): GS	0	-89.50	-4.05	-89.50	-65.19	-17.30	-65.19
Total surplus (in million euros): TS	39.18	40.99	40.99	51.41	32.57	44.70	46.89

Specific (1): The specific subsidy that yields the same price for residents, P_d^R, that the *ad valorem* one.

Specific (2): The specific subsidy that yields the same government's expenditure, GS, that the *ad valorem* one.

Numerical example 4: Monopoly case

Consider the following values for the parameters:

$$a_R = 100;\ b_R = 1;\ a_{NR} = 50;\ b_{NR} = 0.2;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.5;\ N = 10{,}000.$$

In this last example we are considering the case in which non-residents have a very price-elastic demand function and their willingness to pay is low in comparison with residents'. The proportion of resident passengers is 50% as in *Numerical example 2.*

Table 4.4 represents the equilibrium prices, total number of trips and all economic agents' surpluses in absence of public intervention, when the subsidy (either *ad valorem* or specific) is granted to all passengers independently of their place of residence, and when the subsidy (either *ad valorem* or specific) is given only to residents. The equivalent subsidy is computed in order to imply either the same price paid by residents that the *ad valorem* one (specific subsidy (1)), or alternatively the same public expenditure that the *ad valorem* one (specific subsidy (2)).

Again, when the subsidy is granted to all passengers on the route, the distance between the price charged by the airline with an *ad valorem* subsidy and the price charged with the equivalent specific subsidy is very large: 121.67 euros versus 37.92 euros (or alternatively, 59.76 euros).

Is the increase in the monopolist's market power due the *ad valorem* subsidy attenuated when the subsidy is granted only to residents? When the subsidy is granted only to residents, the distance between the price charged by the airline without subsidies and the price charged with subsidies is lower than in *Numerical example 2*. Moreover, the distance between the price charged by the airline with an *ad valorem* subsidy and the price charged with the equivalent specific subsidy is very low: 38.33 euros versus 36.4 euros (or alternatively, 36.53 euros). The same result applies to the comparison of non-residents' surplus, airline's profits and the government's expenditure (or alternatively, residents' surplus). Now the distance between the results obtained with an *ad valorem* subsidy and the results obtained with the equivalent specific subsidy are lower than in the *Numerical example 2.* The reason is that the monopolist faces the trade-off between increasing the ticket price to capture as much as possible of residents' subsidy while losing non-residents' demand, and maintaining the ticket price as before the subsidy. Since, in this example non-residents demand is very price-elastic, the increase of the ticket price charged by the airline is small both with an *ad valorem* or the equivalent specific subsidy for residents. Still, non-residents and taxpayers (or alternatively, residents) are better-off and airlines' profits are lower with the specific subsidy, leading to higher total surplus. Therefore, besides the proportion of resident passengers on the route, non-residents' maximum willingness to pay or their demand price-elasticity are variables that may mitigate the monopolist's market power and, thus, the differences between the *ad valorem* subsidy for residents and the equivalent specific one.

Table 4.4. ***Ad valorem*** **versus specific subsidies: numerical example 4**

$$a_R = 100;\ b_R = 1;\ a_{NR} = 50;\ b_{NR} = 0.2;\ c = 10;\ \sigma = 0.75;\ \alpha = 0.5;\ N = 10{,}000$$

	No public intervention	**Subsidy for ALL**			**Subsidy only for residents**		
		Ad valorem	**Specific (1)** $s = 7.5$	**Specific (2)** $s = 51.19$	***Ad valorem***	**Specific (1)** $s = 26.8$	**Specific (2)** $s = 28.32$
Ticket price charged by the airline (in euros): P_S	34.17	121.67	37.92	59.76	38.33	36.40	36.53
Ticket price paid by each resident passenger (in euros): P_d^R	34.17	30.42	30.42	8.57	9.58	9.58	8.21
Ticket price paid by each non-resident passenger (in euros): P_d^{NR}	34.17	30.42	30.42	8.57	38.33	36.40	36.53
Total number of trips demanded by residents: $\alpha N x^R$	330,000	350,000	350,000	457,500	450,000	450,000	460,000
Total number of trips demanded by non-residents: $(1-\alpha)Nx^{NR}$	395,000	490,000	490,000	1,035,000	290,000	340,000	335,000
Total number of trips in the route: $\alpha N x^R + (1-\alpha)Nx^{NR}$	725,000	840,000	840,000	1,492,500	740,000	790,000	795,000
Consumers surplus for residents (in million euros): CS^R	10.83	12.10	12.10	20.90	20.44	20.44	21.06
Consumers surplus for non-residents (in million euros): CS^{NR}	3.13	4.79	4.79	21.45	1.70	2.31	2.27
Airline's profits (in million euros): PS	17.52	93.52	23.38	74.30	21.07	20.91	21.11
Taxpayers' surplus (in million euros): GS	0	-76.42	-6. 28	-76.42	-12.99	-12.12	-12.99
Total surplus (in million euros): TS	31.48	33.99	33.99	40.23	30.22	31.54	31.45

Specific (1): The specific subsidy that yields the same price for residents, P_d^R, that the *ad valorem* one.

Specific (2): The specific subsidy that yields the same government's expenditure, GS, that the *ad valorem* one.

4.3.3. Other effects that might be considered

So far, we have compared the effects of the *ad valorem* subsidy and the specific subsidy for residents on consumers', producers' and taxpayers' surplus. However, there are other aspects that might be also considered.

First, since with the *ad valorem* subsidy the amount of the subsidy is increasing in the ticket price, airlines do not have incentives to be cost efficient and charge lower prices. This is not the case with a specific subsidy.

Second, with the *ad valorem* subsidy rich passengers that buy more expensive tickets receive a higher subsidy. This is not the case with a specific subsidy.

Recall that with a specific subsidy only for residents, the price finally paid by residents is given by $P_d^R = P_S - s.$ In practice, if the price charged by airlines is low enough, P_d^R might be negative. An easy way to solve this problem consists of defining the specific subsidy equal to s if $P_S > s,$ and equal to P_S if $P_S \leq s.$ In other words, if the price charged by the airline is low enough, resident passengers pay $P_d^R = 0$ while, if the price charged by the airline is higher, they pay $P_d^R = P_S - s.$

Finally, we would like to highlight that the proportion of resident passengers on the route is crucial to predict the change in prices, though this value may not be the same throughout the time and/or during different periods along the year. Airlines may anticipate this fact and increase or decrease the ticket prices of the route during certain periods or charge different prices depending whether the origin is region *A* or region *B*.

5. CONCLUSIONS AND TRANSPORT POLICY RECOMMENDATIONS

The main conclusions and transport policy recommendations derived from the economic analysis performed in **Sections 3** and **4** can be summarized as follows:

- Under perfect competition, the price charged by airlines is always equal to the marginal operating cost. In this context, if a subsidy only for residents is introduced, the price charged by airlines will be exactly the same as before the subsidy. This means that non-residents will be unaffected by the policy, and the subsidy will be fully enjoyed by residents. Therefore, the higher the level of competition on the route, the more effective is the subsidy aimed exclusively for residents.

