Title: Modelling regional accessibility to airports using discrete choice models: an application to a system of regional airports

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Highlights

- Improvements in airport accessibility
- Users and non-users of airport services have differing preferences
- Frequency for public transport is pivotal for airport users
- Non-users are more sensitive to travel cost
- Improvements in bus services would penalise the direct train more than car

Abstract

In this paper, we analyse residents' decisions regarding airport access mode in Apulia, a relatively peripheral multi-airport region in Italy. Both *revealed* and *stated* preferences data are used to estimate probabilistic demand models. The results are employed to calculate the relevant elasticities, separately for airport users and non-users, with respect to dedicated existing and planned/potential public transport services. We measure the effectiveness of specific policies/actions aimed at generating a shift from private modes (car and taxi) towards public transport, rationalising mobility towards the existing airports. Accessibility is one of the key factors in airports' provision, and an efficient public transport system might represent both an alternative to opening “local” – often costly and inefficient – airports in the same catchment area and a means to exploit economies of scale aggregating demand for existing airports.

Keywords: airports, regional accessibility, revealed and stated preferences.

1. Introduction

There is an extensive literature on the role of accessibility in orienting, to a certain extent, travellers' airport choices. The latter are not only driven by price and quality of air services offered at a specific airport, but they might 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 or opening smaller airports – are inversely related to accessibility towards larger ones.

As the Air Transport and Airport Research Center underlines (2010), several elements of airport accessibility have changed in the past decades. Road accessibility still plays an important role, as car access is still predominant (well over 50%) at the majority of airports, and the provision of car parking facilities constitutes a major source of revenues in the non-aviation business of an airport. However, more and more airports throughout Europe see rail access as an important factor to extend the catchment area. Rail is seen as an environmental friendly mode, and the integration of airports into the railway network (especially for high-speed services) has made considerable progress (ARC, 2018). Bus services also maintain a relevant share of passengers, although the lack of an overall planning of the services – which often involves several private and public players – limits their potential development.

In areas where railway links are not fully exploited, or where public transit services are lacking either in number or in 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. Decisions with respect to the opening of "local" (and potentially inefficient) airports are oriented by parochial interests rather than by strict cost-benefit evaluations. 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 is often disregarded. This is particularly true when the investors are public, or split amongst different entities.

More generally, the air passenger growth registered at the worldwide level in the last years is producing tremendous pressures on ground access networks. Determining the direct and indirect impact of any investment, to improve the existing services or to build new infrastructures, is pivotal to use efficiently public money or to assess private investments.

In this paper, we analyse residents' decisions regarding airport access mode, using Apulia, in Italy, as a case study. This region is characterised by the presence of a system of airports: two international - Bari and Brindisi, with 4.7 and 2.3 million passengers a year, respectively, and two no longer in use for commercial aviation - Foggia and Grottaglie. Bari and Brindisi airports are well connected by public transport means to the respective city centres. However, the other cities of the region and the main tourist attractions in the surrounding (Gargano, Salento, and Matera) are not as easily accessible. For this reason, there are continuous pleas to re-open to commercial aviation Foggia and Grottaglie airports, which would closely serve those areas. Similar situations are identified in other parts of Europe, with residents or politicians pressuring for the opening of "local" airports (Lowe and Szary, 2014), some of which located at less than 70km from main ones (Marc, 2013).

For this analysis, we collected *revealed preferences* (RP) and *stated preferences* (SP) on airport access decisions amongst residents of those less accessible areas. Choices are modelled using nested logit (NL), mixed multinomial logit (MMML), and mixed nested logit (MXNL) models. The overall aim is to assess the effectiveness of policy measures aimed at improving surface access by means of public transport services. Ultimately, improving accessibility could represent a more economically sustainable (but also politically acceptable) alternative to the re/opening of small "local" airports, closer to the origin of demand. Differently from other studies, we consider both users and non-user of air transport services, anticipating that these groups might have different preferences.

The remainder of the paper is structured as follows. We review the literature on airport accessibility in Section 2, while Section 3 describes the context of this analysis. Sections 4 and 5 relate to the data, and Section 6 sets out 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 case studies using RP and/or SP data and probabilistic demand models. The choice set typically includes transport modes already available, although very few studies also evaluate the potential market for hypothetical alternatives. Access decisions are, sometimes, jointly modelled together with airport decisions (in multi-airport areas), and even an airline ones. A few works focus on specific categories of travellers or airport users (e.g. elderly people or airport employees).

2.1. Airport accessibility at specific airports

Amongst the first authors interested on this topic, Harvey (1986) analyses air passengers' behaviour in the San Francisco Bay area. Results from the estimation of a MNL model show that business travellers are particularly sensitive to access time; however, their perception towards access cost does not greatly differ from that of non-business travellers.

Jehanfo and Dissanayake (2007) explain residents' choices when accessing Newcastle airport. Using MNL models, they find that the probability of choosing car rather than bus substantially increases when an extra car becomes available in the household, while it reduces if travel time increases by 10 minutes.

Alhussein (2011) uses a binary logit model to estimate the probability of using private car rather than taxi to access King Khaled International Airport in Riyadh. He finds that travel time, luggage count, income, and nationality are the main determinants of access decisions.

In two separate papers, Tam et al. (2008, 2011) look at travellers' behaviour in accessing Hong Kong airport. In the first paper, they show how accessibility choices for business passengers – more than for leisure ones – are driven by the size of the "safety margin", defined as the difference between preferred and expected arrival time at the airport. In the second paper, they explain airport access choices by means of latent variables accounting for travellers' satisfaction levels towards waiting time, travel time and travel time reliability, travel cost, and walking distance to/from stations or car parks.

Finally, Akar (2013) uses a binary logit model to estimate the probability of shifting from car to alternative modes when accessing Columbus airport in Ohio. He accounts for respondents' attitude towards car use – measured using a series of statements – and finds that reliability, travel time and frequency condition such shift, especially for business travellers 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 to access San Francisco International Airport. They employ a nested logit formulation to joint model airport and access mode decisions, finding that accessibility levels highly condition airport attractiveness. An extension of the rapid-transit link would ultimately also reinforce the dominance of the airport versus the other airports in the Bay area.

Tsamboulas and Nikoleris (2008) examine the effects of the introduction of a new express bus service connecting Athens' main bus terminal to the airport, which could reduce access time by 15 minutes. They find that business travellers would be willing to pay more for such a reduction in access time than non-business travellers (1.80€ vs 1.40€).

