Modelling regional accessibility towards airports using discrete choice models: an application to the Apulian airport system

Angela Stefania Bergantino [1*], Mauro Capurso[2], Stephane Hess[2]

[1] *Department of Economics, Management, and Business Law, University of Bari, Italy*
[2] *Institute for Transport Studies & Choice Modelling Centre, University of Leeds, United Kingdom*

Abstract

At the Regional level, accessibility is one of the key factors in airports' provision. An efficient public transport network can represent an alternative to maintaining costly and inefficient airports in the same catchment area, notwithstanding residents' pressures to have a "local" airport. At the same time, airports can better exploit economies of scale aggregating demand. In this paper, we analyse residents' decisions regarding airport access mode in the Apulia region, in Italy, which is characterised by the presence of a system of "local" airports, of which two not fully operating. Both revealed and stated preferences data are collected and are used to estimate probabilistic models (multinomial, nested logit, and mixed logit) in order to calculate the relevant elasticities of dedicated public transit services. Moreover, we measure the effectiveness of specific policies/actions aimed at generating a modal shift from private modes (car and taxi) to public transport, rationalising mobility towards the existing airports..

Keywords: Airports, Regional accessibility, Revealed and Stated preferences.

---

1. Introduction

In the last decade there has been a significant increase in point to point flights due to the advent of low fare operators. In Italy, the share of traditional operators has reduced by about 30% in the last decade, but the number of connection has risen, in the same period, by about 25%.

A stimulus in this direction has come from the involvement of local authorities and airport managing companies in promoting the presence of low fare operators, also through public financing. As an indirect consequence, the number of small/medium size airports in the same catchment areas, often competing for the same traffic, also increased. Currently, 41 airports are open to commercial services, although almost half of them (18) have less and 1 million passengers.

This situation is dictated by a number of factors, among which, accessibility conditions play a role. There is an extensive literature on the role of accessibility in orienting, to a certain extent, traveller's airport choices. The latter are not only driven by price and quality

---

* Corresponding Author: Angela Stefania Bergantino (angelastefania.bergantino@uniba.it)

of air services offered at a specific airport, but they also depend on the time and cost required to access it. Given this, the perceived "need" of having a "local" airport – which translates in political pressures for maintaining in operation of opening smaller airports – are inversely related to accessibility towards larger ones.

As the Air Transport and Airport Research Center (ATRC) 2010's Report underlines, several elements of accessibility of airports have changed in the past decades. Although road accessibility continues to play an important role – as car access is still predominant at the majority of airports (well over 50%), and the provision of car parking facilities constitutes a major source of revenues in the non-aviation business of an airport –, more and more airports throughout Europe see rail access as an important factor to extend their catchment area. Rail is seen as an environmentally friendly mode, and the integration of airports into the railway network (especially for high speed services) has made considerable progress in recent years, notwithstanding the relevant public funding often needed in order to realise the network and operate the services. Bus services also maintain a relevant share of passengers, although the lack of an overall planning of the services – which involves often a number of private and public players – limits its potential development.

In areas where a railway link is not functioning or its potential is not fully exploited, or public transit services are lacking either in number or quality, airport accessibility is hampered, and the requests for "local" airports are stronger. However, direct and indirect costs of operating more airports in the same catchment area, or of financing air services through public subsidies when the aggregated demand is not sufficient, are typically ignored. Moreover, the trade-off between the cost of granting "local" airports due to political pressures, independently of their economic viability, and investing to improve airport accessibility through stable and dedicated services, is often disregarded. This is particularly true when the investors are public, or split among different entities.

In this paper, we analyse residents' decisions regarding airport access mode in the Apulia region, in Italy, which is characterised by the presence of a system of "local" airports, two international (Bari and Brindisi), and two no longer in use for commercial aviation (Foggia and Grottaglie). Bari and Brindisi airports are very well connected to the respective city centres, with a rail link (Bari) and frequent local bus services. However, the main tourist attractions in the surrounding, which are also densely populated areas (Gargano, Salento, and Matera - the European Capital of Culture for 2019), are not as easily accessible by public means. For this reason, residents ask, continually, the Regional government to re-open to commercial aviation Foggia and Grottaglie airports, which would serve those areas. Furthermore, Apulian airports are managed by the same privately managed company, "Aeroporti di Puglia - AdP", which is fully controlled by the Apulian Regional government. As a result, unlike other multi-airport areas, the two operating airports do not compete directly with each other, although they partly share the same catchment area.

For this analysis, both revealed preferences (RP) and stated preferences (SP) data have been collected amongst residents of those less accessible areas, which, currently, heavily depend upon private modes of transportation. Multinomial logit (MNL), nested logit (NL), and mixed logit (MMNL) models have been estimated using both sources of data.

The overall aim of this analysis is to assess the effectiveness of several policy measures and actions designed to provide a modal shift from private (car and taxi) towards more environmental friendly modes (bus and train). Due to travellers' high sensitivity to access time (which increases with the distance to the airport), public transport modes have the potential to achieve larger market shares by increasing their frequency or reducing travel time. Improving accessibility to the two already operating airports would be a more economically sustainable (but also politically acceptable) alternative to the re-opening of the other two small "local" airports.

Results confirm the expectations: there is a small shift towards direct services. The latter, however, is minimal if considering the actual market shares, even when headway time is reduced by 60% at no incremental cost. Similarly, there would be a negligible shift towards the mixed transport alternatives when the in-vehicle travel time is reduced by 30% (a more feasible solution in the short run achieved by reducing the number of intermediate stops).

Finally, this work also analyses the potential impact on elasticity measures derived from the introduction of completely hypothetical direct rail connections between the touristic cities of the region and Bari airport, where a railway station is already available.

The remainder of the paper is as follows. The literature on airport ground accessibility is reviewed in Section 2. In Section 3 the geographical context of this analysis is described, together with the characteristics of the currently available alternatives. Section 4 is dedicated to the data requirements and to the SP survey design, while the main features of the collected data are presented in Section 5. Section 6 provides an outline of the empirical strategy. Section 7 discusses the results from models estimation and the elasticity measures, and contains the analysis of alternative policies. Finally, Section 8 reassembles some conclusions of this work.

2. Literature review

The literature on airport accessibility mainly relies on studies using RP and/or SP data and discrete choice models to estimate the probability for a certain access mode of being chosen. The choice set typically includes the alternatives already available, although very few case studies also evaluate potential market shares for new modes that are not yet available. Recently, more sophisticated model structures (cross-nested logit models) have been used to jointly estimate the probability of choosing an airport and an access mode, or an airport and an airline, or the combination of these three (airport/airline/access mode), especially when multiple airports exist over the same catchment area. Finally, several works focus only on specific categories of travellers and airport users (e.g. elderly people or airport employees). In the remainder of the section, a review of the most interesting works is carried out, grouping them in sub-sections according to their main focus.

2.1. Airport accessibility at specific airports

Among the first authors interested on this topic, Harvey (1986) analyses the behaviour of departing passengers in the San Francisco Bay area using a sample drawn from residents. After segmenting between business and non-business travellers, he estimates an MNL model that shows that business travellers are particularly sensitive to access time. However, their perception towards access cost does not greatly differ from the perception of non-business travellers.

Jehanfo and Dissanayake (2007) use a sample of residents segmented according to three criteria (reason for the trip – leisure or business, destination – domestic or international, and income – more or less than 20,000 pounds/year) to explain travellers' access mode choice to Newcastle airport. They estimate group-specific MNL models that define the utility function for each alternative in terms of access time, car ownership, party-size, and luggage count. They find that the availability of an extra car in the household substantially increases the probability of using a car (long-stay) rather than a bus, while this slightly reduces if a 10-minute increase in travel time by car occurs. Similarly, the odds of being dropped-off rather than using a bus is slightly reduced if the party size increases by one member.

Alhussein (2011) estimates a binary logit model to estimate probabilities of using a private car rather than a taxi to access King Khaled International Airport in Riyadh. Public transport is also available at this airport, but its share is very small. For this reason, the author decides to only concentrate on private car and taxi, and he finds that access time, luggage count, income, and nationality statistically affect mode choice.

In two different works, Tam et al. (2008, 2011) look at travellers' behaviour in accessing Hong Kong airport. In their first paper, they focus on the role of what they call "safety margin", defined as the difference between travellers' preferred and expected arrival time at the airport. They show that this influences mode choice for the business passenger more than for non-business passengers. In the second paper, they also focus on travel time reliability to access the airport. They estimate an MNL model with the inclusion of latent psychological variables related to travellers' satisfaction level (waiting time, travel time and travel time reliability, travel cost and walking distance to/from stations or car parks) constructed using structural equation modelling, which is found to provide higher explanatory power.

Finally, Akar (2013) estimates the probability of choosing a mode different from car to access Columbus airport in Ohio. He first conducts an exploratory principal component analysis to evaluate respondents' attitudes towards car use though a series of statements. Then, these principal components are introduced as regressors in a binary logit, and the probability of shifting from car is separately estimated for business and non-business travellers. Results indicate that reliability, travel time and frequency are important factors in conditioning possible shifts towards alternative modes, especially for travellers on business trips and flying alone.

2.2. *Case studies on the introduction of a new mode*

Monteiro and Hansen (1996) evaluate the potential for an extension of a rapid transit link in reinforcing the dominance role of the San Francisco International Airport in the Bay Area. They estimate two models: 1) an NL model in the airport-choice decision is included at the higher level, and the mode-choice decision is included at the lower lever; and 2) an MNL model is used only to explain access mode choice. In terms of results, they find that ground access is the most important attribute in conditioning airport attractiveness, and they also compare the current levels for access services with those under different scenarios. They consider five different improvements in levels for access services, also including an extension of the rapid-transit link to San Francisco International Airport. This extension is found to reinforce the dominance of San Francisco airport, diverting passengers from the Oakland airport.

Tsamboulas and Nikoleris (2008) employ a different approach to examine the effects of the introduction of a new and faster express bus service connecting Athens' main bus terminal to the airport, which could reduce access time by 15 minutes. In a first step, through a binary probit model, they estimate the probability that respondents have a positive willingness-to-pay (WTP) to reduce access time. They find that business travellers exhibit a higher WTP than non-business travellers (1.80 € vs 1.40 €). In a second step, they use an ordinary least squares (OLS) linear regression to show that 40% of the bus passengers are willing to pay additional 2.10 € to use the express line.