Thus, our first transport policy recommendation is to promote competition on the route as much as possible, either by encouraging the entry of more airlines in the route, by promoting intermodal competition (for example, between air and maritime transport), or by removing all possible barriers to entry. The establishment of PSO in some routes might be acting as a barrier to entry in some cases and, thus, we recommend eliminating this kind of regulation in routes with enough demand.

- Under perfect competition, an *ad valorem* subsidy produces the same effects that the equivalent specific subsidy, meaning by equivalent the one that implies the same price paid by residents. However, as perfect competition does not really exist in actual markets, the specific subsidy is always a preferred policy from the social point of view. The reason is that, when airlines have market power, the *ad valorem* subsidy is equivalent to the combined use of a specific subsidy plus a profit subsidy. Hence, although a specific subsidy leads to the same price for residents as the *ad valorem* one, the *ad valorem* subsidy increases the monopolist's market power and, thus, implies that the airline charges a higher price, resulting in higher profits for the airline, and higher government's expenditure.

Moreover, with the *ad valorem* subsidy, the higher the ticket price the higher the subsidy. This implies that, first, with the *ad valorem* subsidy airlines do not have enough incentives to be cost efficient and charge lower prices. Second, with the *ad valorem* subsidy airlines do not have enough incentives to invest in cost reduction technologies. Third, with the *ad valorem* subsidy the more cost inefficient is the airline, the higher the subsidy is. Under imperfect competition, the fact that more inefficient firms receive higher subsidies implies unfair competition. Finally, with the *ad valorem* subsidy passengers that buy more expensive tickets receive a higher subsidy.

The difference between the *ad valorem* subsidy for residents and the specific one is higher, the higher the proportion of resident passengers on the route is, and the less important is the non-residents' demand for airlines (either because their willingness to pay is low or because they are very price-inelastic).

For all these reasons, our second transport policy recommendation is to use a specific subsidy rather that an *ad valorem* one, especially in those routes with low level of competition (intra or intermodal) and low proportion of non- resident passengers.

- The equivalent specific subsidy to be implemented, that is, the one that implies the same price for residents that the *ad valorem* one (or alternatively, the same public expenditure), strongly depends on the characteristics of the route, such as the level of competition, the proportion of resident passengers, residents' and non-residents' demand functions, airline's operating cost, etc. These characteristics of the route, especially residents' and non-residents' demand functions, may be different in different periods of the year. We should also take into account that airlines' operating costs may be increasing in the short run if there is a large increase in demand, while it might be constant in the long run.

Thus, our third transport policy recommendation is to establish the amount of the specific subsidy route by route, taking into account the particular characteristics of the route, market conditions and the period of time. This specific subsidy should be revised yearly or in case of important changes in the market or route conditions.

The specific subsidy should be defined equal to the fixed amount s if the price charged by the airline is higher than s, and equal to the price charged by the airline if such a price is lower than the fixed amount s. In other words, if the price charged by the airline is low enough, resident passengers pay zero while, if the price charged by the airline is higher, they pay such a price minus the fixed amount s.

- Any CBA to evaluate the effects of the subsidy has to be performed route by route, taking into account the particular characteristics of the route and the period of time. Empirical models that use aggregate data are not informative enough to distinguish those routes where the policy is being effective from those routes where the policy is producing important non-desirable effects in the market.

6. EMPIRICAL METHODOLOGY TO EVALUATE THE EFFECTS OF TRANSFERS FOR RESIDENTS

6.1. Introduction

As described in previous section of the report, passengers with residence in non-peninsular Spanish territories receive discounts on national flights with an origin or destination in their area of residence in the form of an *ad valorem* subsidy on the ticket price. In this section of the report we set out empirical methodologies that can in principle be used to evaluate the causal effects of different forms of subsidy awarded to non-peninsular residents.

We first make some general observations on the nature of the data that will likely be available for evaluation. We then describe the key features that will determine the structure of the econometric approach. Next, in **Subsection 6.4**, we describe causal methods that can be used for evaluation that draw inference from contrasts created by subsidy interventions and changes. Finally, we summarize a panel data regression based approach that could be implemented via formation of pseudo-panel data.

6.2. Data

We are interested in evaluating the impacts of subsidy on ticket prices by route. We anticipate the sources of data that will potentially be available to conduct the evaluation.

i. **Individual level resident data** – records of the number of subsidized passenger trips undertaken by residents; including details of route, price and amount of subsidy. Note that equivalent detailed data for non-residents are not available.

ii. **Aggregate market level data** – the individual level data on resident subsidized trips should allow for construction of an aggregate market level time-series of unsubsidized and subsidized fares by route. Supplementing these data with publicly available information on prices before subsidization will allow for construction of a consistent aggregate source over a reasonably long time period.

The individual level data provide will provide greater detail on actual trips made while the aggregate market level data will provide a longer time series on prices for evaluation.

6.3. Structure of the econometric approach

Our objective is to estimate the causal effects of *ad valorem* subsidies to residents on airline prices. There are four key elements that define the structure of the econometric problem.

1) **Treatment(s)** – the treatments to be evaluated include various levels of *ad valorem* subsidy applied to residents for different routes in two non-peninsular regions: The Balearic Islands and the Canary Islands. The subsidies applied change at particular points in time, differ by route, and are not uniform across the two geographic areas (see **Table 2.2**).

2) **Outcome** – the outcome of interest, that is the effect to be evaluated, is the impact of the subsidy on airline prices by route.

3) **Deterministic treatment assignment** – the treatments are assigned only to residents of the Balearic and Canary Islands. This is a form of assignment which is not only entirely non-random, but actually deterministic. Under this scenario the probability of receiving treatment is either 1 (for residents) or 0 (for non-residents).

4) **Confounding** – residents will likely differ in important ways from non-residents, and subsidized routes will likely differ in basic market characteristics from non-subsidized routes. Consequently, simple comparisons of residents with non-residents, or subsidized with unsubsidized routes, will not yield valid inference on the causal effects of pricing due to potential for confounding.

Under these conditions, and in the absence of extensive data on the characteristics of both residents and non-residents and on routes, econometric estimation will have to proceed via models that exploit 'contrasts' at points of intervention for inference. The data define a number of relevant contrasts which offer scope for application of causal methods.

- **Temporal contrasts** – temporal contrasts occur when interventions first appear (i.e. introduction of subsidies) and when the nature of the intervention changes (i.e. change in the rate of subsidy).

- **Geographical contrasts** – the rate of subsidy applied is not consistently uniform across regions and there is therefore scope to evaluate the impact of policy via geographical contrasts.