Cirillo and Xu (2009) evaluate the potential market share for a new hypothetical cybercar service to access the Baltimore International airport. Using a nested logit model, they show that the cybercar would exhibit the largest market share, besides higher values of travel-time savings (64 $/h) compared with the other modes.

Jou et al. (2011) estimate a mixed logit model to evaluate the impact of the introduction of a new mass rapid transport mode to access the Taoyuan International Airport in Taiwan. Their results indicate that access choices depends on in- and out-of-vehicle travel time, number of interchanges, and convenience of luggage storing.

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

In a first paper, Pels et al. (2001) jointly model the choice of the airport and of the airline in the San Francisco Bay area using a nested logit model. In a subsequent work (2003) they simultaneously model airport and access mode decisions, showing that the former are mainly driven by access time, particularly for business travellers.

Hess and Polak (2006) jointly model airport, airline, and access mode decisions for the Greater London area, using a cross-nested logit model. Results show that airport decisions depend on access cost, in-vehicle access time, flight frequency and departure time.

Gupta et al. (2008) employ a nested logit formulation to model airport and access mode decisions in the New York City metropolitan region. They find that access time, distance from departure place, and river crossing condition airport choice, while access time and cost, and air party size determine access mode choice.

2.4. Focus on particular categories of airport users

Chang (2013) analyses access mode decisions of elderly passengers in Taiwan. Using hierarchical logistic models, their analysis unveils the relative importance of factors such as

‘’safety’’, ‘’user friendliness’’, and ‘’convenience for storing luggage’’ in driving access choice.

Finally, Tsamboulas et al. (2012) focuse on access decisions for airport employees in Athens. From a policy perspective, their analysis sounds very effective: airport employees do not only tend to prefer private modes to public ones, but they can be also easily targeted for policy interventions. Their results show that a suburban rail service with travel time like that of the car and priced at a competitive fare, would allow the expected shift.

3. The geographical context and the Apulian airport network

The white luggage in Figure 1 show the position of the cities of interest for our analysis.

Figure 1. The geogaphical context

Bari and Brindisi airports (blue planes) are managed by the regional government-owned company “Aeroporti di Puglia”, in concession by the Civil Aviation Authority (ENAC). Unlike other multi-airport areas, the two airports do not directly compete with each other, although they partly share the same catchment area. The Apulian airport network (Table 1) also includes the regional airports of Foggia and Grottaglie (red planes in Figure 1), which are no longer in use for commercial services. In recent months, Grottaglie airport hosted trial tests for driverless planes (drones). Similar regional contexts can be found in many other areas of Italy and of the EU. The Airport Regions Conference and Airportwatch confirm that there are a number of areas in which airports are located at less than 100km from one another, and that accessibility conditions influence the sustainability of the infrastructures.

Table 1. The Apulian airport network

	Classification	**Direct link with city centre**	**Car Accessibility (number of residents within 90 min)**	**Rail Accessibility (number of 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

Source: ENAC (2010)

In recent years, Apulia has become a very attractive touristic destination. Furthermore, the city of Matera, in the neighbouring region of Basilicata, is one of the most interesting cultural destinations in Italy: it has gained the European Capital of the Culture 2019 flag thanks to 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: a private concessionary railway links this centre with Bari, with scheduled services operated with old-fashioned diesel carriages. Accessibility on the airside is ensured through Bari airport. In order to improve accessibility with Bari, 50 mil EUR are being invested on the upgrade of the railway line Matera-Bari, while 1.2 mil EUR on service improvements of the airport shuttle service. The latter intervention will increase the number of daily services (currently offered with 29-seat buses) from 5 to 18 each way. 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 comes from paper-based surveys on a sample of residents in five highly populated cities in the catchment areas of Bari and Brindisi airport (Altamura, Foggia, Gravina in Puglia, Matera, and Taranto) collected over three waves between 2015 and 2018.

A first sub-sample comprises airport users, i.e. individuals who had flown through Bari and Brindisi airports in the previous three months. For these respondents, the survey consisted of two parts. The first part was an SP experiment in which they were asked to choose their preferred access mode amongst those available from their city to the airports (5 choice tasks). Then, a hypothetical new alternative, a direct train, was added to the choice set (5 additional tasks). In the second part, we collected information on the last access trip (RP), and the last air journey (airline, destination, trip reason, flight duration and cost, number of baggage, air-party size). A second sub-sample comprises non-users of either airports. These respondents only participated in the first section of the SP experiment. Their preferences were useful to run a counterfactual analysis and compare the potential behaviour of airport users vs. non-users. For all respondents, we also collected socio-economic information.

The SP experiment was created using city/airport-specific Bayesian efficient designs and the software NGene (Choice Metrics, 2009). Priors for the identification of the designs in the first wave were obtained from preliminary modelling on data from a pilot study, in which the SP experiment was created using an orthogonal fractional factorial design with blocks. For the second and third waves, new efficient designs were created using priors obtained from modelling on the data from the first wave. The "efficiency" of the designs was evaluated using the *D-error* criterion (Rose et al., 2008). Each design comprised fifteen choice tasks, grouped into three blocks of five tasks. Hence, respondents were presented ten choice tasks (5+5) instead of thirty, reducing the risk of boredom and fatigue.

With respect to the attributes characterising the alternatives, we considered in- and out-of-vehicle travel time (i.e., the waiting time between two connecting services, for those with an interchange), travel cost (i.e., the ticket price for public transport, the taxi fare, or the total amount outlaid for car trips including fuel costs, highway tolls, and parking fees), and headway time (i.e., the time between two consecutive public transport services). Attributes levels have been rooted on the current provision (Table 2). Moreover, we randomised the order of the alternatives presented across respondents in order to avoid possible *left-to-right* effects (i.e., always choose the first alternative on the left).

5. Collected data descriptive statistics

The sample is made of 1.229 residents in the cities of Matera, Altamura, Gravina in Puglia (MAG hereafter; 644), Taranto (524), Foggia (61), divided by airport users and (1064) non-users (165). For the airport users who took part in the pilot survey (314) only the *revealed preferences* (RP) were retained; their choices were used to better calibrate the *stated preferences* (SP) coming from the official waves.

Airport users were selected amongst those who travelled at least once in the previous three months through Bari (77%) or Brindisi (23%) airports. Given the unavailability of official figures on the socio-demographic composition of airport users, we recruited a sample as close as representative of the Apulian population in terms of sex and age bands. Some categories are slightly under-represented (Table 3); however, this represents a minor inconvenient as individuals in those categories are expected to travel less (e.g. aged 50 and over).