Cirillo and Xu (2010) use an NL model to evaluate the potential market share for a new cybercar service to access the Baltimore Washington International airport. They collect and use both RP and SP data in the estimation. In particular, the SP experiment consists of two parts. In the first part, respondents are asked to choose among the existing modes (car, transit, and taxi) and the cybercar, with attribute levels modelled according to RP values. In the second part, the choice set contains only two cybercars, characterized by different attributes. Results show the cybercar to exhibit the largest market share, besides higher values of travel-time savings ($64/h), compared with those for the other modes.

Jou et al. (2011) estimate an MMNL model using RP and SP data to understand the impact on modal shares for public and private modes of a new mass rapid transport mode at the

Taoyuan International Airport in Taiwan. Their results indicate both in- and out-of-vehicle travel time to affect access mode choice, together with the number of changes (direct services were preferred) and convenience of luggage storing. They find, instead, that access cost is a less important factor.

2.3. *Joint modelling of the choice of airport, airline, and access mode*

In a first paper, Pels et al. (2001) estimate an NL model for the San Francisco Bay Area to jointly model the choice of the airport (at the upper level) and of the airline (at the lower level). In a subsequent work (2003) they jointly model the choice of the airport and of the access mode. Their results show access time to be the most important factor in determining airport choice in a multi-airport area. However, while business travellers place a higher value for access time than leisure ones, the opposite occurs for travel cost.

Basar and Bhat (2004) develop a different approach for the same multi-airport area. These authors develop a probabilistic choice set MNL structure according to which an airport is included in the choice set for a respondent if its consideration utility is greater than a threshold utility. This model is found to outperform a simpler MNL model, and estimation results show how access time is the most influential factor airport choice. Similarly, flight frequency is a determinant for considering an airport.

Hess and Polak (2006) first jointly model the choice of an airport, airline, and of the access mode. They estimate a cross-NL model using a sample of resident business travellers from the Greater London area. Each alternative is assumed to belong to one airport nest, one airline nest, and one access-mode nest. Given that the sample is not representative of the current traffic at each airport, they employ the weighted exogenous sampling maximum likelihood approach to correct for the sampling bias. Respondents report that the choice of an airport, origin, flight availability and departure time are the most important in making a decision. However, proper modelling results find a significant role for access cost, in-vehicle access time, flight frequency and departure time. Seat capacity, parking cost, out-of-vehicle access time, waiting time, and number of interchanges are found to not be statistically significant.

Gupta et al. (2008) also estimate an NL model with the choice of the airport at the upper level and that of the access mode at the lower one. Their interest is in understanding passenger behaviour in the New York City metropolitan region, characterised by the presence of three international airports and six smaller commercial ones. However, they find an MNL specification to be preferred over the NL one. Similar to previous studies, they find that access time is a more important condition for airport choice for business travellers more than for leisure travellers, together with the distance to the airport, average yield, and river crossing. They also find that access time and cost, together with travellers' socio-demographic characteristics and air party size, determine access mode choice.

2.4. *Focus on particular categories of airport users*

Chang (2013) analyses access mode choice decisions of elderly passengers in Taiwan, using a sample of elderly and non-elderly travellers. Elderly travellers state factors such as ''safety'', ''user friendly'', and ''convenience for storing luggage'' as the most important factors in determining the choice of the access mode to the airport. He carries out an importance-performance analysis to examine any differences between expectations and the perceived performance between the two groups. This analysis shows a statistically significant difference for punctuality and waiting time (importance dimension), rapidness, waiting time, number of transfers needed, and convenience for storing luggage (satisfaction dimension). Then, the author conducts a series of hierarchical logistic regression analyses aimed at exploring the relative importance of these factors in affecting access mode choice for elderly people. He finds that this group prefers to be dropped-off at the airport by a family member in 34% of cases, followed by taxi (24.4%), while non-elderly passengers slightly prefer taxi to mass rapid transit (27.5 vs. 27.3%).

Finally, it is also worth noting the work by Tsamboulas et al. (2012), which focuses on access mode choice for airport employees. From a policy perspective, their analysis sounds very effective, given that this particular segment of airport users tends to prefer private access mode to a public one, while also being more easily targeted for policy interventions. A sample of employees at the Athens International Airport was asked to fulfil both an RP and an SP survey. Only two attributes (access time and cost) and two levels (current level and a percentage change of 20%) characterised the presented alternatives in the SP experiment. Their results show the negative sensitivity of employees to both travel time and cost. Moreover, they find that a suburban rail service with travel time like that of car, priced at a competitive fare, could make them to shift from private to public access modes.

3. The geographical context and the Apulian airport network

Figure 1 describes the geographical area that is analysed in this work, where the white luggage shows the position of the cities of interest.

Figure 1. The geogaphical context

Source: Authors' elaboration.

Bari and Brindisi airports (light blue planes) are managed by the regional government-owned company "Aeroporti di Puglia - AdP" on the basis of a 40 years' concession granted from the National Civil Aviation Authority (ENAC). The Apulian airport network also includes the smaller regional airports of Foggia and Grottaglie (red planes), which are no longer in use for scheduled commercial services. While the former hosts helicopter services mainly directed to the Tremiti slands[1], the latter has been completely devoted to intercontinental cargo services. [2] In recent months, Grottaglie airport hosted trial tests for driverless planes (drones). Table 1 describes the main features of the Apulian airports.

Table 1. The Apulian airport network

	Classification	Direct link with city centre	Car Accessibility (residents, within 90 min)	Rail Accessibility (residents, within 60 min)	Distance from Major Centres
Bari International Airport "Karol Wojtyla"	National Interest	Rail, Bus (8 km)	3,150,000	1,460,000	Matera, 75 km Taranto, 105 km Brindisi, 110 km Foggia, 135 km Potenza, 135 km
Brindisi International Airport	National Interest	Bus (6 km)	2,700,000	900,000	Lecce, 35 km Taranto, 75 km
Foggia "Gino Lisa"	Regional	na	2,220,000	490,000	Bari, 135 km Naples, 170 km Pescara, 190 km
Grottaglie "Marcello Arlotta"	Regional	na	1,740,000	720,000	Taranto, 20 km Brindisi, 50 km Matera, 80 km Lecce, 85 km

The city of Matera is undoubtedly one of the most interesting tourist destinations in Italy. The European Capital of the Culture 2019 is famous for its extensive network of cave-dwellings, called "*sassi*" (UNESCO World Heritage Site), where hundreds of families still lived until the 1950s. Despite this, Matera is the only county-town in Italy that is not connected to the national railway network, and a private concessionary railway links this centre with Bari, with scheduled services operated with old-fashioned diesel carriages. Matera does not even have a city airport, and accessibility on the airside is ensured through the airport of Bari. Among other things, the "Matera 2019" committee aims at improving the accessibility between Bari and Matera (Matera 2019 Application Pack, 2013). To this purpose, 50 mil EUR have been promised for the upgrade of the railway line Matera - Bari, while 1.2 mil EUR will be devoted to the improvement of the airport shuttle service. With respect to the latter intervention, in September 2016, the regional Government of Basilicata

[1] In the past, a very small number of scheduled flight services were also active at Foggia airport (mainly towards Milan, Turin, and Palermo). However, these services were highly subsidised. As soon as the start-up contracts ended, the carriers decided to no longer offer those services because they were not profitable. According to a more recent report of Bocconi University and CERTeT centre (2014), residents' demand could be satisfied with the introduction of a daily direct flight to Milano Linate, where travellers could find connecting flights for all major European destinations. They proposed to subsidise the service in a regime of public service obligation for 1.2 mil EUR/year, with an estimated number of passengers of 40,000/year. Moreover, a project for an upgrading of the runway is in place, with an estimated cost of 14 mil EUR. The Regional government would like to finance the upgrading of the runway through European funds, although several issues are stopping its implementation (state-aid legislation).

[2] Grottaglie airport is mainly used for military and cargo purposes. In 2006, the airport was upgraded, following the opening in the nearby of an Alenia - Finmeccanica factory, where fuselages for Boeing 787 are produced.

committed itself to increase the number of daily services from the actual 5, to 17-18 each way. The service is currently offered with 29-seat buses, and the amount of additional resources available translates into a subsidy of 126 EUR for any additional service (4.34 EUR/additional seat).

4. Data requirements

Data for this analysis were gathered through paper-based surveys from a sample of residents in five large cities (Altamura, Foggia, Gravina in Puglia, Matera, and Taranto) during two waves in November 2015 (first) and November 2016 (second). The survey consisted of three parts. In the first part, respondents were presented with an SP experiment. They were first asked to choose among the alternatives currently available from their departure place to their preferred airport (5 choice tasks), and then to choose from an enlarged choice set which contained a hypothetical new alternative, a direct train to the airport (additional 5 choice tasks). The second part contained several detailed questions regarding their last trip to the airport (RP on the last access mode used), and their last air journey (airline, destination, reason of the trip, flight duration and cost, number of baggage, air-party size). The third part collected respondents' socio-economic information.

4.1. The SP experiment and the survey design

The SP experiment was created using a set of city-airport-specific Bayesian efficient designs and the software NGene (Choice Metrics, 2012). Priors for the identification of the efficient design for the first wave were obtained from a pilot study on the same reference population, where the SP experiment was created using an orthogonal fractional factorial design with blocks. For the second wave of the data collection, new efficient designs were created using parameters' estimates obtained from preliminary modelling using the data gathered from the first wave. Different efficient designs were produced, and their efficiency was evaluated with respect to the *D-error* criterion (Rose et al., 2008). Fifteen choice tasks were produced in each design, which were grouped into three blocks of five choice tasks each. Hence, respondents were asked to only complete ten choice tasks (5 + 5) instead of thirty, in order to reduce the risk of boredom and fatigue.

With respect to the attributes that characterise the alternatives, these are chosen among those attributes mostly used in the literature, and are modelled starting from the current provision (Table 2). In particular, we decided to separately consider in-vehicle and out-of-vehicle travel time (defined for the mixed-transit options as the time spent in waiting between two connecting services), travel cost (defined as the ticket price for both mixed-transit and direct bus/train alternatives, the taxi fare, or the total amount outlaid for car trips including fuel costs, highway tolls, and parking fees), and headway time (defined for the mixed-transit options and the direct bus as the time between two consecutive services to the airport). Moreover, the order of the alternatives presented across respondents was also randomised in order to avoid possible *left-to-right* effects (i.e., always choose the first alternative on the left).