- **Route contrasts** – the scheduling and rate of subsidy differs by route (e.g. interisland versus domestic flights).

These contrasts, or some combination of them, allow for definition of 'treated' and 'control' units (i.e. residents, time periods, or routes) to which causal inference can be applied. Below we outline empirical methodologies and procedures that can be used in practice to measure and quantify the effects of subsidy for each category of contrast.

6.4. Causal methods to evaluation subsidy interventions and changes

6.4.1. Methods to evaluate impacts that exploit contrasts in time

The evolution of the subsidy over time creates several temporal contrasts that can be potentially be exploited to draw causal inference on the impacts of the policy. **Table 6.1** below shows the temporal contrasts of interest, the markets they are relevant to, and the distinction these contrasts imply for treatment allocation.

Table 6.1. Temporal contrasts from evolution of the *ad valorem* subsidy for residents

	Contrast	*Markets*	*Control (C) / treated (T)*
1	no-subsidy / 10% subsidy	Balearic Islands: interisland flights	C < 1982 1982 < T ≤ 1998
2	no-subsidy / 25% subsidy	Balearic Islands: non-interisland flights	C < 1982 1982 < T ≤ 1998
3	10% subsidy / 33% subsidy	Balearic Islands: interisland flights	1982 < C ≤ 1998 1982 < T ≤ 2005
4	25% subsidy / 33% subsidy	Balearic Islands: non-interisland flights	1982 < C ≤ 1998 1982 < T ≤ 2005
5	no-subsidy / 33% subsidy	Canary Islands: Interisland flights	C < 1988 1988 < T ≤ 2005
6	no-subsidy / 33% subsidy	Canary Islands: non-interisland flights	C < 1988 1988 < T ≤ 2005
7	33% subsidy / 38% subsidy	Canary Islands: Al domestic flights	1988 < C ≤ 2005 2005 < T ≤ 2006
8	33% subsidy / 38% subsidy	Balearic Islands: Al domestic flights	1988 < C ≤ 2005 2005 < T ≤ 2006
9	38% subsidy / 45% subsidy	Canary Islands: Al domestic flights	2005 < C ≤ 2006 2006 < T ≤ 2007
10	38% subsidy / 45% subsidy	Balearic Islands: Al domestic flights	2005 < C ≤ 2006 2006 < T ≤ 2007
11	45% subsidy / 50% subsidy	Canary Islands: Al domestic flights	2006 < C ≤ 2007 2007 < T ≤ 2017
12	45% subsidy / 50% subsidy	Balearic Islands: Al domestic flights	2006 < C ≤ 2007 2007 < T ≤ 2017
13	50% subsidy / 75% subsidy	Canary Islands: interisland flights	2007 < C ≤ 2017 T ≥ 2017
14	50% subsidy / 75% subsidy	Balearic Islands: interisland flights	2007 < C ≤ 2017 T ≥ 2017
15	50% subsidy / 75% subsidy	Canary Islands: non-interisland flights	2007 < C ≤ 2018 T ≥ 2018
16	50% subsidy / 75% subsidy	Balearic Islands: non-interisland flights	2007 < C ≤ 2018 T ≥ 2018

Each of the contrasts shown in the table involves a *temporal change* in subsidy (i.e. in intervention) that occurs at a particular point in time. This allows us to define 'control' observations as those prior to the change in intervention and 'treated units as those after the intervention. Thus, for example, contrasts 1 and 2 define trips made prior to 1982 as control in the sense that they were not subject to subsidy, and those after 1982 but before 1998 as treated, where the treatment is a 10% subsidy discount. For contrast 3 on the other hand, the control observations are Balearic interisland flights that were subject to a 10% discount and the treated observations are Balearic interisland flights subject to a 33% discount. The intervention that creates contrast 3 is a change in the rate of subsidy that occurred in 1998 and remained in place until 2005.

Note that with purely temporal contrasts allocation of observations to treated and control status is defined purely by their position in time. To estimate causal effects, a suitable approach is via application of regression discontinuity design (RDD), which identifies the causal effect of the treatment by measuring the magnitude of any discontinuity in trends around the point of the intervention. In our case, RDD will be used to study discontinuity in prices over time. Below we provide an intuitive explanation of how RDD determines the causal effect of intervention.

RDD is applicable when a given covariate, referred to as the forcing or running variable, partly or completely determines assignment to the treatment. Under a so-called 'sharp' RDD design, the conditional probability of receiving the treatment is of size one at some given threshold of the forcing variable, while under a 'fuzzy' design the probability change at the threshold is less than one. The RDD method exploits this discontinuity in treatment assignment to study the conditional distribution of the outcome either side of the threshold of the forcing variable. A discontinuity in outcome is interpreted as evidence of a causal effect of the treatment.

For the temporal contrasts shown in **Table 6.1** we have a sharp RDD with time, which we denote by T, as the forcing variable. We define treatment status by variable $D \in \{0,1\}$, which takes a value of 1 for treated and a value of 0 for control. The treatment status of observation i at time t is given by

$$D_{it} = 1[T_t \geq c] ,$$

where c is the time the contrast was introduced and $1[T_t \geq c]$ is an indicator function that takes a value of one if the statement in brackets is true or zero otherwise.

RDD estimates

$$\tau_{RRD} = E[Y_i(1)|T_i = c] - E[Y_i(0)|T_i = c] ,$$

as the causal effect of the intervention. However, we cannot observe both expectations in the above equation simultaneously because time separates treatment and control. Instead, we assume continuity of the expectations in T such that

$$E[Y_i(0)|T_i = c] = \lim_{t \uparrow c} E[Y_i(0)|T_i = t] = \lim_{t \uparrow c} E[Y_i|T_i = t],$$

and apply the estimator

$$\tau_{RRD} = \lim_{t \downarrow c} E[Y_i|T_i = t] - \lim_{t \uparrow c} E[Y_i|T_i = t],$$

to estimate the causal effect of the treatment. The causal effect we estimate via the sharp temporal RDD is thus the difference in the conditional expectation of the outcome either side of the discontinuity.

To estimates these conditional expectations separate regressions are run either side of the contrast and the difference in intercepts taken as a measure of the causal effect of the intervention. In practice, there are two strategies for specifying the functional form of such regressions:

1. **Parametric method** - the parametric method provides a global estimate using every observation in the sample. Usually, different functional forms can be specified, including linear and polynomial.

2. **Nonparametric regression** - the nonparametric method restricts estimation to observations close to the discontinuity. Within a selected bandwidth, local linear or polynomial regressions can be implemented to consistently estimate the treatment effect.

In order to use RRD to evaluate the contrasts shown in **Table 6.1**, data will be required to represent the temporal evolution of the outcome variable, e.g. airlines prices, for a sufficient number of observations in periods before and after the day that the contrast first began. These observations could be formed as average prices for intervals in time (e.g. days or weeks) and could incorporate cross-sectional variation by forming the averages for different for different routes, thus providing additional identifying variation.