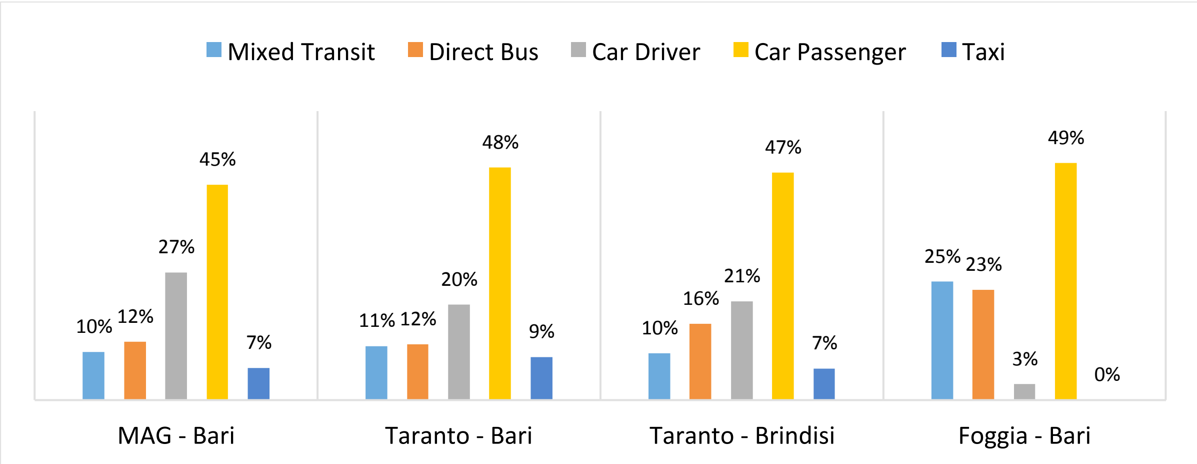
Table 3. Demographic characteristics of the sample with respect to the actual population

	Demographic Class	Airport Users		Non-Users		Region
		N	%	N	%	%
Matera, Altamura, Gravina in Puglia	Male 18-24	81	15%	6	6%	5%
	Female 18-24	60	11%	12	11%	5%
	Male 25-34	93	17%	24	23%	8%
	Female 25-34	75	14%	15	14%	8%
	Male 35-49	78	14%	6	6%	16%
	Female 35-49	56	10%	11	10%	16%
	Male 50+	46	9%	14	13%	20%
	Female 50+	50	9%	17	16%	22%
Taranto	Male 18-24	54	12%	5	8%	5%
	Female 18-24	55	12%	12	20%	5%
	Male 25-34	91	20%	11	18%	8%
	Female 25-34	83	18%	11	18%	8%
	Male 35-49	57	12%	3	5%	14%
	Female 35-49	60	13%	2	3%	15%
	Male 50+	32	7%	9	15%	21%
	Female 50+	32	7%	7	12%	24%
Foggia	Male 18-24	5	8%	-	-	6%
	Female 18-24	10	16%	-	-	5%
	Male 25-34	17	28%	-	-	8%
	Female 25-34	9	15%	-	-	8%
	Male 35-49	9	15%	-	-	14%
	Female 35-49	7	11%	-	-	15%
	Male 50+	2	3%	-	-	21%
	Female 50+	2	3%	-	-	23%

Full Sample	1064	165

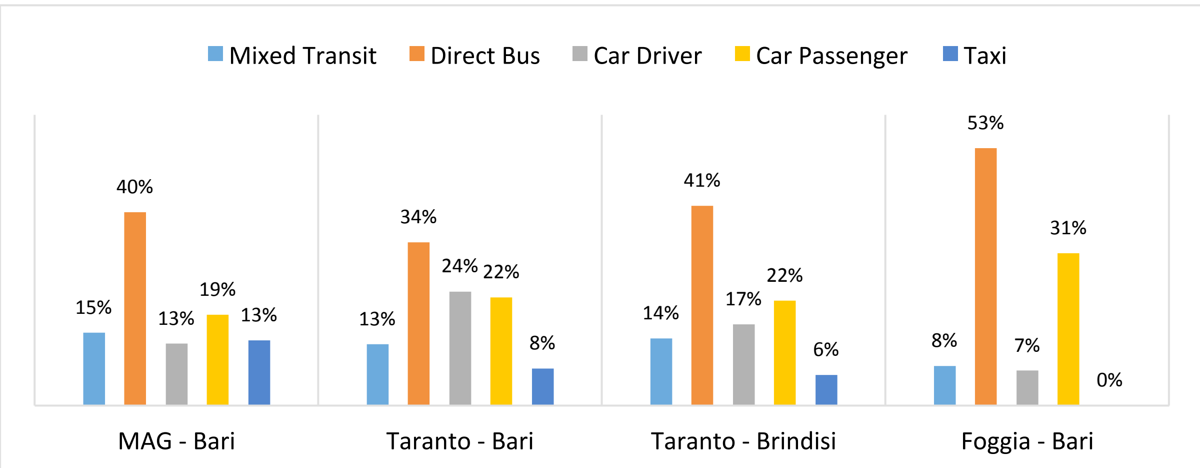
Figures on the access mode chosen (i.e., used) during last access to the airport (*revealed preference,* Figure 2), show that private means (car as “Passenger” or as “Driver”) were strictly preferred to public ones (mixed transit or direct bus). The taxi option was the least preferred.

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



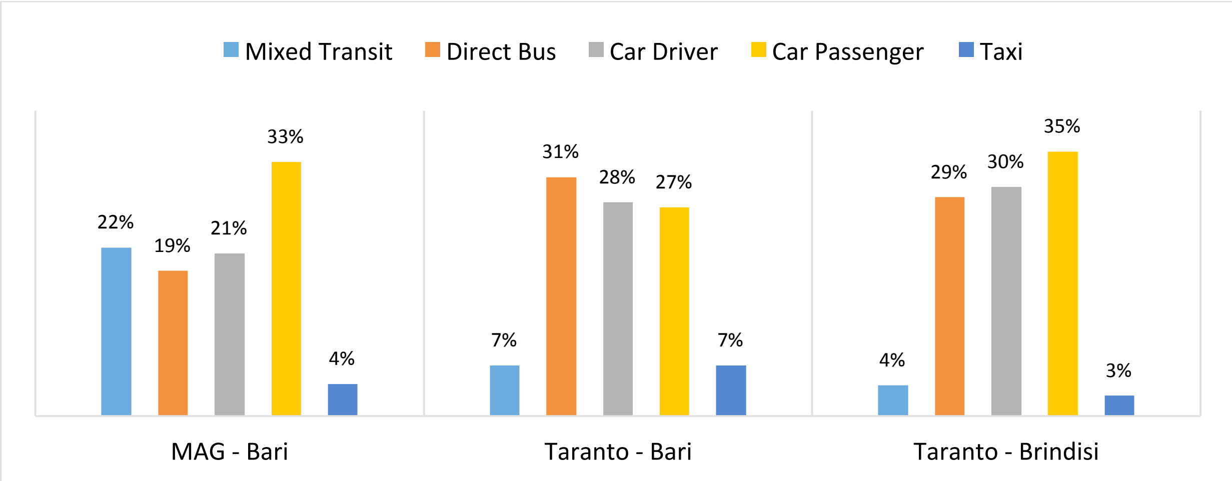
Interestingly, direct bus becomes the most preferred alternative during the *stated preferences* experiment (Figure 3) at the expense of the car passenger. A possible explanation to this might be that direct costs associated to all alternatives were shown in the experiment, while individuals do not typically face them when are dropped off by friends and relatives.