Table 2. Status quo options on the considered access routes

	Travel Time (min.)	Travel Cost (€)	Headway (min.)
Matera - Bari	*(in-vehicle/out-of-vehicle)*	*(fare/fuel+toll+parking)*	*(next ride after)*
Mixed Transit: Train + Train	123/17	9.90	74
Mixed Transit: Train + Bus	150/30	8.90	74
Direct Bus (AirShuttleBus)	75	6 (3 today)	220 (5 rides/day)
Car Driver	+ 5 min. (parking)	21.40 (6.40+15)	na
Car Drop-off	+ 10 min. (to say goodbye)	14.3 (12.80+1.5)	na
Taxi (Private Hire Licensing)	60-70 (depending on drop-on)	90-120 (4-8 persons)	na
Taranto - Bari			
Mixed Transit	107/23	11.85	72
Direct Bus	70 (from Central Rail Station)	9.5	300 (2 rides/day)
Car Driver	+ 5 min. (parking)	34.24 (14.44+4.80+15)	na
Car Drop-off	+ 10 min. (to say goodbye)	39.98 (28.88+9.6+1.5)	na
Taxi (Private Hire Licensing)	60-90 (depending on drop-on)	45 (pp)	na
Foggia - Bari			
Mixed Transit	95/57	13.10	105
Direct Bus	90 (from Central Rail Station)	11	213 (5 rides/day)
Car Driver	+ 5 min. (parking)	33.24 (10.44+7.80+15)	na
Car Drop-off	+ 10 min. (to say goodbye)	37.98 (20.88+15.6+1.5)	na
Taxi (Private Hire Licensing)	80-100 (depending on drop-on)	na	na
Taranto - Brindisi			
Mixed Transit	68/27	5.90	97
Direct Bus	70 (from Central Rail Station)	5.50	233 (5 rides/day)
Car Driver	+ 5 min. (parking)	25.14 (10.14+15)	na
Car Drop-off	+ 10 min. (to say goodbye)	21.78 (20.28+1.50)	na
Taxi (Private Hire Licensing)	60-80 (depending on drop-on)	35 (pp)	na

Source: Authors' elaboration based on operators' websites and www.viamichelin.com.

5. Collected data descriptive statistics

The data comprise both *revealed* and *stated* preferences plus answers to socio-demographic questions for a sample of 1062 air users who reside in the cities of Matera, Altamura, Gravina in Puglia (MAG, 539), Taranto (464), Foggia (61). However, for those respondents who took part in the pilot survey (314) only the RP information was retained, and used to better calibrate the SP information coming from the 2 official waves. Respondents were selected among those who travelled at least once in the previous three months through either Bari (77%) or Brindisi (23%) international airports. Given the unavailability of official figures that represent the socio-demographic composition of airport users, respondents were chosen to be representative of the resident population in terms of sex and age bands, even though some categories appeared to be slightly under-represented (Table 3). Individuals belonging to the under-represented classes were also those who were expected to travel less (e.g. individuals aged 50 and over).

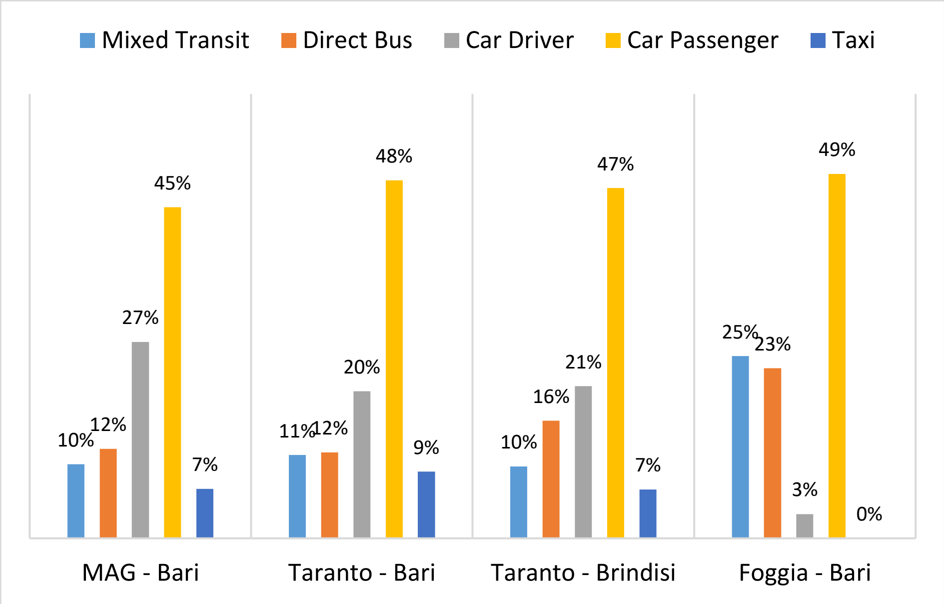
Table 3. Demographic characteristics of the sample with respect to the actual population

	Demographic Class	N	Sample Quota	Population Quota	Difference
Matera Altamura Gravina in Puglia	Male 18-24	81	15%	5%	53
	Female 18-24	60	11%	5%	34
	Male 25-34	93	17%	8%	49
	Female 25-34	75	14%	8%	31
	Male 35-49	78	14%	16%	-6
	Female 35-49	56	10%	16%	-30
	Male 50+	46	9%	20%	-62
	Female 50+	50	9%	22%	-69
Taranto	Male 18-24	54	12%	5%	29
	Female 18-24	55	12%	5%	32
	Male 25-34	91	20%	8%	56
	Female 25-34	83	18%	8%	32
	Male 35-49	57	12%	14%	-9
	Female 35-49	60	13%	15%	-10
	Male 50+	32	7%	21%	-66
	Female 50+	32	7%	24%	-79
Foggia	Male 18-24	5	8%	6%	2
	Female 18-24	10	16%	5%	7
	Male 25-34	17	28%	8%	12
	Female 25-34	9	15%	8%	4
	Male 35-49	9	15%	14%	0
	Female 35-49	7	11%	15%	-2
	Male 50+	2	3%	21%	-11
	Female 50+	2	3%	23%	-12
Full Sample		1062			

Source: Authors' elaboration based on the collected data.

According to the revealed information on the ground access mode chosen for the last trip, private means were strictly preferred to public ones (Figure 2). In particular, the car drop-off option was the most preferred, especially on the Taranto-Bari access route, followed by the car driver option. Taxi was the least preferred.

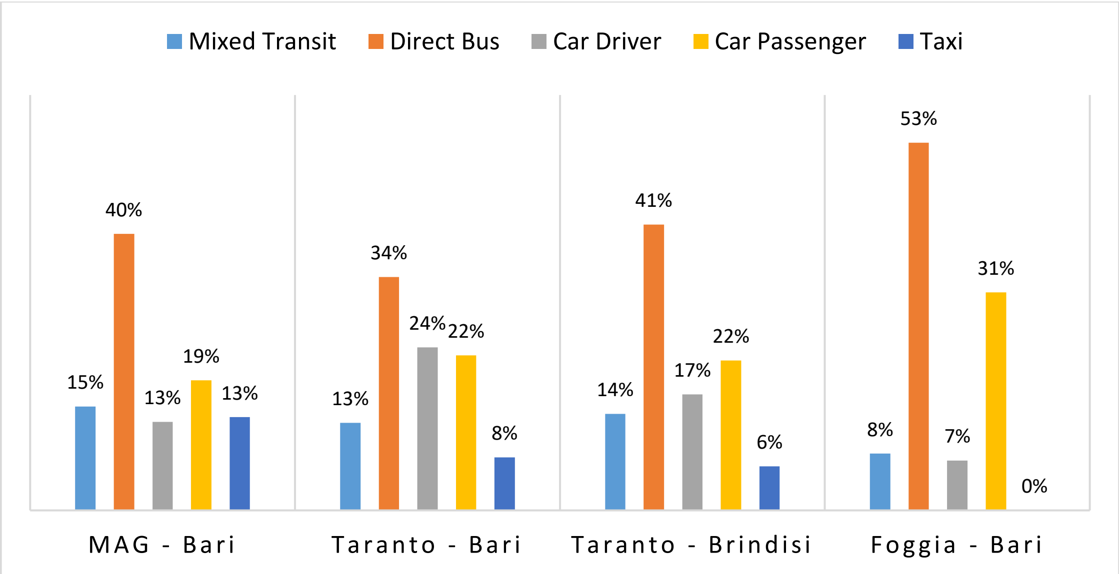
Figure 2. The chosen mode on the last trip (RP)



Source: Authors' elaboration based on the collected data.

Interestingly, the direct bus option becomes the most preferred alternative during the SP experiment for all considered access routes (Figure 3) at the expense of the car drop-off option. A possible explanation to this is that direct costs for all alternatives were shown in the SP experiment, while individuals do not typically pay for being dropped off to the airport by friends and relatives.

Figure 3. The chosen mode in the SP experiment



Source: Authors' elaboration based on the collected data.