Such data could potentially be gathered in one of two ways

- **Aggregate market data** – via publicly available sources of data on relevant airline prices by route and date.

- **Averaged individual data** – use the resident subsidy data to form averages by route and time interval.

6.4.2. Methods to evaluate impacts that exploit geographical and temporal contrasts

The rate of subsidy has been applied non-uniformly by geographic region over time. This means that we can define both treated and control observations and observe them in periods both before and after the treatment. This allows us to apply methods that achieve identification of causal effects via comparison of dual dimensions of the contrast (e.g. treated / control and before / after). **Table 6.2** below shows the temporal-geographical contrasts formed via evolution of the policy, the markets they are relevant to, the treated and control regions, and the before and after intervention period.

Table 6.2. Temporal-geographical contrasts from evolution of the *ad valorem* subsidy for residents

	Contrast	*Market*	*Control (C) / treated (T)*	*Before (B) / after (A)*
1	no subsidy / 10% subsidy	interisland flights	C = Canary T = Balearic	B < 1982 1982 < A ≤ 1988
2	no subsidy / 25% subsidy	non-interisland flights	C = Canary T = Balearic	B < 1982 1982 < A ≤ 1988
3	10% subsidy / 33% subsidy	interisland flights	C = Canary T = Balearic	1988 ≤ B ≤ 1988 1988 < A < 1998
4	25% subsidy / 33% subsidy	non-interisland flight	C= Canary T = Balearic	1998 ≤ B ≤ 2005 1988 < A < 1998

The first contrast shown in the table is between no subsidy and subsidy applied at a rate of 10% for interisland flights. Subsidy was not applied in either the Balearic and Canary Islands before 1982, and after 1982 a 10% rate of subsidy was applied to interisland flights for residents in the Balearic Islands but not the Canary Islands. The second contrast shown in table is similar to the first, but for non-interisland flights and the rate of subsidy is 25% not 10%.

To evaluate contrast 1 and 2 we require data for the treated and control regions (i.e. Balearic and Canary) in the periods before and after 1982 (prior to 1988 when the policy changed again). As for the temporal contrasts described above, this could involve aggregate market data or averaged individual level data. The former may hold greater potential if records of resident trips are incomplete prior to imposition of the subsidy.

Contrast 3 shown in the table is between subsidy applied at a rate of 10% relative to 33% for interisland flights. In 1988 both the Canary and Balearic Islands had the same rate of subsidy for interisland flights of 10%. From 1988 to 1998 the subsidy rate was changed in the Canary Islands to 33% but remained at 10% in the Balearic Islands until 1998. Individual resident level data on airline trips could be used to evaluate this contrast.

The final contrast shown in **Table 6.2** is between subsidy applied at a rate of 25% relative to 33% for non-interisland flights. To conceptualize how this contrast arises it is useful to view time as running in reverse. After 1998, and before 2005, both the Balearic and Canary Islands had the same subsidy rate for non-interisland flights: 33%. Between 1988 and 1998 the subsidy rate was 25% in the Balearic Islands and 33% in the Canary Islands. Thus in evaluating this policy our 'before' period is when subsidy rates were equivalent in both regions (i.e. between 1998 and 2005) and out 'after' period is when they diverged (i.e. between 1988 and 1998). Individual resident level data on airline trips could be used to evaluate this contrast.

The contrasts described in this section, which have the dual dimensions of treated / control and before / after can be evaluated using difference-in-differences (DiD). The DiD approach uses information for both treated and control groups in both pre and post treatment periods. The DiD estimator approximates the expression

$$\tau_{DID} = \{E[Y_i(1)|D_i = 1] - E[Y_i(1)|D_i = 0]\} - \{E[Y_i(0)|D_i = 1] - E[Y_i(0)|D_i = 0]\}.$$

The 'double-differencing' of the DiD estimator removes two potential sources of bias. First, it eliminates biases in second period comparisons between the treated and control groups that could arise from time invariant characteristics. Second, it corrects for time varying biases in comparisons over time for the treated group that could be attributable to time trends unrelated to the treatment.

An estimate of τ_{DID} can obtained via linear regression. For instance, we can estimate the model

$$Y_{i,t} = \mu + X_i'\beta + \alpha D_{i,t} + \delta^* t + \tau D_{i,1} + \varepsilon_{i,t}\ ,$$

for units of observation i, $i = (1, \ldots, n)$ in binary time periods $t \in \{0,1\}$, with $t = 0$ representing the pre-treatment period and $t = 1$ the post-treatment period. In this model $D_{i,t}$ is the treatment indicator variable such that $D_{i,t}=1$ if unit i has been exposed to the treatment prior to period t and $D_{i,t}= 0$ otherwise, δ is a time specific component, and $\varepsilon_{i,t,}$ is a potentially autoregressive error with mean zero in each time period. The effect of the treatment is captured by the parameter τ.

DiD relies on the strong identifying assumption that the average outcomes for the treated and control groups would have followed parallel paths over time in the absence of the treatment. Adding covariates to the linear DiD regression (i.e. X) can help in satisfying the parallel trend assumption because it is then assumed to hold conditional on those covariates, thus accommodating heterogeneity in outcome dynamics between the two groups.

6.4.3. Methods to evaluate impacts that exploit temporal-route contrasts

The rate of subsidy has been applied non-uniformly by route over time. This allows us to define treated and control routes for periods before and after a contrast. **Table 6.3** below shows the main temporal-route contrast formed via evolution of the policy.

Table 6.3. Temporal-route contrasts from evolution of the *ad valorem* subsidy for residents

	contrast	*regions*	*control (C) / treated (T)*	*before (B) / after (A)*
1	50% subsidy / 75% subsidy	Balearic Canary	C = non-interisland T = interisland	B < 2018 2017 < A ≤ 2018

Between 2007 and 2017 all interisland and non-interisland flights in both the Balearic and Canary Islands were subject to a resident subsidy of 50%. In 2017 the rate of subsidy was increased to 75% for interisland flights, but this increase was not given to non-interisland flights until 2018. Thus, creating a short before and after period of one year in which some routes had a high level of subsidy than others. As with the temporal-geographical contrasts the DiD method summarized above will provide a viable approach to evaluating this policy subject to the available data.

6.5. Panel data regression approach for evaluation

In addition to the causal methods outlined above, which achieve identification by emphasizing differences at the point of interventions, it could also be possible to generate evidence for evaluation via a typical regression approach. The advantage of using regression is that it can provide an estimate of how a 'dose' of subsidy affects airline price in general, in contrast to the estimates described in the previous section which relate to specific step-changes in policy. However, because the available data are likely to lack information on covariates that could be influential for both subsidy levels and airline prices, there is potential for bias in estimation (i.e. via omitted variables and reverse causality). To address this, panel data approaches can be used to achieve causal identification.