Figure 3. The chosen mode in the SP experiment (airport users)



For non-users, only information on the access mode chosen during the SP experiment is available (Figure 4). Interestingly, while on the MAG – Bari access route car passenger outstands with respect to the other alternatives, on the Taranto – Bari and Taranto – Brindisi routes direct bus, car driver, and car passenger displays very similar modal shares.

Figure 4. The chosen mode in the SP experiment (airport users)



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, the gain that an individual *n* obtains from choosing an access mode *i* in a choice occasion *t* is given by the utility $U_{n,t}(i)$, and the alternative with the highest utility is chosen (under the assumption of rational choice behaviour). However, only a certain part of the utility, $V_{n,t}(i)$, is observed, and the remaining, $\varepsilon_{n,t}(i)$, is unobserved. Given this, the choice process becomes probabilistic, and the probability of an access mode being chosen, $P_{n,t}(i)$, can be defined as (Equation 1):

$$P_{n,t}(i) = P\big(V_{n,t}(i) + \varepsilon_{n,t}(i) \geq V_{n,t}(j) + \varepsilon_{n,t}(j), \forall\, j \neq i \in C_n\big) \qquad (1)$$

The typical assumption is to consider the random (i.e. unobserved) components to be independently and identically extreme value (Gumbel) distributed (*iid*), leading to the multinomial logit (MNL) model formulation. However, if the random components amongst groups of alternatives are correlated (e.g. if unobserved attributes are shared by two or more alternatives), the MNL model would predict unrealistic substitution patterns. Alternatively, one might specify a joint distribution for the error terms, and estimate a nested logit (NL) model (Daly and Zachary 1978). The choice set is divided into mutually exclusive *nests* of alternatives; each alternative belongs to only one nest, and the error terms of the alternatives in each nest are assumed to be correlated. As a result, there will be higher cross-elasticities between alternatives in the nest with respect to alternatives in another nest. Choice probability will be conditional on the probability of this alternative of belonging to a pre-determined nest $m \in M$ (equations 2-5):

$$P_{n,t}(i) = P_{n,t}(S_m)\, P_{n,t}(i|S_m), \tag{2}$$

where:

$$P_{n,t}(S_m) = \frac{exp\ (\lambda_m I_m)}{\sum_{m \in M} exp\ (\lambda_I I_I)}, \tag{3}$$

$$P_{n,t}(i|S_m) = \frac{exp\ (V_{n,t}(i)/\lambda_m)}{\sum_{j \in S_m} exp\ (V_{n,t}(j)/\lambda_m)}, \tag{4}$$

and:

$$I_m = ln \sum_{j \in S_m} (V_{n,t}(j)/\lambda_m) \tag{5}$$

In this work, we compare three different nesting formulations. 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 passenger) 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 passenger) 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 (collapsing back to the MNL model).

Additional random variation in tastes across individuals is taken into account through the estimation of the mixed multinomial logit (MMNL) model (Train, 2002). Assuming a normal distribution for the random coefficients, the unconditional choice probability becomes (equations 6-7):

$$P_{n,t}(i|\mu_x, \sigma_x) = \int_{\beta_x} \left[\prod_{t=1}^{T_n} \frac{exp(\beta_x x(i))}{\sum_{j \in C_n} exp\ (\beta_x x(j))} \phi\ (\mu_x, \sigma_x) \right] \mathrm{d}\beta_x \tag{6}$$

where

$$\beta_x \sim N(\mu_x, \sigma_x), \text{ with } \phi\ (\mu_x, \sigma_x) = \frac{1}{\sigma_x \sqrt{2\pi}} exp\ (-\frac{(\beta_x - \mu_x)^2}{2{\sigma_x}^2}) \tag{7}$$

The maximization of the MMNL choice probability does not have a closed solution. Therefore, simulation with draws replaces the continuous integral with a summation (equation 8):

$$P_{n,t}(\widehat{i|\mu_x}, \sigma_x) = \frac{1}{R} \sum_{r=1}^{R} \left[\prod_{t=1}^{T_n} P_{n,t}(i|(\mu_x, \sigma_x)^r) \right] \tag{8}$$

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

In this paper we estimate NL, MMNL and mixed nested logit (MXNL, a combination of the NL and MMNL) models, separately for airport users and non-users. For both airport users and non-users, utility is represented as a function of alternatives' core characteristics (travel time, travel cost, headway), and individuals' socio-demographics (age, sex, education). For airport users only, utility is also a function of some characteristics of their last trip to the airport (departing airport, pieces of luggage, air party size, trip destination).

To exploit the relative advantages of RP and SP data, both sources were used in estimation[1]. RP data (actual choices) is used to "calibrate" the SP data (hypothetical choices). This is 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

[1] Only for airport users.

[2] Estimation results for the MNL model are not presented here, but available upon request to the authors.

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 to allow for differences in the variance of the error terms between SP and RP observations. This additional parameter, μ, multiplies the SP utility (which implies that the scale factor for RP data is normalized to 1). The deterministic component of utility becomes (equations 9):

$$V^*{}_{n,t}(i) = exp(\mu SP_{dummy})(V_{n,t}(i)) \tag{9}$$

7. Results

This section is further articulated in four sub-sections. In the first sub-section we discuss the results of the NL models. The second sub-section contains the elasticities and the policy analysis. In the third sub-section, we report the results of the estimation of the MMNL and MXNL models. NL and MXNL models are separately estimated on the sub-samples of users vs. non-users of the airports. Finally, the fourth sub-section contains the results for the NL models when a new hypothetical alternative is added to the choice set.