6. Methodology

In recent decades, various approaches have been used to analyse decisions related to airport accessibility. However, many of them are rooted in the random utility maximisation theory

(RUM, McFadden, 1974). According to this theory, individuals, *n*, aim a maximising their utility in a choice occasion *t*, and for access mode *i*, which is defined by equation 1:

$$U_{n,t}(i) = V_{n,t}(i) + \varepsilon_{n,t}(i), \tag{1}$$

where $V_{n,t}(i)$ represents the deterministic component of utility, and $\varepsilon_{n,t}(i)$ its random component. According to the theory, individuals will choose the access mode among those that are available to them (C_n), and which provides the highest utility. Hence, the probability of an access mode being chosen, $P_{n,t}(i)$, is defined by equation 2:

$$P_{n,t}(i) = P\big(V_{n,t}(i) + \varepsilon_{n,t}(i) \geq V_{n,t}(j) + \varepsilon_{n,t}(j), \forall\, j \neq i \in C_n\big) \tag{2}$$

Then, by assuming that the random components are independently and identically extreme value (Gumbel) distributed (*iid*), it is possible to represent this probability using a multinomial logit model (MNL, equation 3):

$$P_{n,t}(i) = \frac{exp(V_{n,t}(i)\,)}{\sum_{j \in C_n} exp(V_{n,t}(j))} \tag{3}$$

The assumption of considering the random components as *iid*, although it leads to a convenient form for the specification of the alternatives' probabilities, has some limitations. If the random components among groups of alternatives are somehow correlated, rather than independently distributed, the MNL model is not able to account for this. The MNL model is built on the so-called irrelevance of independent alternatives (IIA) assumption that states that the choice between any two alternatives is independent on a third alternative. The main limitation of the IIA assumption comes together with forecasting, rather than at the estimation stage. At the individual level, if an alternative becomes more or less attractive in terms of its characterising attributes, the MNL model will predict a proportional substitution towards the other alternatives, which might appear unrealistic in many cases. One solution to this problem is to relax the IIA assumption, allowing the error terms to be somehow correlated among two or more alternatives. This is exactly what the nested logit (NL) model (Daly and Zachary 1978) assumes. In this model, the choice set is divided into mutually exclusive *nests* of alternatives. Each alternative can belong to only one nest, and we assume that the error terms of the alternatives in each nest are correlated. As a result, there will be higher cross-elasticities between alternatives in the nest with respect to alternatives in another nest. Analytically, the probability of choosing an alternative according to the NL model can be described as the joint probability of choosing an alternative conditional on the probability of this alternative of belonging to a pre-determined nest $m \in M$ (equations 4-7):

$$P_{n,t}(i) = P_{n,t}(S_m)\, P_{n,t}(i|S_m), \tag{4}$$

where:

$$P_{n,t}(S_m) = \frac{exp(\lambda_m I_m)}{\sum_{m \,\in\, M} exp(\lambda_I I_I)}, \tag{5}$$

$$P_{n,t}(i|S_m) = \frac{exp(V_{n,t}(i)/\lambda_m)}{\sum_{j \,\in\, S_m} exp(V_{n,t}(j)/\lambda_m)}, \tag{6}$$

and:

$$I_m = ln \textstyle\sum_{j \,\in\, S_m} (V_{n,t}(j)/\lambda_m) \tag{7}$$

In this work, three different nesting formulations were assumed and compared in terms of statistical fit. In the first one, direct- access modes and non-direct ones are grouped in two separate nests, while the car driver alternative stays alone in a third nest (NL1). In the second formulation, access modes are grouped into 4 separate nests. Mixed-transit modes are grouped in one nest, direct bus stays alone in another nest, private modes (car driver and car drop-off) are nested together, and taxi stands alone in a fourth nest (NL2). Finally, in a third formulation, three separate nests are created. Mixed-transit modes are together in one nest, direct bus and taxi are in another nest, and private modes (car driver and car drop-off) are in the last one (NL3).

Correlation of alternatives within the nest is measured by the nesting parameter (λ_m), which is normalised to lie between 0 and 1, hence keeping consistency with utility maximisation. This means that a value of 1 (0) for this parameter means zero (full) correlation.

A second limitation of the MNL model is that while systematic taste variation can be accommodated within this model (through respondents' segmentation), this is not the case for random variation in tastes across individuals. To overcome this limitation, mixed multinomial logit (MMNL) models (Train, 2002) are now extensively used in all fields. However, they need some *a priori* assumptions regarding the mixing distribution for random coefficients. With respect to previous applications related to access mode choice, a normal distribution for random coefficients has been proven to better accommodate the data (equation 8):

$$\beta_x \sim N(\mu_x, \sigma_x), \text{ with } \phi\ (\mu_x, \sigma_x) = \frac{1}{\sigma_x\sqrt{2\pi}} exp(-\frac{(\beta_x - \mu_x)^2}{2{\sigma_x}^2}) \tag{8}$$

It is possible to re-define the unconditional choice probability, assuming constant tastes across respondents, as (equation 9):

$$P_{n,t}(i|\mu_x, \sigma_x) = \int\limits_{\beta_x} \left[\prod_{t=1}^{T_n} \frac{exp(\beta_x x(i))}{\sum_{j\in C_n} exp(\beta_x x(j))} \phi\ (\mu_x, \sigma_x) \right] \mathrm{d}\beta_x \tag{9}$$

However, the maximization of the MMNL choice probability, which is given by this integral, does not have a closed solution. Hence, simulation with draws is needed, which replaces the continuous integral with a summation (equation 10):

$$P_{n,t}(\widehat{i|\mu_x}, \sigma_x) = \frac{1}{R}\sum_{r=1}^{R}\left[\prod_{t=1}^{T_n} P_{n,t}(i|(\mu_x, \sigma_x)^r)\right] \tag{10}$$

This approximation assumes the estimation of a simulated log-likelihood function $\widehat{L_n(\phi)}$.

In this paper the MNL, the NL, and the MMNL models have been estimated, keeping the structure of the utility functions constant. These include alternatives' core characteristics (travel time, travel cost, headway), as well as features of respondents' last trip (i.e., departing airport, pieces of luggage, air party size, trip destination), and their socio-demographics (age, sex, education). We decided not to, *ex-ante*, divide respondents by trip purpose, hence, we did not estimate different models for business vs non-business travellers; instead we used separate coefficients that accounted for this within a single estimation.

To exploit the relative advantages of RP and SP data, both sources were used in the estimation. When available, RP data should be used to calibrate the SP data (which refers to hypothetical situations) with respondents' actual behaviour (Morikawa, 1989). This issue sounds particularly relevant when the SP data contain a new alternative not available yet, in order to reduce the hypothetical bias. However, RP and SP data cannot be directly used together because they might show errors in the independent and dependent variables, respectively (de Dios Ortuzar and Simonetti, 2008). To overcome this problem, Ben-Akiva and Morikawa (1990) propose to estimate an additional scale parameter, μ, which is multiplied by the RP utilities to yield errors of the same variance. Respondents' utility functions for each alternative can be re-written as in equations 11-12 (de Dios Ortuzar and Simonetti, 2008 and Cirillo and Xu, 2009):

$$\mu U_{n,t}(i)^{RP} = \mu(V_{n,t}(i)^{RP} + \varepsilon_{n,t}(i)^{RP}), \forall\, i \in C_n{}^{RP} \tag{11}$$
$$U_{n,t}(i)^{SP} = V_{n,t}(i)^{SP} + \eta_{n,t}(i)^{SP}, \forall\, i \in C_n{}^{SP} \tag{12}$$

This implies that the scale factor for SP data is normalized to 1.

7. Results

This section is further articulated in four sub-sections. In the first sub-section, we present and discuss the results for the MNL and the NL models (three different specifications). The second sub-section contains the elasticities and the policy analysis. In the third sub-section, we report the results of the estimation of two MMNL models. Finally, the fourth sub-section contains the results for the MNL and the NL models when a new hypothetical alternative is added to the choice set.

In this work, the attribute "travel cost" for the car alternatives (car driver, car drop-off, and taxi) is modified in the estimation to take into account the number of passengers. It is reasonable to assume that although the travel cost for these modes might be greater in absolute terms than for the other modes, this no longer is the case if the travel costs are split among the passengers. This variable has been parameterised to the number of travellers using the following formula (13):

$$travel\_cost_{car\_taxi} = \frac{travel\_cost_{car\_taxi}}{(1 + \ln(party\_size))} \tag{13}$$

7.1. The MNL and the NL models

Table 4 shows that now the NL2 model over performs the MNL model. Differences with the other NL specifications are very limited, and slightly more accentuated if considering the AIC and BIC criteria. For this reason, the MNL is now compared with the second NL model (NL2).

Table 4. Model comparison

	MNL	NL1	NL2	NL3
LL(0):	-9355.936			
LL(final):	-6936.943	-6927.357	-6926.38	-6926.377
AIC:	13939.89	13924.71	13922.76	13924.75
BIC:	14153.66	14151.45	14149.49	14157.96
Rho-sq (adj.):	0.26	0.26	0.26	0.26
Estimated parameters:	33	35	35	36

Previous literature reports that business travellers place a higher value on travel time and a lower value on travel cost compared to travellers on non-business trips. Business users who drive to the airport might be interested in reducing the risk, at any cost, of not getting to the airport, and this risk is likely to be reduced only if they use their own car. The results partially confirm this hypothesis (Table 5). Travel costs have a lower (negative) influence on the utility of business travellers than on the utility of non-business travellers. Results regarding travel time is rather mixed: negative coefficients are obtained in all cases but for car driver (business); however, in many cases, the coefficient is not statistically different from zero, (e.g. car drop-off or direct bus for non-business travellers). Interestingly, results also show a greater negative impact on utility for the travel time on the taxi mode for respondents on non-business trips.

Table 5. Results of the MNL and NL2 models (business vs non-business trips)

	MNL		NL2	
	est	t_ratio (0)	est	t_ratio (0)
ASC Direct Bus	3.159	6.60	2.810	6.97
ASC Mixed Transit 1	0.375	0.78	-2.045	-1.88
ASC Mixed Transit 2	-0.066	-0.15	-3.452	-2.40
ASC Mixed Transit 3	0.769	1.64	0.705	1.76
ASC Car Driver	-0.539	-1.54	0.110	0.58
ASC Taxi	-0.417	-0.89	-0.529	-1.24
In-Vehicle Travel Time Mixes Transit (business)	-0.009	-2.07	-0.008	-1.99
In-Vehicle Travel Time Mixes Transit (other)	-0.009	-2.82	-0.010	-2.96
Out-Of-Vehicle Travel Time Mixed Transit (business)	-0.013	-1.36	-0.032	-3.10
Out-Of-Vehicle Travel Time Mixed Transit (other)	0.006	1.06	-0.006	-1.00
Travel Time Direct (business)	-0.006	-1.63	-0.006	-1.82
Travel Time Direct (other)	-0.004	-1.60	-0.003	-1.40
Travel Time Car Driver (business)	0.008	1.49	0.001	0.29
Travel Time Car Driver (other)	-0.008	-1.71	-0.008	-2.84
Travel Time Car Drop-Off (business)	-0.003	-0.48	0.000	0.11
Travel Time Car Drop-Off (other)	-0.002	-0.39	-0.002	-0.56
Travel Time Taxi (business)	-0.011	-1.45	-0.013	-1.89
Travel Time Taxi (other)	-0.023	-3.49	-0.024	-3.81
Travel Cost (business)	-0.024	-2.79	-0.019	-2.89
Travel Cost (other)	-0.043	-7.29	-0.038	-6.92
Headway Mixed Transit	-0.011	-5.09	-0.008	-3.86
Headway Direct Bus	-0.008	-12.98	-0.008	-15.00
Matera-Bari Bus (wrt Taranto-Brindisi)	0.308	2.41	0.296	2.47
Altamura-Bari Bus (wrt Taranto-Brindisi)	0.548	3.31	0.523	3.35
Gravina in Puglia-Bari Bus (wrt Taranto-Brindisi)	0.219	1.09	0.219	1.14
Taranto-Bari Bus (wrt Taranto-Brindisi)	-0.208	-1.66	-0.246	-2.06
Foggia-Bari Bus (wrt Taranto-Brindisi)	0.414	2.50	0.193	2.45
Male (Car Driver)	-0.106	-1.31	-0.026	-0.57
Age (Direct Bus)	-0.036	-8.68	-0.035	-8.93
Baggage (Mixed Transit)	-0.405	-4.27	-0.402	-4.37
Education (Direct Bus)	-0.045	-2.28	-0.043	-2.27
Air Party Size (Taxi)	0.060	3.46	0.059	3.53
Scale SP	-0.308	-20.64*	-0.259	-22.81*
Lambda Mixed Transit (NL2)			4.506	2.98
Lambda Car (NL2)			0.438	4.28
IDs (RP)	1062			
IDs (SP)	749			
Observations	4808			
LL(0):	-9355			
LL(final):	-6936		-6926	
AIC:	13939.89		13922.76	
BIC:	14153.66		14149.49	
Rho-sq (adj.):	0.26		0.26	
Estimated parameters:	33		35	