As far as we are aware, actual panel data at the individual level do not exist. To proceed with a viable regression approach, it should be possible to form a 'pseudo-panel' of data on prices and rates of subsidy. Under the pseudo-panel approach, observations are formed as averages of cohorts using time invariant attributes and mean values for each cohort are then taken. In the present case, data on resident trips would be grouped into cohorts for distinct time intervals (by route and region) to produce a dataset in which each observation represents an average taken over resident trips in a given interval. The resulting dataset is known as a pseudo-panel, and it allows us to follow cohorts, rather than individuals, consistently over time.

For example, for a static regression model, with the dependent variable ticket price p_i for trip i and the treatment variable being subsidy level s_i, a trip level panel model could be

$$p_{it} = g(s_{it}) + \alpha_i + \gamma_T + x'_{it}\beta + \varepsilon_{it} ,$$

say, where i, $i = (1,\ldots,N)$ indexes a trip and t, $t = (1,\ldots,T)$ indexed points in time, $g(\,)$ is an unknown structural function for the treatment variable to be assumed or estimated, α_i is a trip level time invariant individual effect, γ_T is a time specific effect, x_{it} is a vector of covariates describing characteristics of the trip, β is a vector of parameters to be estimated and ε_{it} is an error term. Averaging observations to cohort level gives the model

$$p_{ct} = g(s_{ct}) + \alpha_{ct} + \gamma_T + x'_{ct}\beta + \varepsilon_{ct} ,$$

where p_{ct} is the average value of the price of the trip observed in cohort c in time t, i.e. ,

$$p_{ct} = \sum_{i=1}^{N_{ct}} p_i ,$$

with N_{ct} being the number of units in cohort c at time t, s_{ct} is the average subsidy for cohort c is located in interval t, and α_{ct} is the average of the trip level individual effects observed in cohort c in time t.

If temporal variation in the cohort specific effect α_{ct} can be ignored, such that we can assume $\alpha_{ct} = \alpha_c$, then we can use standard panel approaches to adjust for unobserved heterogeneity between the cohorts. The assumption that $\alpha_{ct} = \alpha_c$ is defensible if the size of the cohorts is relatively large and the composition of resident trips within them reasonably stable over time. When there is a relatively large degree of within-cohort variation, compared to cross-cohort variation, the pseudo-panel estimates may be less efficient than those of the underlying true panel.

With pseudo-panel data causal estimates of the treatment effect can be obtained via the dynamic vector autoregressive (VAR) model

$$p_{ct} = \rho p_{ct-1} + g(s_{ct}) + \gamma_T + x'_{ct}\beta + \varepsilon_{ct} ,$$

which is estimated using instrumental variables, partly due to correlation between the individual effects and the lagged response, but also to address other sources of bias and endogeneity in estimation of the treatment effect. This can be achieved using the dynamic Generalized Method of Moments (GMM) instrumental variables estimator for panel data. This approach specifies the dynamic equation in both levels and first-differences, and uses the time series nature of the data to derive a set of instruments which are assumed correlated with the covariates but orthogonal to the errors. Specifically, lagged first-differences are used as instruments for equations in levels and lag levels as instruments for first-differenced equations. A set of moment conditions can then be defined and solved within a GMM framework to yield consistent estimates of model parameters.

The dynamic panel model can be used to derive causal estimates of the elasticity of price with respect to subsidy: $\partial \log p_{it} / \partial \log s_{it}$. This provides a general indication of how a 'dose' of subsidy affects airline price.

ANNEX A. MATHEMATICAL EXPRESSIONS OF THE ECONOMIC MODEL OF TRANSFERS FOR RESIDENTS

A.1. Equilibrium in absence of public subsidies: the monopoly case

The monopoly carrier chooses the ticket price P_S that solves the following maximization program:

$$\underset{P_s}{Max}\ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S - c)x^{NR}, \qquad \textbf{(A.1)}$$

with $x^R = \dfrac{a_R - P_S}{b_R}$, and $x^{NR} = \dfrac{a_{NR} - P_S}{b_{NR}}$.

The first order condition of the above maximization program is given by:

$$\frac{N}{b_R b_{NR}}(b_{NR}\alpha(a_R + c) + b_R(1-\alpha)(a_{NR} + c) - 2P_S(\alpha b_{NR} + (1-\alpha)b_R)) = 0. \qquad \textbf{(A.2)}$$

Solving the first order condition we obtain the following optimal ticket price:

$$P_S^0 = \frac{b_{NR}\alpha(a_R + c) + b_R(1-\alpha)(a_{NR} + c)}{2(\alpha b_{NR} + (1-\alpha)b_R)}. \qquad \textbf{(A.3)}$$

By substituting the optimal ticket price in the demand function of each passenger, we obtain the following demanded quantities per passenger (residents and non-residents, respectively):

$$\begin{aligned} x_0^R &= \frac{a_R - P_S^0}{b_R} = \frac{\alpha a_R b_{NR} + 2a_R b_R(1-\alpha) - (1-\alpha)b_R a_{NR} - c(\alpha b_{NR} + (1-\alpha)b_R)}{2b_R(\alpha b_{NR} + (1-\alpha)b_R)}, \\ x_0^{NR} &= \frac{a_{NR} - P_S^0}{b_{NR}} = \frac{(1-\alpha)b_R a_{NR} + 2\alpha a_{NR} b_{NR} - \alpha a_R b_{NR} - c(\alpha b_{NR} + (1-\alpha)b_R)}{2b_{NR}(\alpha b_{NR} + (1-\alpha)b_R)}. \end{aligned} \qquad \textbf{(A.4)}$$

A.2. Equilibrium with public subsidies to all passengers: the monopoly case

When an *ad valorem* subsidy for all passengers is introduced, the airline solves the following maximization program:

$$\underset{P_S}{Max}\ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S - c)x^{NR}, \quad \textbf{(A.5)}$$

where x^R and x^{NR} represents, the quantity demanded by a representative resident passenger and a representative non-resident passenger, respectively, with $x^R = \dfrac{a_R - (1-\sigma)P_S}{b_R}$ and $x^{NR} = \dfrac{a_{NR} - (1-\sigma)P_S}{b_{NR}}$.