The attribute "travel cost" for the car alternatives (car driver, car passenger, and taxi) is modified in the estimation of the models to take into account the number of passengers (10). Indeed, travel cost for these modes might be lower in absolute terms than for the other modes if split amongst passengers.

$$travel\_cost_{car\_taxi} = \frac{travel\_cost_{car\_taxi}}{(1 + \ln(party\_size))} \tag{10}$$

7.1. The NL models

Table 4 shows that the NL2 model over performs the MNL model[2] (a difference of 10 LL units, at the price of two additional parameters), and the other NL specifications (on the basis of the AIC and BIC criteria). Therefore this has been chosen for the subsequent analysis.

Table 4. Model comparison

[2] Estimation results for the MNL model are not presented here, but available upon request to the authors.

	MNL	NL1	NL2	NL3
LL(0):		-9355.936		
LL(final):	-6936.94	-6927.36	-6926.38	-6926.38
AIC:	13939.89	13924.71	13922.76	13924.75
BIC:	14153.66	14151.45	14149.49	14157.96
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 non-business (i.e. leisure) ones. Business users might be also interested in reducing the risk, at any cost, of not getting to the airport on time, where this risk could reduced only if they use their own car. The results for Model 1 partially confirm this hypothesis (Table 5). Travel costs have a lower (negative) influence on the utility of business travellers than for non-business ones. Results regarding travel time are rather mixed: negative coefficients are obtained in all cases but for car driver and car passenger for business travellers; however, in many cases, the coefficient is not statistically different from zero (e.g. car passenger or direct bus for non-business travellers).

Model 2 only refers to the sub-sample of non-users of the airport. We only estimated a single coefficient for travel time and travel cost since we could not make any distinctions between business/non-business. Interestingly, the coefficient associated to travel costs is around three times larger than in Model 1. Negative coefficients for travel time are - also in this case - obtained for all modes but car driver and car passenger.

Table 5. Results of the NL2 models

	Model 1 (airport users)		Model 2 (non-users)	
	est	t_ratio (0)	est	t_ratio (0)
ASC Direct Bus	2.810	6.97	-0.483	-0.34
ASC Mixed Transit 1	-2.045	-1.88	0.180	0.15
ASC Mixed Transit 2	-3.452	-2.40	0.079	0.07
ASC Mixed Transit 3	0.705	1.76	-0.813	-0.63
ASC Car Driver	0.110	0.58	0.092	0.08
ASC Taxi	-0.529	-1.24	2.013	1.63
In-Vehicle Travel Time Mixes Transit (business)	-0.008	-1.99	-	
In-Vehicle Travel Time Mixes Transit (other)	-0.010	-2.96	-	
In-Vehicle Travel Time Mixes Transit (all)	-		-0.011	-2.22
Out-Of-Vehicle Travel Time Mixed Transit (business)	-0.032	-3.10	-	
Out-Of-Vehicle Travel Time Mixed Transit (other)	-0.006	-1.00	-	
Out-Of-Vehicle Travel Time Mixed Transit (all)	-		-0.001	-0.17
Travel Time Direct (business)	-0.006	-1.82	-	
Travel Time Direct (other)	-0.003	-1.40	-	
Travel Time Direct (all)	-		-0.010	-2.34
Travel Time Car Driver (business)	0.001	0.29	-	
Travel Time Car Driver (other)	-0.008	-2.84	-	
Travel Time Car Driver (all)	-		0.045	3.01

Travel Time Car Passenger (business)	0.000	0.11	-	
Travel Time Car Passenger (other)	-0.002	-0.56	-	
Travel Time Car Passenger (all)	-		0.015	1.33
Travel Time Taxi (business)	-0.013	-1.89	-	
Travel Time Taxi (other)	-0.024	-3.81	-	
Travel Time Taxi (all)	-		-0.049	-2.64
Travel Cost (business)	-0.019	-2.89	-	
Travel Cost (other)	-0.038	-6.92	-	
Travel Cost (all)	-		-0.094	-4.78
Headway Mixed Transit	-0.008	-3.86	-0.008	-1.90
Headway Direct Bus	-0.008	-15.00	-0.003	-1.44
Matera-Bari Bus (wrt Taranto-Brindisi)	0.296	2.47	0.074	0.26
Altamura-Bari Bus (wrt Taranto-Brindisi)	0.523	3.35	-	
Gravina in Puglia-Bari Bus (wrt Taranto-Brindisi)	0.219	1.14	-	
Taranto-Bari Bus (wrt Taranto-Brindisi)	-0.246	-2.06	0.375	1.12
Foggia-Bari Bus (wrt Taranto-Brindisi)	0.193	2.45	-	
Male (Car Driver)	-0.026	-0.57	1.458	4.12
Age (Direct Bus)	-0.035	-8.93	-0.005	-0.60
Baggage (Mixed Transit)	-0.402	-4.37	-	
Education (Direct Bus)	-0.043	-2.27	0.063	1.85
Air Party Size (Taxi)	0.059	3.53	-	
Scale SP	-0.259	-22.81*	-	
Lambda Mixed Transit (NL2)	4.506	2.98	0.702	1.92
Lambda Car (NL2)	0.438	4.28	-1.860	-2.82
IDs (RP)	1064		-	
IDs (SP)	749		165	
Observations	4808		825	
LL(0):	-9355		-1605	
LL(final):	-6926		-1192	
AIC:	13923		2428	
BIC:	14150		2531	
Rho-sq (adj,):	0.26		0.24	
Estimated parameters:	35		22	

Note: *t-ratio(1)

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 assume an important role in transport-planning decisions, being used as a key input for cost-benefit analysis.

Table 6. WTP measures for Model 1 and 2

	Model 1 (airport users)		Model 2 (non-users)	
	min (€)	hour (€)	min (€)	hour (€)
In-Vehicle Travel Time Mixed Transit Business	0.42	25.42	-	
In-Vehicle Travel Time Mixed Transit Other	**0.25**	**15.04**	-	
In-Vehicle Travel Time Mixed Transit All	-		**0.12**	**7.23**
Out-of-Vehicle Travel Time Mixed Transit Business	**1.66**	**99.59**	-	
Out-of-Vehicle Travel Time Mixed Transit Other	0.16	9.58	-	

Out-of-Vehicle Travel Time Mixed Transit All	-		0.01	0.49
Travel Time Direct Bus Business	0.31	18.77	-	
Travel Time Direct Bus Other	0.08	4.91	-	
Travel Time Direct Bus All	-		**0.11**	**6.64**
Travel Time Car Driver Business	-0.06	-3.33	-	
Travel Time Car Driver Other	**0.22**	**13.21**	-	
Travel Time Car Driver All	-		-0.47	-28.42
Travel Time Car Passenger Business	-0.02	-1.22	-	
Travel Time Car Passenger Other	0.04	2.63	-	
Travel Time Car Passenger All	-		-0.16	-9.76
Travel Time Taxi Business	0.66	39.8	-	
Travel Time Taxi Other	**0.62**	**37.3**	-	
Travel Time Taxi All	-		**0.52**	**31.11**

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

As expected, WTP indicators for business travellers in Model 1 are larger than for non-business ones; interestingly, when WTP indicators for non-users (Model 2) are statistically significant, these are generally smaller than those obtained for airport users (Model 1).