Estimation results for travel time and travel cost become more interesting when looking at them in terms of *willingness-to-pay* (WTP) measures (Table 6). These are assigned an important role in transport-planning decisions being used as a key input for cost-benefit analysis. When a linear-in-parameters model is estimated, the calculation of the marginal rate of substitution between time and cost can be obtained as the ratio of the coefficients related to travel time and travel cost.

Table 6. WTP for business and non-business trips

	MNL		NL2	
	min (€)	hour (€)	min (€)	hour (€)
Mixed Transit Business (IVT)	0.38	22.73	0.42	25.42
Mixed Transit Other (IVT)	**0.22**	**13.04**	**0.25**	**15.04**
Mixed Transit Business (OVT)	0.53	31.89	**1.66**	**99.59**
Mixed Transit Other (OVT)	-0.13	-7.68	0.16	9.58
Direct Bus Business	0.26	15.66	0.31	18.77
Direct Bus Other	0.09	5.33	0.08	4.91
Car Driver Business	-0.35	-21.07	-0.06	-3.33
Car Driver Other	0.19	11.26	**0.22**	**13.21**
Car drop-off Business	0.11	6.72	-0.02	-1.22
Car drop-off Other	0.04	2.45	0.04	2.63
Taxi Business	0.46	27.83	0.66	39.80
Taxi Other	**0.55**	**32.70**	**0.62**	**37.30**

Note: Statistically significant WTP (p-value ≤ 0.1) in bold.

As expected, WTP indicators for business travellers are larger than for non-business ones; Interestingly, WTP indicators obtained with the NL2 model are overall larger than those obtained with the MNL model, and this sounds particularly evident for the WTP for out-of-vehicle travel time for business travellers.

7.2. Elasticities and policy analysis

When MNL models are used, the direct elasticity of $P_n\ (i)$ with respect to z_{in}, a variable which directly enters the utility for alternative i (e.g. headway time and travel cost for direct bus, or in-vehicle travel time for mixed transit), is given by the following formula (14) (Train, 2002):

$$E_{z_{in}}(i) = \frac{\partial V_n(i)}{\partial z_{in}} z_{in}(1 - P_n\ (i)) \qquad (14)$$

which collapses to $E_{z_{in}}(i) = ß_z z_{in}(1 - P_n\ (i))$ if the representative utility is linear in z_{in} with coefficient β_z. Similarly, the cross-elasticity of $P_n\ (i)$ with respect to a variable that directly enters the utility for alternative j, is given by formula (15) (Train, 2002):

$$E_{z_{jn}}(i) = -\frac{\partial V_n(j)}{\partial z_{jn}} z_{jn}(P_n\ (j)) \qquad (15)$$

which reduces to $E_{z_{jn}}(i) = \beta_z z_{jn} P_n\ (j)$ if the representative utility is linear in z_{jn} with coefficient β_z. The cross-elasticity is the same for all other alternatives.

Direct and cross elasticities when NL models are used equal MNL ones if the alternative for which the elasticity is calculated does not share a nest with the alternative that includes the variable object of the analysis. Given these premises, *RP* direct and cross elasticities are summarised in Table 7.

Table 7. RP direct and cross elasticities

Direct	*Business*	*Other*
Headway Time (bus)	-0.75	
Travel Cost (bus)	-0.10	-0.20
In-Vehicle Travel Time (mixed transit)	-0.65	-0.76
Cross		
Headway Time	0.38	
Travel Cost	0.05	0.10
In-Vehicle Travel Time	0.10	0.11

Note: Based on the NL2 model estimates.

All elasticities have the expected signs. Moreover, business travellers show a smaller (negative) direct elasticity for increases in travel cost for the direct bus, while the opposite occurs when observing direct elasticities for increases in travel time for the mixed-transit alternatives.

The analysis of direct and cross elasticities is followed by the analysis of a set of 10 policies. In particular, we have analysed the effects on market shares due to changes in the headway time and in the travel cost for the direct bus alternative, and on the in-vehicle and out-of-vehicle travel time and travel cost for the mixed-transit alternatives. The analysis of alternative policies is conducted by means of the demand response with respect to the initial situation (16) (Espino et al., 2007):

$$\Delta P\ (i) = \frac{P^1\ (i) - P^0\ (i)}{P^0\ (i)} * 100 \tag{16}$$

where $P^1\ (i)$ is the aggregate probability of choosing alternative i when the policy is applied, while $P^0\ (i)$ is the aggregate probability at the initial situation (do-nothing).

According to the collected RP data, the vast majority of respondents used the car alternatives to access the airports. In particular, the car drop-off mode was the most preferred alternative, followed by the car driver alternative. The direct bus alternative is found to have a very low market share, similar to that of the mixed-transit alternatives. This means that policy measures need to be strong enough to allow for a modal shift from the car alternatives. By looking at respondents' behaviour in the SP experiment, instead, the most chosen alternative is the direct bus. This result is surprising, and a possible explanation might be that when travellers are shown the real cost of all alternatives, they realise that the car alternative is quite expensive compared to other alternatives. The direct bus, for example, is not only cheaper, but it also takes the same time to get to the airport. Results of the policy analysis are reported in Tables 8-10, using the parameters' estimates as shown in the previous sections.

When the headway time for the direct bus alternative is reduced at no additional cost (Table 8), the aggregate choice probability (market share) for this alternative increases up to 34.9% over its initial market share. The NL model shows a more contained increase with respect to the MNL model (34.1%), and a larger expected reduction for the car passenger alternative. In particular, when the headway time is decreased by 60% at no additional costs, the car drop-off alternative loses 18.4% of its market share. At the opposite, the reduction for all other alternatives (mixed modes, car driver, and taxi) is more contained in absolute terms.

Table 8. Reductions in headway time at no additional costs

	MNL	NL2
Scenario 1 (-30% headway direct bus)		
Mixed Transit 1	-9.6%	-6.4%
Mixed Transit 2	-14.2%	-10.6%
Mixed Transit 3	-8.9%	-8.7%
Direct Bus	15.4%	15.2%
Car Driver	-7.8%	-7.3%
Car Drop-off	-6.8%	-7.7%
Taxi	-8.7%	-8.5%
Scenario 2 (-60% headway direct bus)		
Mixed Transit 1	-20.9%	-16.3%
Mixed Transit 2	-24.3%	-19.8%
Mixed Transit 3	-18.2%	-17.6%
Direct Bus	34.9%	34.1%
Car Driver	-17.2%	-16.6%
Car Drop-off	-17.8%	-18.4%
Taxi	-17.4%	-17.0%

Source: Elaboration based on the collected data.

However, it is more reasonable that a reduction in the headway time for the direct bus will be accompanied also by an increase in the travel cost. When both attributes vary (Table 9), the market share for the direct bus still increases by 29.7% when headway time is reduced by 60% with a corresponding increase in the travel cost of 30%. This percentage would be lower if travel cost increased by 60%, suggesting that respondents are not very sensitive to increases in the travel cost of this alternative.

Table 9. Reductions in headway time at a cost

	MNL	NL2
Scenario 3 (-30% headway direct bus, +30% cost direct bus)		
Mixed Transit 1	-7.7%	-4.4%
Mixed Transit 2	-12.3%	-8.7%
Mixed Transit 3	-5.9%	-5.9%
Direct Bus	10.9%	11.0%
Car Driver	-5.7%	-5.4%
Car Passenger	-4.3%	-5.4%
Taxi	-6.6%	-6.5%
Scenario 4 (-60% headway direct bus, +60% cost direct bus)		
Mixed Transit 1	-16.8%	-12.2%
Mixed Transit 2	-20.2%	-15.9%
Mixed Transit 3	-12.0%	-11.9%
Direct Bus	25.3%	25.3%
Car Driver	-12.8%	-12.5%
Car Passenger	-12.5%	-13.6%
Taxi	-12.8%	-12.8%
Scenario 5 (-60% headway direct bus, +30% cost direct bus)		
Mixed Transit 1	-18.9%	-14.2%
Mixed Transit 2	-22.3%	-17.8%
Mixed Transit 3	-15.1%	-14.8%
Direct Bus	30.1%	29.7%
Car Driver	-15.0%	-14.6%
Car Passenger	-15.1%	-16.0%
Taxi	-15.1%	-14.9%
Scenario 6 (-30% headway direct bus, +60% cost direct bus)		
Mixed Transit 1	-5.8%	-2.5%
Mixed Transit 2	-10.3%	-6.9%
Mixed Transit 3	-3.0%	-3.2%
Direct Bus	6.4%	6.9%
Car Driver	-3.7%	-3.5%
Car Passenger	-1.9%	-3.2%
Taxi	-4.5%	-4.5%

Source: Elaboration based on the collected data.