The first order condition of the above maximization program is given by:

$$\frac{N}{b_{NR}b_R}(\alpha b_{NR}(c(1-\sigma) + a_R - 2P_S(1-\sigma)) + (1-\alpha)b_R(c(1-\sigma) + a_{NR} - 2P_S(1-\sigma))) = 0. \quad \textbf{(A.6)}$$

Solving the first order condition we obtain the following optimal ticket price:

$$P_S^1 = \frac{\alpha b_{NR}(c(1-\sigma) + a_R) + (1-\alpha)b_R(c(1-\sigma) + a_{NR})}{2(1-\sigma)(\alpha b_{NR} + b_R(1-\alpha))}. \quad \textbf{(A.7)}$$

The ticket price finally paid by residents and non-residents with an *ad valorem* subsidy is then given by:

$$P_d^R = P_d^{NR} = P_S^1(1-\sigma) = \frac{\alpha b_{NR}(c(1-\sigma) + a_R) + (1-\alpha)b_R(c(1-\sigma) + a_{NR})}{2(\alpha b_{NR} + b_R(1-\alpha))}. \quad \textbf{(A.8)}$$

On the contrary, when a specific subsidy for all passengers is introduced, the airline solves the maximization program given by expression **(A.5)**, but taking into account that the quantity demanded by a representative resident passenger and a representative non-resident passenger is now given by: $x^R = \dfrac{a_R - P_S + s}{b_R}$ and $x^{NR} = \dfrac{a_{NR} - P_S + s}{b_{NR}}$.

The first order condition of such a maximization program is given by:

$$\frac{N}{b_{NR}b_R}(\alpha b_{NR}(c + a_R - 2P_S + s) + (1-\alpha)b_R(c + a_{NR} - 2P_S + s)) = 0. \quad \textbf{(A.9)}$$

Solving the first order condition we obtain the following optimal ticket price:

$$P_S^1 = \frac{\alpha b_{NR}(c + a_R + s) + (1-\alpha) b_R (c + a_{NR} + s)}{2(\alpha b_{NR} + b_R(1-\alpha))}. \quad \textbf{(A.10)}$$

The ticket price finally paid by residents and non-residents with a specific subsidy is then given by:

$$P_d^R = P_d^{NR} = P_S^1 - s = \frac{\alpha b_{NR}(c + a_R - s) + (1-\alpha) b_R (c + a_{NR} - s)}{2(\alpha b_{NR} + b_R(1-\alpha))}. \quad \textbf{(A.11)}$$

By setting a specific subsidy $s = c\sigma,$ expressions **(A.9)** and **(A.11)** coincide, that is, the specific subsidy yields the same price for residents and non-residents that the *ad valorem* one.

Notice that for $s = c\sigma,$ the ticket price given by expression **(A.7)** is higher that the ticket price given by expression **(A.10)**, and thus the ticket price charged by the airline is lower with a specific subsidy, leading to lower profits for the monopolist and lower public expenditure.

A.3. Equilibrium with *ad valorem* subsidies for residents: the monopoly case

When the route is operated by a monopolist and an *ad valorem* subsidy only for residents is introduced, the airline solves the following maximization program:

$$\underset{P_S}{Max}\ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S - c)x^{NR}, \quad \textbf{(A.12)}$$

where x^R and x^{NR} represents, given the price that they finally pay, the quantity demanded by residents and non-residents, respectively. Thus: $x^R = \frac{a_R - (1-\sigma)P_S}{b_R}$ and $x^{NR} = \frac{a_{NR} - P_S}{b_{NR}}$.

The first order condition of the above maximization program is given by:

$$\frac{N}{b_R b_{NR}}(\alpha b_{NR}(-2P_S(1-\sigma) + c(1-\sigma) + a_R) + (1-\alpha) b_R(-2P_S + c + a_{NR})) = 0. \quad \textbf{(A.13)}$$

Solving the first order condition we obtain the following optimal ticket price:

$$P_S^1 = \frac{\alpha b_{NR}(c(1-\sigma) + a_R) + (1-\alpha) b_R (c + a_{NR})}{2(b_R(1-\alpha) + \alpha b_{NR}(1-\sigma))}. \quad \textbf{(A.14)}$$

The ticket price finally paid by residents with an *ad valorem* subsidy only for residents is given by:

$$P_d^R = P_S^1(1-\sigma) = \frac{\alpha b_{NR}(c(1-\sigma)+a_R)+(1-\alpha)b_R(c+a_{NR})}{2(b_R(1-\alpha)+\alpha b_{NR}(1-\sigma))}(1-\sigma). \qquad \textbf{(A.15)}$$

By substituting the optimal ticket price in the demand function of each passenger, we obtain the following demanded quantities per passenger (residents and non-residents, respectively):

$$x_1^R = \frac{a_R - P_S^1(1-\sigma)}{b_R} = \frac{\alpha b_{NR}(1-\sigma)(-c(1-\sigma)+a_R)+(1-\alpha)b_R(-c(1-\sigma)+2a_R-a_{NR}(1-\sigma))}{2b_R(b_R(1-\alpha)+\alpha b_{NR}(1-\sigma))},$$

$$x_1^{NR} = \frac{a_{NR}-P_S^1}{b_{NR}} = \frac{\alpha b_{NR}(-c(1-\sigma)+2a_{NR}(1-\sigma)-a_R)+(1-\alpha)b_R(a_{NR}-\mathrm{c})}{2b_{NR}(b_R(1-\alpha)+\alpha b_{NR}(1-\sigma))}.$$

(A.16)

A.4. Equilibrium with specific subsidies for residents: the monopoly case

When the route is operated by a monopolist and a specific subsidy only for residents is introduced, the airline solves the following maximization program:

$$\underset{P_S}{Max}\ \alpha N(P_S - c)x^R + (1-\alpha)N(P_S-c)x^{NR}, \qquad \textbf{(A.17)}$$

where x^R and x^{NR} represents, given the price that they finally pay, the quantity demanded by residents and nonresidents, respectively. Thus: $x^R = \dfrac{a_R - P_S + s}{b_R}$ and $x^{NR} = \dfrac{a_{NR}-P_S}{b_{NR}}$.

The first order condition of the above maximization program is given by:

$$\frac{N}{b_R b_{NR}}(\alpha b_{NR}(-2P_S+s+c+a_R)+(1-\alpha)b_R(-2P_S+c+a_{NR}))=0. \qquad \textbf{(A.18)}$$

Solving the first order condition we obtain the following optimal ticket price:

$$P_S^1 = \frac{\alpha b_{NR}(s+c+a_R)+(1-\alpha)b_R(c+a_{NR})}{2(b_R(1-\alpha)+\alpha b_{NR})}. \qquad \textbf{(A.19)}$$

The ticket price finally paid by residents with a specific subsidy only for residents is given by:

$$P_d^R = P_S^1 - s = \frac{\alpha b_{NR}(s + c + a_R) + (1-\alpha)b_R(c + a_{NR})}{2(b_R(1-\alpha) + \alpha b_{NR})} - s. \qquad \textbf{(A.20)}$$

By substituting the optimal ticket price in the demand function of each passenger, we obtain the following demanded quantities per passenger (residents and non-residents, respectively):

$$\begin{aligned} x_1^R &= \frac{a_R - P_S^1 + s}{b_R} = \frac{\alpha b_{NR}(s - c + a_R) + (1-\alpha)b_R(-c + 2s + 2a_R - a_{NR})}{2b_R(b_R(1-\alpha) + \alpha b_{NR})}, \\ x_1^{NR} &= \frac{a_{NR} - P_S^1}{b_{NR}} = \frac{\alpha b_{NR}(-s - c + 2a_{NR} - a_R) + (1-\alpha)b_R(a_{NR} - c)}{2b_{NR}(b_R(1-\alpha) + \alpha b_{NR})}. \end{aligned} \qquad \textbf{(A.21)}$$