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 (11) (Train, 2002):

$$E_{z_{in}}(i) = \frac{\partial V_n(i)}{\partial z_{in}} z_{in}(1 - P_n(i)) \tag{11}$$

which collapses to $E_{z_{in}}(i) = \beta_z z_{in}(1 - P_n(i))$ 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 (12) (Train, 2002):

$$E_{z_{jn}}(i) = -\frac{\partial V_n(j)}{\partial z_{jn}} z_{jn}(P_n(j)) \tag{12}$$

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 with NL models are equivalent to those obtain with 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, direct and cross elasticities for the NL models (presented in Table 5) are summarised in Table 7.

Table 7. Direct and cross elasticities

	Model 1 (airport users)		Model 2 (non-users)
Direct	*Business*	*Other*	*All*
Headway Time (bus)	-0.75		-0.21
Travel Cost (bus)	-0.10	-0.20	-0.75
In-Vehicle Travel Time (mixed transit)	-0.65	-0.76	-1.29
Cross			
Headway Time	0.38		0.06
Travel Cost	0.05	0.10	0.22
In-Vehicle Travel Time	0.10	0.11	0.25

All elasticities have the expected signs. For airport users (Model 1), business travellers show smaller (in absolute terms) direct and cross elasticities for increases in travel cost for the direct bus and for increases in travel time for the mixed-transit alternatives. Non-users (Model 2), instead, are less sensitive to the headway time for the bus alternative, and more sensitive to the travel cost for the bus alternative and to travel time for the mixed-transit alternatives with respect to actual users.

The analysis of direct and cross elasticities is followed by the analysis of a set of 6 policies (Tables 8-10)[3]. 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. We compare the demand changes with respect to the initial situation (13) (Espino et al., 2007), using the parameters' estimates provided in Table 5:

$$\Delta P\ (i) = \frac{P^1\ (i) - P^0\ (i)}{P^0\ (i)} * 100 \qquad (13)$$

[3] A more detailed set of policies is reported in Bergantino et al. (2018).

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).

When the headway time for the direct bus alternative is reduced at no additional cost (Table 8), its market share for the airport users' increases by up to 34.1%; considering the initial market shares, the car passenger alternative suffers the most. The impact on non-users would be, instead, more limited, given their smaller elasticity (Table 7).

Table 8. Reductions in headway time at no additional costs

	Model 1 (airport users)	Model 2 (non-users)
Scenario 1 (-60% headway direct bus)		
Mixed Transit 1	-16.3%	-1.1%
Mixed Transit 2	-19.8%	-4.5%
Mixed Transit 3	-17.6%	-5.5%
Direct Bus	34.1%	11.2%
Car Driver	-16.6%	-2.5%
Car Passenger	-18.4%	-3.9%
Taxi	-17.0%	-3.6%

However, it is more reasonable that a reduction in the headway time for the direct bus will come together with an increase in the travel cost. When both attributes vary (Table 9), the predicted market share for the direct bus still increases up to 29.7% over the initial value (for airport users, when headway time reduces by 60% while travel cost increases by 30%). Similar policies, however, might have an undesirable side effect, i.e. to absorb demand mainly from other public means and not by private ones. As a result, the new policy might revert in the need to increase subsidies to the other public alternatives, which are cannibalized.

Consistently with the estimation of the direct elasticities for non-users, any increase in the travel cost for the direct bus would instead lead to a reduction in the predicted market share for the bus alternative, even if this is accompanied by a reduction in the headway time.

Table 9. Reductions in headway time at a cost

	Model 1 (airport users)	Model 2 (non-users)
Scenario 2 (-60% headway direct bus, +60% cost direct bus)		
Mixed Transit 1	-12.2%	9.5%
Mixed Transit 2	-15.9%	5.6%
Mixed Transit 3	-11.9%	11.3%
Direct Bus	25.3%	-24.5%
Car Driver	-12.5%	7.7%
Car Passenger	-13.6%	6.9%
Taxi	-12.8%	7.5%
Scenario 3 (-60% headway direct bus, +30% cost direct bus)		
Mixed Transit 1	-14.2%	4.7%
Mixed Transit 2	-17.8%	1.0%
Mixed Transit 3	-14.8%	3.3%
Direct Bus	29.7%	-8.1%
Car Driver	-14.6%	3.1%
Car Passenger	-16.0%	1.9%
Taxi	-14.9%	2.4%

When the in-vehicle time for the mixed transit alternatives is reduced (Table 10), there is an increase in their market share for both airport users and non-users. Such increase is the largest when travel time decreases by 30% at no additional cost. Finally, reductions in out-of-vehicle time (which can be obtained through a better coordination of operators' timetable) only increase the market share for the mixed-transit alternatives for the airport users.

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

	Model 1 (airport users)	Model 2 (non-users)
Scenario 4 (-30% IVT mixed transit)		
Mixed Transit 1	22.2%	29.6%
Mixed Transit 2	15.6%	18.1%
Mixed Transit 3	17.6%	28.0%
Direct Bus	-3.3%	-4.5%
Car Driver	-2.5%	-3.6%
Car Passenger	-1.9%	-5.0%
Taxi	-3.9%	-4.9%
Scenario 5 (-30% IVT mixed transit, +15% cost mixed transit)		
Mixed Transit 1	19.0%	17.0%

Mixed Transit 2	12.4%	21.0%
Mixed Transit 3	13.9%	28.0%
Direct Bus	-2.7%	-4.0%
Car Driver	-2.0%	-3.1%
Car Passenger	-1.3%	-4.4%
Taxi	-3.5%	-4.3%
Scenario 6 (-30% OVT mixed transit)		
Mixed Transit 1	9.0%	2.5%
Mixed Transit 2	3.5%	-0.8%
Mixed Transit 3	4.4%	0.4%
Direct Bus	-1.3%	-0.1%
Car Driver	-0.9%	0.6%
Car Passenger	0.4%	-0.6%
Taxi	-2.3%	-0.1%

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. With respect to the actual users of the airports, results suggest that reductions in headway time for the bus alternative, and in (in- or out-of-vehicle) travel time for the mixed transit alternatives would lead to increases in their market shares, even if such reductions come at a cost. Nevertheless, the car passenger might still remain the most preferred alternative.