Similarly, when the in-vehicle time for the mixed transit alternative is reduced (Table 10), there is an increase in its market share. However, such increase is far more limited, and it is larger when travel time decreases by 30% at no additional cost (15.7% and 18.5%, on average, with MNL and NL models, respectively). Finally, reductions in out-of-vehicle time (which can be obtained through a better coordination of operators' timetable) also provide an increase in the market share for the mixed-transit alternative. Although positive, this policy is not very effective (5.6% increase in the market share according to the NL2 model).

Table 10. Reductions in in-vehicle and out-of-vehicle travel time

	MNL	NL2
Scenario 7 (-15% IVT mixed transit)		
Mixed Transit 1	9.6%	11.8%
Mixed Transit 2	1.8%	6.1%
Mixed Transit 3	7.7%	8.1%
Direct Bus	-1.9%	-1.9%
Car Driver	-1.4%	-1.1%
Car Drop-off	0.8%	-0.3%
Taxi	-2.7%	-2.6%
Scenario 8 (-30% IVT mixed transit)		
Mixed Transit 1	20.5%	22.2%
Mixed Transit 2	10.0%	15.6%
Mixed Transit 3	16.6%	17.6%
Direct Bus	-3.2%	-3.3%
Car Driver	-2.8%	-2.5%
Car Drop-off	-0.7%	-1.9%
Taxi	-4.0%	-3.9%
Scenario 9 (-30% IVT mixed transit, +15% cost mixed transit)		
Mixed Transit 1	17.0%	19.0%
Mixed Transit 2	6.4%	12.4%
Mixed Transit 3	12.6%	13.9%
Direct Bus	-2.6%	-2.7%
Car Driver	-2.3%	-2.0%
Car Drop-off	-0.1%	-1.3%
Taxi	-3.5%	-3.5%
Scenario 10 (-30% OVT mixed transit)		
Mixed Transit 1	-0.9%	9.0%
Mixed Transit 2	-6.3%	3.5%
Mixed Transit 3	-1.4%	4.4%
Direct Bus	-0.6%	-1.3%
Car Driver	-0.2%	-0.9%
Car Drop-off	2.4%	0.4%
Taxi	-1.5%	-2.3%

Source: Elaboration based on the collected data.

To sum up, any improvement needs to be strongly advertised in order to be effective, given that the modal shift towards more environmental friendly modes is not particularly relevant. Starting from the actual market shares, the car drop-off would still remain the most preferred alternative, even when the direct bus alternative and the mixed transit become more competitive. The car drop-off alternative will show the largest reduction, which means that it is far more difficult to drive passengers away from the car driver alternative and from the taxi.

Tables 11 and 12 report the RP elasticities and results of the policy analysis for the access route Matera-Bari. On this access route, the Regional Government of Basilicata has already committed to increase the frequency of the shuttle bus service towards the airport of Bari. From the actual five (per day) to hourly services, frequency is expected to increase to 17-18 buses/day in each direction. This means that the headway time will reduce from 220 minutes to 60 minutes (-70%). Hence, the effectiveness of three additional policies has been evaluated, which assume that the decrease in headway time will come at no additional costs, or at a price of an increase of 10%, 50% and 100% of the fare.

Table 11. RP direct and cross elasticities for residents in Matera/Altamura/Gravina

Direct	Business	Other
Headway Time (bus)	-1.12	
Travel Cost (bus)	-0.31	-0.54
In-Vehicle Travel Time (mixed transit)	-2.32	-2.31
Cross		
Headway Time	0.54	
Travel Cost	0.15	0.26
In-Vehicle Travel Time	0.37	0.37

Source: Based on NL2 model estimates on a subsample of respondents.

Table 12. Reductions in headway time for the Matera-Bari access route

	MNL	NL2
Scenario Matera-1 (-70% headway direct bus)		
Mixed Transit 1	-29.3%	-28.8%
Mixed Transit 2	-28.3%	-23.2%
Direct Bus	63.6%	61.8%
Car Driver	-29.0%	-28.5%
Car Drop-off	-33.2%	-32.9%
Taxi	-30.0%	-29.1%
Scenario Matera-2 (-70% headway direct bus, +10% cost direct bus)		
Mixed Transit 1	-27.2%	-26.7%
Mixed Transit 2	-25.9%	-20.7%
Direct Bus	59.6%	57.8%
Car Driver	-27.3%	-26.8%
Car Drop-off	-31.1%	-31.0%
Taxi	-28.3%	-27.4%
Scenario Matera-3 (-70% headway direct bus, +50% cost direct bus)		
Mixed Transit 1	-18.8%	-18.4%
Mixed Transit 2	-16.7%	-11.2%
Direct Bus	43.6%	42.1%
Car Driver	-20.4%	-20.2%
Car Drop-off	-23.0%	-23.2%
Taxi	-21.4%	-20.5%
Scenario Matera-4 (-70% headway direct bus, +100% cost direct bus)		
Mixed Transit 1	-2.0%	-8.7%
Mixed Transit 2	-1.1%	-0.6%
Direct Bus	10.4%	23.8%
Car Driver	-6.0%	-12.4%
Car Drop-off	-5.9%	-13.9%
Taxi	-6.7%	-12.5%

Source: Elaboration based on the collected data.

When elasticities are calculated using only the subset of residents living the cities of Matera, Altamura, and Gravina, they look slightly higher in absolute terms (in particular those related to in-vehicle travel time).

The analysis of the alternative policies reveals that the increase in the market share for the direct bus alternative would be far more pronounced, with a maximum of 63.6% (61.8% with the NL2 model). This means that respondents from these cities are more sensitive to the headway time, and more likely to change to the direct bus alternative as soon as this becomes more attractive. There would also be a positive increase – although definitely reduced – in the market share even if reductions in headway time come at the price of an increase of travel cost of 100%.

7.3. The Mixed Logit Models

The MNL and the NL2 models have also been estimated using random coefficients for the travel time to accommodate random tastes across respondents. When mixed logit models are estimated, the researcher needs to assume a specific distribution for the random coefficients. In this case, we have investigated the effects of three different distributions (i.e., normal, lognormal, and uniform) for the random coefficients, and the normal distribution was in the end chosen, given that it provided the best fit to the data. The estimation is performed using 2000 Halton draws, and results are reported in Table 13. In terms of statistical fit, both mixed logit models over perform the NL2 model, with a gain of more than 1000 log-likelihood units. The interpretation of the results is very similar to that of the previously estimated MNL and NL models with fixed parameters.

Table 13. The mixed logit models (Normal distribution and 2000 Halton draws)

	MMNL		NL2-MMNL	
	est	t_ratio (0)	est	t_ratio (0)
ASC Direct Bus	1.278	3.47	0.160	0.78
ASC Mixed Transit 1	0.358	1.13	-0.055	-0.33
ASC Mixed Transit 2	0.246	0.82	-0.073	-0.44
ASC Mixed Transit 3	0.458	1.49	-0.220	-1.29
ASC Car Driver	-0.284	-0.86	-1.010	-3.30
ASC Taxi	1.034	2.60	0.205	0.89
In-Vehicle Travel Time Mixes Transit (business)	-0.017	-4.93	-0.005	-4.25
In-Vehicle Travel Time Mixes Transit (other)	-0.012	-5.70	-0.003	-4.49
Out-Of-Vehicle Travel Time Mixed Transit (business)	0.000	0.01	0.000	-0.04
Out-Of-Vehicle Travel Time Mixed Transit (other)	0.002	0.65	0.000	-0.46
Travel Time Direct (business)	-0.002	-0.76	0.000	-0.17
Travel Time Direct (other)	-0.001	-0.61	0.000	0.48
Travel Time Car Driver (business)	-0.003	-0.57	-0.003	-0.54
Travel Time Car Driver (other)	-0.019	-4.20	-0.020	-4.28
Travel Time Car Drop-Off (business)	-0.005	-1.40	-0.010	-3.80
Travel Time Car Drop-Off (other)	-0.005	-1.52	-0.009	-3.95
Travel Time Taxi (business)	-0.042	-5.71	-0.017	-4.32
Travel Time Taxi (other)	-0.052	-7.34	-0.023	-5.88
Travel Cost (business)	-0.022	-3.14	-0.020	-4.77
Travel Cost (other)	-0.034	-7.01	-0.024	-7.85
Headway Mixed Transit	-0.004	-3.08	-0.001	-1.76
Headway Direct Bus	-0.005	-10.11	-0.001	-5.30
Matera-Bari Bus (wrt Taranto-Brindisi)	0.144	1.40	0.045	0.78
Altamura-Bari Bus (wrt Taranto-Brindisi)	0.212	1.66	0.129	1.89
Gravina-Bari Bus (wrt Taranto-Brindisi)	0.122	0.76	0.068	0.81
Taranto-Bari Bus (wrt Taranto-Brindisi)	-0.206	-2.09	-0.106	-2.14
Foggia-Bari Bus (wrt Taranto-Brindisi)	0.236	1.67	0.115	1.68
Male (Car Driver)	-0.083	-1.04	-0.056	-0.99
Age (Direct Bus)	-0.018	-5.20	-0.006	-3.58
Baggage (Mixed Transit)	-0.275	-3.39	-0.112	-3.26
Education (Direct Bus)	-0.022	-1.39	-0.011	-1.33
Air Party Size (Taxi)	0.064	2.39	0.031	2.10
Scale SP	0.588	-5.34*	1.399	4.50*
Sigma Parameters				
In-Vehicle Travel Time Mixes Transit (business)			0.005	4.98
In-Vehicle Travel Time Mixes Transit (other)			0.003	5.75
Out-Of-Vehicle Travel Time Mixed Transit (business)			0.001	0.43
Out-Of-Vehicle Travel Time Mixed Transit (other)			0.000	-0.02
Travel Time Direct (business)			-0.001	-1.13
Travel Time Direct (other)			0.003	4.52
Travel Time Car Driver (business)			0.034	6.85
Travel Time Car Driver (other)			0.024	8.17
Travel Time Car Drop-Off (business)			-0.008	-5.55
Travel Time Car Drop-Off (other)			0.007	8.66
Travel Time Taxi (business)			-0.014	-6.08
Travel Time Taxi (other)			0.011	7.54
Lambda Public Modes (NL2)			0.179	4.09
Lambda Private Modes (NL2)			3.527	17.94
IDs (RP)	1062			
IDs (SP)	749			
Observations	4808			
LL(0):	-9356			
LL(final):	-6052		-5909	
AIC:	12193.01		11912.28	
BIC:	12484.52		12216.75	
Rho-sq (adj.):	0.35		0.36	
Estimated parameters:	45		47	

Note: *t-ratio(1)

7.4. The introduction of a new alternative

This final sub-section looks, in detail, to the change in parameters' estimates and elasticities when a new, hypothetical mode, is included in the choice set. Data for the estimation of these models come from the RP information and the second set of choice tasks of the SP experiment. The direct train alternative was added to the choice set only for respondents travelling to/from the airport of Bari, where a railway station within the airport premises is already available.