A.5. ***Ad valorem*** **versus specific subsidies for residents: the monopoly case**

The specific subsidy s^* that allows resident passengers to pay exactly the same price that they would pay with an *ad valorem* subsidy is given by solving the equation resulting from making equal expression **(A.15)** and expression **(A.20)**, that is:

$$\frac{\alpha b_{NR}(c(1-\sigma) + a_R) + (1-\alpha)b_R(c + a_{NR})}{2(b_R(1-\alpha) + \alpha b_{NR}(1-\sigma))}(1-\sigma) = \frac{\alpha b_{NR}(s + c + a_R) + (1-\alpha)b_R(c + a_{NR})}{2(b_R(1-\alpha) + \alpha b_{NR})} - s,$$

whose solution is given by:

$$s^* = \frac{\sigma(b_R^2(1-\alpha)^2(c + a_{NR}) + \alpha^2 b_{NR}^2 c(1-\sigma) + \alpha(1-\alpha)b_{NR}b_R(2c + a_R - c\sigma))}{(2b_R(1-\alpha) + \alpha b_{NR})(b_R(1-\alpha) + \alpha b_{NR}(1-\sigma))}. \qquad \textbf{(A.22)}$$

ANNEX B: INFORMATION SOURCES REGARDING TRANSFERS TO RESIDENTS

The empirical analysis requires data of subsidized routes, including details of the route (such as total number of passengers, percentage of residents, number of airlines operating the route, level of intermodal competition, type of the route, PSO regulation, etc.), ticket price paid by residents and non-residents, type of fare (economic, business, etc.), and amount of the subsidy for residents. All this data should be provided by the General Directorate of Civil Aviation, the Ministry of Transport, Mobility and Urban Agenda, and airlines.

Data on passengers and prices will also be required for non-subsidized routes in order to conduct the econometric analysis of the effects of transfers to residents. This data may be provided by airlines.

Finally, in order to evaluate the fairness of the subsidy for residents, data about residents' income may be required. This data should be provided by the Ministry of Economy and Finance.

ANNEX C: INFORMATION ABOUT MAIN ROUTES WITH 75% DISCOUNT FOR RESIDENTS IN SPAIN

Table C.1 includes information about the main routes with 75% discount for residents in Spain. In particular, for the period from July 2018 to June 2019 and for each route, we include the available information on the total number of passenger-trips, total number of resident passenger-trips, percentage of residents on the route, level of competition on the route (measured through the Herfindahl-Hirschman index and the number of passenger-trips in the mode of transport that competes with the air transport in interisland routes, that is, the maritime transport), the total subsidy granted, and the average subsidy per resident passenger-trip in the route. In this sense, the average subsidy per resident passenger-trip on inter-island routes is about 50 euros, while for domestic non-interisland routes is about 90 euros in the case of the Canary Islands and about 50 euros in the Balearic Islands.

Table C.1. Main routes with 75% discount for residents in Spain

Non-peninsular territory	Type of the route	Route (direct flights)	Total number of passenger-trips in 2018-19 (2)	Total number of resident passenger-trips in 2018-19 (2)	% of residents in 2018-19 (2)	Level of competition: HH index (1)	Level of competition: Total number of passenger-trips in maritime transport in 2018-19 (2)	Amount of the subsidy in 2018-19 (2) (€)	Average subsidy per passenger-trip (€)
The Canary Islands	Interisland routes	Gran Canaria - Tenerife	1,129,230	965,801	85.5	0.68	1,327,834	42,873,186	44.39
		Gran Canaria -Lanzarote	804,732	715,118	88.9	0.54	105,634	37,024,018	51.77
		Tenerife North - La Palma	760,709	676,186	88.9	0.53	201,514	28,205,924	41.71
		Gran Canaria -Fuerteventura	657,273	586,557	89.2	0.57	566,826	27,225,809	46.42
		Tenerife North -Lanzarote	382,369	337,381	88.2	0.81	2,583	23,459,841	69.54
		Tenerife North - Fuerteventura	288,186	259,384	90.0			16,859,887	65.00
		Tenerife North - El Hierro	205,221	168,569	82.1			7,914,457	46.95
		Gran Canaria- La Palma	157,285	137,434	87.4			9,196,434	66.92
		Tenerife North - La Gomera	60,693	46,949	77.4			1,627,413	34.66
		Gran Canaria - El Hierro	49,352	42,335	85.8			2,755,696	65.09
		Gran Canaria - La Gomera	8,584	7,807	90.9			377,546	48.36
		La Palma -Lanzarote	97	0	0.0			0	-
	Total interisland routes: The Canary Islands		**4,503,731**	**3,943,521**	**87.56**			**197,520,211**	**50.09**
	Domestic non-interisland routes	Gran Canaria-Madrid	1,656,580	751,959	45.4			67,523,175	89.80
		Gran Canaria- Sevilla	219,716	119,881	54.6			10,189,796	85.00
		Gran Canaria- Málaga	184,476	92,263	50.0			6,797,977	73.68
		Gran Canaria- Granada	33,957	23,576	69.4			1,644,961	69.77
		Gran Canaria-Alicate	26,484	11,085	41.9			1,293,458	116.69

Non-peninsular territory	Type of the route	Route (direct flights)	Total number of passenger-trips in 2018-19 (2)	Total number of resident passenger-trips in 2018-19 (2)	% of residents in 2018-19 (2)	Level of competition		Amount of the subsidy in 2018-19 (2) (€)	Average subsidy per passenger-trip (€)
						HH index (1)	Total number of passenger-trips in maritime transport in 2018-19 (2)		
The Canary Islands	Domestic non-interisland routes	Gran Canaria- Valencia	71,042	32,137	45.2			2,227,311	69.31
		Gran Canaria-Barcelona	508,768	217,066	42.7			17,441,188	80.35
		Gran Canaria- Bilbao	111,313	44,655	40.1			4,504,381	100.87
		Gran Canaria- Santander	9,049	2,808	31.0			158,025	56.28
		Gran Canaria- Asturias	22,159	11,710	52.8			1,269,303	108.39
		Gran Canaria- Vigo	20,047	15,749	78.6			2,314,640	146.97
		Gran Canaria- Santiago	98,581	44,964	45.6			3,423,179	76.13
		Gran Canaria- A Coruña	11,056	4,066	36.8			432,489	106.37
		Tenerife - Madrid	1,827,992	725,307	39.7			67,664,644	93.29
		Tenerife - Sevilla	287,136	134,350	46.8			11,933,823	88.83
		Tenerife - Málaga	245,471	92,849	37.8			6,834,309	73.61
		Tenerife - Granada	28,213	16,478	58.4			1,086,886	65.96
		Tenerife - Alicate	99,597	30,736	30.9			2,222,307	72.30
		Tenerife - Valencia	96,969	29,744	30.7			2,092,802	70.36
		Tenerife - Barcelona	684,484	228,435	33.4			19,970,412	87.42
		Tenerife - Zaragoza	19,709	6,838	34.7			670,308	98.03
		Tenerife - Bilbao	199,522	54,202	27.2			5,126,887	94.59
		Tenerife - Asturias	73,242	23,910	32.6			2,546,184	106.49
		Tenerife - Vigo	20,682	11,387	55.1			1,553,764	136.45
		Tenerife - Santiago	167,620	60,349	36.0			5,010,850	83.03
		Tenerife - A Coruña	10,975	2,688	24.5			272,565	101.40