Non-users are more sensitive to travel cost than to headway time for the direct bus; therefore, only policies aimed at reducing headway time - while keeping its cost unchanged - would be effective; different is the case for the mixed transit alternatives, for which also non-users would be willing to pay some extra money for improvements of the service.

We now focus only on the Matera-Bari access route. The Regional Government of Basilicata has already committed to increase the frequency of the shuttle bus service from Matera towards Bari airport. From the actual 5 (per day) to hourly services, frequency will increase to 18 buses/day in each direction, i.e. headway time will reduce from 220 to 60 minutes (-70%). Elasticity measures for residents in Matera, Altamura, and Gravina are reported in Table 11, followed by the analysis of three additional policies, which assume that the decrease in headway time will come at no additional costs, or together with a fare increase.

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

	Model 1* (airport users)		Model 2* (non-users)
Direct	*Business*	*Other*	*All*
Headway Time (bus)	-1.12		-0.05
Travel Cost (bus)	-0.31	-0.54	-0.60
In-Vehicle Travel Time (mixed transit)	-2.32	-2.31	-1.21
Cross			
Headway Time	0.54		0.01
Travel Cost	0.15	0.26	0.14
In-Vehicle Travel Time	0.37	0.37	0.34

* Based on models estimated only on respondents from Matera/Altamura/Gravina.

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

	Model 1* (airport users)	Model 2* (non-users)
Scenario Matera-1 (-70% headway direct bus)		
Mixed Transit 1	-28.80%	-1.41%
Mixed Transit 2	-23.20%	-0.39%
Direct Bus	61.80%	3.09%
Car Driver	-28.50%	0.51%
Car Passenger	-32.90%	-1.47%
Taxi	-29.10%	-0.80%
Scenario Matera-2 (-70% headway direct bus, +10% cost direct bus)		
Mixed Transit 1	-26.70%	0.02%
Mixed Transit 2	-20.70%	1.01%
Direct Bus	57.80%	-2.46%
Car Driver	-26.80%	1.72%
Car Passenger	-31.00%	-0.18%
Taxi	-27.40%	0.57%
Scenario Matera-3 (-70% headway direct bus, +50% cost direct bus)		
Mixed Transit 1	-18.40%	5.11%
Mixed Transit 2	-11.20%	6.01%
Direct Bus	42.10%	-22.14%
Car Driver	-20.20%	5.95%
Car Passenger	-23.20%	4.41%
Taxi	-20.50%	5.44%
Scenario Matera-4 (-70% headway direct bus, +100% cost direct bus)		
Mixed Transit 1	-8.70%	10.20%
Mixed Transit 2	-0.60%	10.99%
Direct Bus	23.80%	-41.60%
Car Driver	-12.40%	10.07%
Car Passenger	-13.90%	8.95%
Taxi	-12.5%	10.3%

* Based on models estimated only on respondents from Matera/Altamura/Gravina.

Elasticities obtained on the subset of residents living the cities of Matera, Altamura, and Gravina look slightly higher in absolute terms for the airport users (in particular those related to in-vehicle travel time), and lower for the non-users. The analysis of the alternative policies do not reveal substantial differences with respect to the macro-trends observed on the full sample. We might only mention that, for the airport users, the expected increase in the market share for the direct bus would be far more pronounced, i.e. up to 61.8% over the initial. Residents of these cities are more likely to shift to the direct bus as soon as this alternative becomes more attractive, even if this comes at a cost.

7.3. The Mixed Logit Models

In this paper, MMNL and MXNL models have been estimated using random coefficients for the travel time to accommodate random tastes across respondents. We assumed a normal distribution for travel time as this provided the best fit to the data over the lognormal and the uniform distributions. 2000 Halton draws have been used for the simulation, and results are reported in Table 13. In terms of statistical fit, both the MMNL and the MXNL models over perform the NL2 model, (with a gain of more than 1000 log-likelihood units for the sub-sample of airport users).

Table 13. The MMNL and MXNL models (Normal distribution and 2000 Halton draws)

	Model 3 (airport users) MMNL		Model 4 (airport users) MXNL2		Model 5 (non-users) MXNL2	
	est	t_ratio (0)	est	t_ratio (0)	est	t_ratio (0)
ASC Direct Bus	1.278	3.47	0.160	0.78	-5.457	-3,22
ASC Mixed Transit 1	0.358	1.13	-0.055	-0.33	-2.064	-1,38
ASC Mixed Transit 2	0.246	0.82	-0.073	-0.44	-2.341	-1,69
ASC Mixed Transit 3	0.458	1.49	-0.220	-1.29	-3.728	-2,38
ASC Car Driver	-0.284	-0.86	-1.010	-3.30	-2.313	-1,26
ASC Taxi	1.034	2.60	0.205	0.89	4.007	1,82
In-Vehicle Travel Time Mixed Transit (business)	-0.017	-4.93	-0.005	-4.25	-	
In-Vehicle Travel Time Mixed Transit (other)	-0.012	-5.70	-0.003	-4.49	-	
In-Vehicle Travel Time Mixed Transit (all)	-		-		-0.032	-4.24
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	-	
Out-Of-Vehicle Travel Time Mixed Transit (all)	-		-		-0.002	-0.44
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 Direct (all)	-		-		-0.012	-2.24
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 Driver (all)	-		-		-0.053	-2.14