The two sets of models are not directly comparable (Table 14), given that they were not run on the same data. We find that the coefficients on the travel time, travel cost, and headway time for model NL2 - POST all have the expected (negative) sign and they are all statistically different from zero. The only exceptions are travel time for car driver and taxi for both categories of users. As expected, travel cost is more important for non-business users. Interestingly, respondents place a larger negative value on the headway time for the mixed transit alternative than for the direct bus and for the direct train. With respect to the access-route dummies, these reveal that travellers on the Altamura-Bari and Foggia-Bari routes are more likely to choose the direct bus alternatives and the direct train than those travelling on the Gravina in Puglia-Bari route.

Tables 15 and 16 report the RP elasticities and the predicted variations in the market shares for the routes towards Bari airport when the headway time for the direct bus is reduced, before and after the introduction of a direct train alternative.

Table 14. Results for the MNL and the NL2 models with and without the new mode (direct train)

	PRE				POST			
	MNL		NL2		MNL		NL2	
	est	t_ratio (0)	est	t_ratio (0)	est	t_ratio (0)	est	t_ratio (0)
ASC Direct Bus	3.524	6.18	3.384	6.31	6.376	9.07	4.965	5.42
ASC Direct Train					5.686	7.97	4.803	5.37
ASC Mixed Transit 1	1.275	2.27	1.223	2.31	2.878	3.56	3.716	4.51
ASC Mixed Transit 2	0.773	1.47	0.742	1.48	1.746	2.38	2.979	3.99
ASC Mixed Transit 3	1.445	2.52	1.291	2.45	2.802	3.34	3.924	4.44
ASC Car Driver	-0.191	-0.51	0.226	0.92	0.421	1.04	-1.594	-1.83
ASC Taxi	-0.137	-0.29	-0.341	-0.74	-0.319	-0.60	1.866	2.82
In-Vehicle Travel Time Mixes Transit (business)	-0.015	-2.76	-0.016	-2.98	-0.025	-3.11	-0.010	-2.79
In-Vehicle Travel Time Mixes Transit (other)	-0.014	-3.53	-0.013	-3.20	-0.049	-3.02	-0.006	-1.95
Out-Of-Vehicle Travel Time Mixed Transit (business)	0.003	0.34	0.003	0.34	-0.016	-2.37	-0.024	-2.75
Out-Of-Vehicle Travel Time Mixed Transit (other)	0.011	2.01	0.009	1.69	-0.037	-3.97	-0.019	-4.07
Travel Time Direct (business)	-0.005	-1.13	-0.006	-1.34	-0.043	-7.25	-0.008	-4.46
Travel Time Direct (other)	-0.006	-2.21	-0.006	-1.97	-0.036	-8.63	-0.008	-5.34
Travel Time Car Driver (business)	0.009	1.26	0.004	0.78	-0.011	-1.52	0.034	4.20
Travel Time Car Driver (other)	-0.014	-2.53	-0.012	-2.66	-0.018	-2.85	-0.008	-0.93
Travel Time Car Drop-Off (business)	0.001	0.17	0.004	0.74	-0.011	-1.41	-0.013	-1.79
Travel Time Car Drop-Off (other)	-0.003	-0.62	-0.002	-0.42	-0.001	-0.10	0.015	2.56
Travel Time Taxi (business)	-0.010	-1.17	-0.010	-1.29	-0.019	-2.04	0.006	1.22
Travel Time Taxi (other)	-0.026	-3.69	-0.024	-3.51	-0.022	-2.78	-0.001	-0.30
Travel Cost (business)	-0.033	-3.32	-0.029	-3.31	-0.039	-3.73	-0.032	-5.66
Travel Cost (other)	-0.050	-7.30	-0.049	-7.34	-0.077	-9.89	-0.048	-8.11
Headway Mixed Transit	-0.016	-5.62	-0.015	-5.44	-0.021	-5.36	-0.007	-3.65
Headway Direct Bus	-0.008	-11.88	-0.008	-12.94	-0.012	-12.98	-0.003	-5.41
Headway Direct Train					-0.009	-5.66	-0.002	-5.05
Matera-Bari Bus (wrt Gravina in Puglia-Bari)	0.071	0.36	0.074	0.37	0.428	1.82	0.055	0.50
Altamura-Bari Bus (wrt Gravina in Puglia-Bari)	0.357	1.60	0.348	1.55	0.717	2.67	0.364	2.81
Taranto-Bari Bus (wrt Gravina in Puglia-Bari)	-0.503	-2.41	-0.487	-2.34	-0.247	-0.98	0.055	0.46
Foggia-Bari Bus (wrt Gravina in Puglia-Bari)	0.138	0.58	0.080	0.67	-0.603	-1.81	0.583	3.77
Matera-Bari Train (wrt Gravina in Puglia-Bari)					0.026	0.08	0.093	0.79
Altamura-Bari Train (wrt Gravina in Puglia-Bari)					0.544	1.55	0.336	2.52
Taranto-Bari Train (wrt Gravina in Puglia-Bari)					0.248	0.78	0.147	1.19
Foggia-Bari Train (wrt Gravina in Puglia-Bari)					1.856	4.87	0.921	5.64
Male (Car Driver)	-0.093	-1.00	-0.045	-0.70	-0.093	-0.90	-0.188	-2.03
Age (Direct Bus)	-0.035	-7.25	-0.035	-7.44	-0.043	-8.05	-0.022	-7.33
Baggage (Mixed Transit)	-0.584	-5.07	-0.585	-5.05	-0.513	-3.69	-0.368	-4.34
Education (Direct Bus)	-0.050	-2.22	-0.050	-2.22	-0.055	-2.33	-0.032	-2.47
Air Party Size (Taxi)	0.055	3.14	0.056	3.22	0.071	3.69	0.031	2.84
Scale SP	-0.277	-17.88*	-0.2886	-20.58*	-0.347	-17.36*	0.391	-6.67*
Lambda Mixed Transit (NL2)			0.833	3.22			1.409	2.91
Lambda Direct Modes (NL2)							0.325	7.88
Lambda Private Modes (NL2)			0.546	4.34			6.455	6.50
IDs (RP)	823							
Observations	3554							
LL(0):	-6.915.765				-7.390.335			
LL(final):	-5.136.725		-5.133.522		-5.291.925		-5249.433	
AIC:	10337.45		10335.04		10659.85		10580.87	
BIC:	10535.08		10545.02		10894.53		10834.07	
Rho-sq (adj.):	0.25		0.25		0.28		0.28	
Estimated parameters:	32		34		38		41	

Note: *t_ratio(1)

Table 15. RP direct and cross elasticities before and after the introduction of direct train

	Before		*After*	
Direct	*Business*	*Other*	*Business*	*Other*
Headway Time (bus)	-1.21		-0.37	
Travel Cost (bus)	-0.23	-0.39	-0.20	-0.29
In-Vehicle Travel Time (mixed transit)	-1.09	-0.91	-0.90	-0.55
Cross				
Headway Time	0.01		0.12*	
Travel Cost	0.00	0.00	0.06*	0.09*
In-Vehicle Travel Time	0.37	0.31	0.09	0.05

Note: Based on NL2 model estimates; * not for the direct train.

Table 16. Reductions in headway time for direct bus when direct train is introduced

	MNL	NL2
Scenario Rail 1 (-60% headway direct bus)		
Mixed Transit 1	-31.8%	-10.9%
Mixed Transit 2	-30.0%	-7.1%
Mixed Transit 3	-22.3%	-12.0%
Direct Bus (direct)	70.3%	44.8%
Direct Train	-9.4%	-23.2%
Car Driver	-24.9%	-5.3%
Car Drop-Off	-26.4%	-11.5%
Taxi	-24.0%	-8.1%
Scenario Rail 2 (-60% headway direct bus. +60% cost direct bus)		
Mixed Transit 1	-25.7%	-3.9%
Mixed Transit 2	-24.2%	-0.0%
Mixed Transit 3	-13.9%	-4.3%
Direct Bus (direct)	50.1%	4.0%
Direct Train	-3.6%	0.1%
Car Driver	-19.5%	-5.8%
Car Drop-Off	-19.8%	-1.9%
Taxi	-18.7%	-29.1%
Scenario Rail 3 (-60% headway direct bus. +30% cost direct bus)		
Mixed Transit 1	-28.7%	-7.2%
Mixed Transit 2	-27.1%	-3.4%
Mixed Transit 3	-18.0%	-7.6%
Direct Bus (direct)	60.0%	22.7%
Direct Train	-6.4%	-8.8%
Car Driver	-22.2%	-2.3%
Car Drop-Off	-23.0%	-8.4%
Taxi	-21.4%	-4.7%

Source: Elaboration based on the collected data.

Interestingly, when the new alternative is introduced, direct elasticities are smaller (particularly those for headway time and in-vehicle travel time), while the effect on cross elasticities is rather mixed. It is possible, in this case, to ascribe such difference to the use of different datasets in the estimation of the parameters. Only the best performing policies were chosen for this comparison. In the SP experiment, the direct bus, the direct train, and the car drop-off were the most chosen alternatives. According to the MNL model, as soon as the headway time for the direct bus alternative is reduced, its market share increases at the price (mainly) of the car-driver alternative. However, when the NL model is used, the direct train alternative gets more penalised from reductions in headway time for the direct bus. This result is not surprising given the particular nesting formulation adopted for the NL model with direct bus and direct train nested together.

8. Conclusion

In the last decade there has been a generalised increase in the number of point-to-point connections operated by low fare operators. Their presence is promoted by local authorities and airport managing companies, also through public financing. As an indirect consequence, the number of small/medium size airports in the same catchment areas of larger ones also increased.