Non-peninsular territory	Type of the route	Route (direct flights)	Total number of passenger-trips in 2018-19 (2)	Total number of resident passenger-trips in 2018-19 (2)	% of residents in 2018-19 (2)	Level of competition: HH index (1)	Level of competition: Total number of passenger-trips in maritime transport in 2018-19 (2)	Amount of the subsidy in 2018-19 (2) (€)	Average subsidy per passenger-trip (€)
The Canary Islands	Domestic non-interisland routes	Lanzarote-Madrid	489,925	143,758	29.3			12,273,478	85.38
		Lanzarote - Sevilla	79,668	30,500	38.3			1,695,091	55.58
		Lanzarote - Málaga	33,839	11,544	34.1			837,830	72.58
		Lanzarote - Valencia	47,866	11,309	23.6			613,509	54.25
		Lanzarote -Barcelona	158,766	37,381	23.5			3,718,700	99.48
		Lanzarote -Bilbao	107,396	15,134	14.1			1,474,485	97.43
		Lanzarote - Asturias	25,076	5,736	22.9			621,168	108.29
		Lanzarote - Santiago	84,168	25,477	30.3			1,621,532	63.65
		Fuerteventura-Madrid	329,297	84,380	25.6			7,425,303	88.00
		Fuerteventura - Sevilla	52,888	18,564	35.1			931,175	50.16
		Fuerteventura - Málaga	30,929	10,413	33.7			650,859	62.50
		Fuerteventura - Valencia	4,998	1,359	27.2			102,667	75.55
		Fuerteventura -Barcelona	161,431	30,936	19.2			2,294,902	74.18
		Fuerteventura -Bilbao	32,515	4,466	13.7			443,894	99.39
		Fuerteventura - Santiago	34,981	15,352	43.9			1,396,800	90.98
		La Palma-Madrid	137,671	40,488	29.4			4,727,104	116.75
	Total domestic non-interisland routes: The Canary Islands		**8,546,254**	**3,275,989**	**38.3**			**287,034,121**	**87.62**

Non-peninsular territory	Type of the route	Route (direct flights)	Total number of passenger-trips in 2018-19 (2)	Total number of resident passenger-trips in 2018-19 (2)	% of residents in 2018-19 (2)	Level of competition: HH index (1)	Level of competition: Total number of passenger-trips in maritime transport in 2018-19 (2)	Amount of the subsidy in 2018-19 (2) (€)	Average subsidy per passenger-trip (€)
	TOTAL CANARY ISLANDS		**13,049,985**	**7,219,510**	**55.3**			**484,554,332**	**67.12**
The Balearic Islands	**Interisland routes**	Mallorca - Ibiza	535,191	404,031	75.5	0.53	95,760	19,597,661	48.51
		Mallorca -Menorca	376,274	301,874	80.2	0.65	185,048	14,032,867	46.49
		Menorca - Ibiza	4,364	1,251	28.7	0.8		79,685	63.70
	Total interisland routes: The Balearic Islands		**915,829**	**707,156**	**77.21**			**33,710,213**	**47.67**
	Domestic non-interisland routes	Mallorca-Sevilla	323,796	155,950	48.2			10,568,588	67.77
		Mallorca-Malaga	206,954	79,787	38.6			4,743,276	59.45
		Mallorca-Granada	188,003	114,390	60.8			7,320,519	64.00
		Mallorca-Alicante	278,252	111,627	40.1			6,471,058	57.97
		Mallorca-Valencia	511,361	205,791	40.2			10,700,267	52.00
		Mallorca-Barcelona	2,093,583	766,151	36.6			31,886,977	41.62
		Mallorca-Zaragoza	82,346	30,129	36.6			1,845,916	61.27
		Mallorca-Madrid	1,977,045	763,258	38.6			45,704,453	59.88
		Mallorca-Bilbao	244,409	89,077	36.4			5,870,541	65.90
		Mallorca-Asturias						2,722,597	
		Mallorca-Santiago	153,813	67,625	44.0			4,571,474	67.60
		Menorca-Madrid	290,011	63,376	21.9			4,737,204	74.75
		Menorca-Valencia	51,731	9,630	18.6			647,945	67.28

Non-peninsular territory	Type of the route	Route (direct flights)	Total number of passenger-trips in 2018-19 (2)	Total number of resident passenger-trips in 2018-19 (2)	% of residents in 2018-19 (2)	Level of competition		Amount of the subsidy in 2018-19 (2) (€)	Average subsidy per passenger-trip (€)
						HH index (1)	Total number of passenger-trips in maritime transport in 2018-19 (2)		
The Balearic Islands	**Domestic non-interisland routes**	Menorca-Barcelona	823,028	220,202	26.8			11,597,785	52.67
		Ibiza-Sevilla	86,532	26,699	30.9			1,305,170	48.88
		Ibiza-Málaga	132,643	32,827	24.7			1,500,059	45.70
		Ibiza-Alicante	83,635	20,399	24.4			1,153,753	56.56
		Ibiza-Valencia	324,009	88,662	27.4			3,135,234	35.36
		Ibiza-Madrid	816,174	202,158	24.8			9,773,921	48.35
		Ibiza-Barcelona	1,191,357	265,822	22.3			12,084,112	45.46
		Ibiza-Bilbao	94,823	14,154	14.9			708,684	50.07
	Total domestic non-interisland routes: The Balearic Islands		**9,953,505**	**3,327,714**	**33.4**			**179,049,533**	**53.81**
	TOTAL BALEARIC ISLANDS		**10,869,334**	**4,034,870**	**37.1**			**212,759,746**	**52.73**
TOTAL			**23,919,319**	**11,254,380**	**47.1**			**697,314,078**	**61.96**

(1) HH index ((Herfindahl-Hirschman): it is calculated by squaring the market share (in percentage) of each operator, and then summing the resulting numbers.
(2) Data from July 2018 to June 2019.

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