Travel Time Car Passenger (business)	-0.005	-1.40	-0.010	-3.80	-	
Travel Time Car Passenger (other)	-0.005	-1.52	-0.009	-3.95	-	
Travel Time Car Passenger (all)	-		-		-0.056	-3.06
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 Time Taxi (all)	-		-		-0.202	-4.92
Travel Cost (business)	-0.022	-3.14	-0.020	-4.77	-	
Travel Cost (other)	-0.034	-7.01	-0.024	-7.85	-	
Travel Cost (all)	-		-		-0.149	-6.67
Headway Mixed Transit	-0.004	-3.08	-0.001	-1.76	-0.013	-2,66
Headway Direct Bus	-0.005	-10.11	-0.001	-5.30	-0.004	-1,71
Matera-Bari Bus (wrt Taranto-Brindisi)	0.144	1.40	0.045	0.78	0.028	0,07
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	0.047	0,11
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	0.209	0,52
Age (Direct Bus)	-0.018	-5.20	-0.006	-3.58	0.010	0,99
Baggage (Mixed Transit)	-0.275	-3.39	-0.112	-3.26	-	
Education (Direct Bus)	-0.022	-1.39	-0.011	-1.33	0.141	3,17
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	-	
In-Vehicle Travel Time Mixes Transit (all)			-		0.019	5.23
Out-Of-Vehicle Travel Time Mixed Transit (business)			0.001	0.43	-	
Out-Of-Vehicle Travel Time Mixed Transit (other)			0.000	-0.02	-	
Out-Of-Vehicle Travel Time Mixed Transit (all)			-		0.000	0.30
Travel Time Direct (business)			-0.001	-1.13	-	
Travel Time Direct (other)			0.003	4.52	-	
Travel Time Direct (all)			-		-0.002	-0.74
Travel Time Car Driver (business)			0.034	6.85	-	
Travel Time Car Driver (other)			0.024	8.17	-	
Travel Time Car Driver (all)			-		-0.073	-5.29
Travel Time Car Passenger (business)			-0.008	-5.55	-	
Travel Time Car Passenger (other)			0.007	8.66	-	
Travel Time Car Passenger (all)			-		-0.024	-5.35
Travel Time Taxi (business)			-0.014	-6.08	-	
Travel Time Taxi (other)			0.011	7.54	-	
Travel Time Taxi (all)			-		0.066	6.08
Lambda Public Modes (MXNL2)			0.179	4.09	0.817	2.45
Lambda Private Modes (MXNL2)			3.527	17.94	2.343	5.65
IDs (RP)	1064				-	
IDs (SP)	749				165	
Observations	4808				825	
LL(0):	-9356				-1605	
LL(final):	-6052		-5909		-1034	
AIC:	12193		11912		2124	
BIC:	12485		12218		2256	
Rho-sq (adj,):	0.35		0.36		0.34	
Estimated parameters:	45		47		28	

Note: *t-ratio(1)

7.4. The introduction of a new alternative

This final sub-section investigates the market effects when a new, hypothetical mode, is introduced. This improvement will only affect those travelling to/from Bari airport, where a railway station within the airport premises is already available. For this analysis, we only used data from the sub-sample of airport users; we thought that asking individuals who had never flown through Bari airport to state their potential behaviour towards a further hypothetical scenario could have increased the hypothetical bias in the SP experiment. The results of the estimation are reported Bergantino et al (2018).

Tables 14 and 15 report the 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 15. Direct and cross elasticities before and after the introduction of the 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: * not for the direct train.

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

	Model 7 (airport users)
Scenario Rail 1 (-60% headway direct bus)	
Mixed Transit 1	-10.9%
Mixed Transit 2	-7.1%
Mixed Transit 3	-12.0%
Direct Bus (direct)	44.8%
Direct Train	-23.2%
Car Driver	-5.3%
Car Passenger	-11.5%
Taxi	-8.1%
Scenario Rail 2 (-60% headway direct bus. +60% cost direct bus)	
Mixed Transit 1	-3.9%
Mixed Transit 2	-0.0%
Mixed Transit 3	-4.3%
Direct Bus (direct)	4.0%
Direct Train	0.1%
Car Driver	-5.8%
Car Passenger	-1.9%
Taxi	-29.1%
Scenario Rail 3 (-60% headway direct bus. +30% cost direct bus)	

Mixed Transit 1	-7.2%
Mixed Transit 2	-3.4%
Mixed Transit 3	-7.6%
Direct Bus (direct)	22.7%
Direct Train	-8.8%
Car Driver	-2.3%
Car Passenger	-8.4%
Taxi	-4.7%

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 passenger were the most chosen alternatives. The direct train alternative gets more penalized 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

The political pressures for opening and maintaining “local” airports are stronger when accessibility towards main airports is poor, as it is the case in Apulia, in Italy, and in many other European peripheral regions. Despite Bari and Brindisi being very well connected to the respective city centres through frequent bus services (Bari also with a rail link), many other densely populated and/or touristic areas in the region are not as easily accessible by public services. For this reason, residents of those less accessible areas continually ask to re-open the “local” airports of Foggia and Grottaglie, which would reduce their isolation.

In this paper we use both *revealed* and *stated* preferences to assess the effectiveness of several policy measures designed to improve accessibility by public transport means, some of which will become operative in 2019. Improvements in accessibility conditions might be a more economically sustainable, as well as more politically acceptable, alternative to re-opening and maintaining inefficient “local” airports.

Results of the estimation of probabilistic models reveal that policies aimed at increasing the frequency of direct bus services (e.g. via reductions in the headway time between consecutive services) have a positive effect, especially for airport users. Non-users of the airports are far more sensitive to travel costs than actual users; for them, increases in frequency for bus services lead to a shift towards this mode only if travel costs do not increase as well. Our results also suggest that the substitution patterns between the direct bus and a hypothetical direct rail connection are such that any improvements in the characteristics of the former actually penalise the latter more than other modes. Interestingly, in all the proposed scenarios, car (passenger) remains the alternative with the largest predicted market share.

We understand that our results might underestimate the actual modal shifts, given that they do not take into account, for example, the fact that policy makers might strongly advertise such improvements. Nevertheless, it is also worth considering that a large portion of users might still prefer being dropped off by relatives or friends, because they wish to spend additional time with them or because they do not fully take into account the cost they bear.

To conclude, unveiling the drivers of access mode choices for definitely yields interesting insights for airport managers, private operators, and regional transport authorities for the evaluation of future investments, particularly those aimed at improving accessibility conditions. The number of passengers at Bari and Brindisi airports is growing year after year, and a share of those who are non-users now might possibly become users of the airports in the next future. Despite our analysis being focused on the Apulian context, our findings might be generalised to airports of similar size/catchment area and might be useful to assess the potential impact of public and/or private policies in relation to different territorial contexts.

The substantial amount of air passenger growth of the last years is producing tremendous pressure on ground access networks and airports all over the world, and in order to accommodate this growing air passenger demand, major airports developed extensive Ground Transport Plans (GTPs).

A future research avenue would be to test similar approach in different geographical contexts. This would allow comparing WTP and elasticities. Also a quantification of the pollution abatement of the modal shift induced by the introduction of the new services would be useful in defining the full cost/benefit of the investment, when the public sector is involved. Finally, changing the optic of the research, it would be very interesting also to study the effect of the closure of a specific airport on the mobility patterns of passengers, in order to develop plans to compensate potential demand through improved accessibility to the remaining airports, in a cost-benefit analysis perspective.

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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 Passenger	+ 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 Passenger	+ 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 Passenger	+ 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 Passenger	+ 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.