The political pressures for opening and maintaining "local" airports are even stronger when accessibility towards larger airports is poor, as it is the case in the Apulia region, in Italy. This is characterised by the presence of a system of "local" airports, two international (Bari and Brindisi), and two no longer in use for commercial aviation (Foggia and Grottaglie). Bari and Brindisi airports are very well connected to the respective city centres, with frequent local bus services and, Bari, also with a rail link. However, the main tourist attractions in the surrounding, which are also densely populated areas, are not as easily accessible by public services. For this reason, residents continually ask for the Regional government to re-open to commercial aviation Foggia and Grottaglie airports, which would closely serve those areas.

In this paper we use both *revealed* and stated *preferences* collected amongst residents of less accessible areas to assess the effectiveness of several policy measures designed to provide a modal shift from private (car and taxi) towards more environmental friendly modes (bus and train), as a consequence of their improvement in terms of travel time and frequency. Improvements in accessibility conditions might be a more economically sustainable, as well as politically acceptable, alternative to re-opening and maintaining the other two "local" airports in the region.

Results of the estimation of probabilistic models (multinomial, nested logit, and mixed logit) reveal that policies aimed at increasing the frequency of direct bus services (via reductions in the headway time between consecutive services) will have a positive effect. However, despite a significant increase in the predicted market share for direct bus (more accentuated on the Matera-Bari access route), the drop-off alternative would still remain the most used, when considering the current market shares. On the one side, these results underestimate the actual modal shift, given that they do not take into account the fact that policy makers might strongly advertise the improvements. On the other side, it is worth considering that a large portion of users might still prefer being dropped off at the airport by relatives or friends, because they wish to spend additional time with them or because they do not take account fully of the cost they bear.

Finally, an exploratory analysis on the potential impact of the introduction of hypothetical direct rail connections between these cities and Bari airport reveals that policies aimed at reducing headway time for the direct bus alternative might penalise the new alternative. Again, the car drop-off alternative would reduce most its market share.

To conclude, this analysis yields interesting insights for airport managers, private operators, and regional transport authorities for the evaluation of future investments that aim to improve the accessibility of the Apulian airports. However, at least two limitations could possibly affect findings and forecasts. First, collected data might not be fully representative of both the actual (due to the characteristics of the air party size, or due to seasonal variations) and of the future passenger traffic at these airports. Second, the estimated models do not deterministically include characteristics of the alternatives such as comfort, reliability, and willing to being dropped-off at any costs.

Bibliography

Akar, G. (2013) Ground access to airports, case study: Port Columbus International Airport, *Journal of Air Transport Management*, 30, pp. 25-31.

Alhussein, S. N. (2011) Analysis of ground access modes choice King Khaled international airport, Riyadh, Saudi Arabia, *Journal of Transport Geography*, 19(**6**), pp. 1361-1367.

Apulian Regional Government (2016) Regional plan for transport 2015 – 2019 (in Italian), available at http://www.regione.puglia.it/index.php?page=documentifa&opz=getdoc&id=1204.

Başar, G., and Bhat, C. (2004) A parameterized consideration set model for airport choice: an application to the San Francisco Bay area, *Transportation Research Part B: Methodological*, 38(**10**), pp. 889-904.

Ben-Akiva, M., and Morikawa, T. (1990) Estimation of switching models from revealed preferences and stated intentions, *Transportation Research Part A: General*, 24(**6**), pp. 485-495.

Bhat, C. (1999) Quasi-random maximum simulated likelihood estimation of the mixed multinomial logit model, Working Paper, Department of civil engineering, University of Texas, Austin.

Bliemer, M. C., Rose, J. M., and Hess, S. (2008) Approximation of Bayesian efficiency in experimental choice designs, *Journal of Choice Modelling*, 1(**1**), pp. 98-126.

Bocconi University and CERTeT (2014) Il ruolo degli aeroporti del comprehensive network delle Ten-T e le potenzialità dell'aeroporto di Foggia (in Italian), available at https://www.dropbox.com/sh/f2vax66loxzxhld/AADf5vEh4MqvaGL1Qyk35y7qa/IL%20RUOLO%20POTENZIALE%20AEROPORTO%20DI%20FOGGIA/POTENZIALITA_AEROPORTO_RAPPORTO.pdf?dl=0.

Chang, Y. C. (2013) Factors affecting airport access mode choice for elderly air passengers, *Transportation research part E: logistics and transportation review*, 57, pp. 105-112.

Choice Metrics (2009) Ngene v1.0 user manual and reference guide, Choice Metrics Ltd, Sidney

Cirillo, C., and Xu, R. (2009) Forecasting cybercar use for airport ground access: case study at Baltimore Washington International Airport, *Journal of Urban Planning and Development*, 136(**3**), pp. 186-194.

Daly, A., and Zachary, S. (1978) Improved multiple choice models, *Determinants of travel choice*, pp. 335-357.

de Dios Ortúzar, J., and Simonetti, C. (2008) Modelling the demand for medium distance air travel with the mixed data estimation method, *Journal of Air Transport Management*, 14(**6**), pp. 297-303.

ENAC - National Civil Aviation Authority (2010) Studio sullo sviluppo degli aeroporti italiani (in Italian), available at http://www.enac.gov.it/La_Comunicazione/Pubblicazioni/info464245000.html.

ENAC - National Civil Aviation Authority (2012) Piano Nazionale degli Aeroporti (in Italian), available at https://www.enac.gov.it/La_Comunicazione/Pubblicazioni/info-1156450804.html.

ENAC - National Civil Aviation Authority (2016) Dati di traffico 2015 (in Italian), available at https://www.enac.gov.it/repository/ContentManagement/information/N1171036406/Dati_di_traffico_2015_160711.pdf.

Espino, R., de Dios Ortúzar, J., and Román, C. (2007) Understanding suburban travel demand: Flexible modelling with revealed and stated choice data, *Transportation Research Part A: Policy and Practice*, 41(**10**), pp. 899-912.

Gosling, G. (2006) Predictive reliability of airport ground access mode choice models, *Transportation Research Record: Journal of the Transportation Research Board*, 1951, pp. 69-75.

Gupta, S., Vovsha, P., and Donnelly, R. (2008) Air passenger preferences for choice of airport and ground access mode in the New York City metropolitan region, *Transportation Research Record: Journal of the Transportation Research Board*, 2042, pp. 3-11.

Harvey, G. (1986) Study of airport access mode choice, *Journal of transportation Engineering*, 112(**5**), pp. 525-545.

Hausman, J., and McFadden, D. (1984) Specification tests for the multinomial logit model, *Econometrica: Journal of the Econometric Society*, 52(**5**), pp. 1219-1240.

Hess, S., and Polak, J. W. (2006) Exploring the potential for cross-nesting structures in airport-choice analysis: a case-study of the Greater London area, *Transportation Research Part E: Logistics and Transportation Review*, 42(**2**), pp. 63-81.

ISTAT - Italian National Institute of Statistics (2015) Viaggi e vacanze in Italia e all’estero (in Italian), available at http://www.istat.it/it/archivio/180083.

Jehanfo, S., and Dissanayake, D. (2007) Modelling airport surface access using discrete choice methods: A Case Study in Newcastle upon Tyne, Paper presented at the 11th World Conference on Transport Research, Berkley.

Jou, R. C., Hensher, D. A., and Hsu, T. L. (2011) Airport ground access mode choice behaviour after the introduction of a new mode: A case study of Taoyuan International Airport in Taiwan, *Transportation Research Part E: Logistics and Transportation Review*, 47(**3**), pp. 371-381.

Luce, R. D. (1959) On the possible psychophysical laws, *Psychological review*, 66(**2**), pp. 81-95.

Matera 2019 Application Pack (2013) Matera città candidata capitale europea della cultura 2019 (in Italian), available at http://www.matera-basilicata2019.it/it/mt2019/dossier-di-candidatura.html.

McFadden, D. (1974) The measurement of urban travel demand, *Journal of public economics*, 3(**4**), pp. 303-328.

Monteiro, A. B., and Hansen, M. (1996) Improvements to airport ground access and behaviour of multiple airport system: BART extension to San Francisco International Airport, *Transportation Research Record: Journal of the Transportation Research Board*, 1562, pp. 38-47.

Morikawa, T. (1989) Incorporating stated preference data in travel demand analysis, Doctoral dissertation, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge.

Pels, E., Nijkamp, P., and Rietveld, P. (2001) Airport and airline choice in a multiple airport region: an empirical analysis for the San Francisco Bay Area, *Regional Studies*, 35(**1**), pp. 1-9.

Pels, E., Nijkamp, P., and Rietveld, P. (2003) Access to and competition between airports: a case study for the San Francisco Bay area, *Transportation Research Part A: Policy and Practice*, 37(**1**), pp. 71-83.

Psaraki, V., and Abacoumkin, C. (2002) Access mode choice for relocated airports: the new Athens International Airport, *Journal of Air Transport Management*, 8(**2**), pp. 89-98.

Puglia Promozione (2015) I numeri della destinazione: La Puglia nell'economia turistica globale (in Italian), available at http://www.agenziapugliapromozione.it/portal/documents/10180/1715049/Report%20turismo%20Puglia_Bit2016.

Roh, H. J. (2013) Mode choice behaviour of various airport user groups for ground airport access, *Open Transportation Journal*, 7, pp. 43-55.

Tam, M. L., Lam, W. H., and Lo, H. P. (2008) Modeling air passenger travel behaviour on airport ground access mode choices, *Transportmetrica*, 4(**2**), pp. 135-153.

Tam, M. L., Lam, W. H., and Lo, H. P. (2011) The impact of travel time reliability and perceived service quality on airport ground access mode choice, *Journal of Choice Modelling*, 4(**2**), pp. 49-69.

Train, K. (2000) Halton sequences for mixed logit, Working Paper, Department of Economics, University of California, Berkley.

Train, K. (2002) Discrete choice methods with simulation, Cambridge University Press, Cambridge.

Tsamboulas, D., Evmorfopoulos, A. P., and Moraiti, P. (2012) Modeling airport employees commuting mode choice, *Journal of Air Transport Management*, 18(**1**), pp. 74-77.

Tsamboulas, D. A., and Nikoleris, A. (2008) Passengers' willingness to pay for airport ground access time savings, *Transportation Research Part A: Policy and Practice*, 42(**10**), pp. 1274-1282.