Accessibility to Italian remote regions. When air transport is the best alternative?

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Historically, for geographically disadvantaged areas, air transport services have represented the main alternative to guarantee residents' mobility needs. In the last decades, many investments in local airports have been promoted as a way to increase accessibility in many Italian regions. On the other side, transport services have also witnessed important changes as the entrance of low cost carriers, the development of high speed services or the increasing role of long distance passenger coach transport. These services together with an improved intermodality could provide an alternative to access areas of the country. The paper, adopting a policymaker perspective, studies the different passenger transport alternatives for a sample of zones in the catchment area of a local airport. It is based on a long distance multimodal transport model describing the entire Italian long distance supply thus it allows to estimate the generalized cost to access all the zones of the country by road, rail, coach and air services. The analysis of the generalized costs for the period 2013/2014 helps to better understand the role of air transport with respect to the other available modes for each zone. It could also represent the first step to reconsider the possible strategies to improve national accessibility levels.

Key words: generalized cost, transport modes, remote regions

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1. Introduction and aim

Policymakers have always seen air transport as the main alternative to guarantee access to remote regions (or regions with a lower level of infrastructure). This view has strengthened following the liberalization of air transport that, thanks mainly to low cost carriers, has made possible connections and higher frequencies at lower fares also from many secondary airports, which have gained increasing importance improving the level of connectivity of some Italian areas. On the other side, many cases of scarce results in passengers and financial terms have been registered for some airports in the rush to attract low cost carriers (Laurino et al., 2014).

The key concept in air transport accessibility of remote regions is that of Public Service Obligation[1] (PSO). PSOs are foreseen by countries whereas air services are deemed to be "vital for the economic and social development of the region which the airport serves" (EU Regulation 1008/2008) and where no air services are present due to their scarce viability in commercial terms. Ten countries[2] currently apply PSOs in Europe mainly on domestic routes. However, Williams and Pagliari (2004), analyzing PSOs across the European Union, evidence different attitudes and approaches in the extent and way in which PSO mechanisms are applied by countries.

As described also by Braathen (2011), the terms "remote regions" and "lifeline services" have had different interpretations. PSOs have been established towards peripheral remote communities (Norway), between regional airports and major cities or between major cities (France), between islands and their mainlands (Italy, Spain, Portugal). In France, PSO have been established even where traffic volumes could be commercially viable or where more convenient surface transport alternatives exist (Williams and Pagliari, 2004).

Air PSOs are not the only possible strategy to improve connectivity of remote regions. Lian and Rønnevik (2011), concerning passengers' choice between local airports with PSO services and larger regional airports in Norway, find that travelers prefer to drive several hours to a larger airport to take advantage of lower fares and more convenient airline services, entailing the phenomenon known as traffic leakage (Suzuki et al., 2004). The results could be the erosion of the catchment areas of the nearby local airport offering only indirect flights, in favor of a distant airports with direct services, consequently reducing the effectiveness and efficiency of PSOs.

In general, the accessibility of a region depends on different conditions and can be improved using different strategies, also combined:

1. market forces, based on carriers offering flights at market conditions;
2. market forces, based on other transport modes (train, coach services, etc) providing services at market conditions;
3. provision of temporary start-up aids in order to foster a new route;
4. public service obligation on air services;
5. public service obligation on other land services (train, coach);
6. improving the land-side accessibility to the closest airport with better services in terms of destinations and frequencies;
7. promote/build new local airports.

[1] For further review on this topic see also (Reynolds-Feighan, 1995; Reynolds-Feighan, 1999; Merkert and O'Fee, 2013).

[2] According to European Commission, PSOs are imposed in Italy, Portugal, Spain, Estonia, UK, Greece, France, Norway, Sweden and Finland. The list of the PSO applied at December 2014 could be found at http://ec.europa.eu (Accessed Aprile 2015).

Clearly, these strategies are not mutually alternative, but are applicable under specific conditions and can differ under various aspects, primarily in terms of public expenditure required. A comprehensive and efficient policy should consider all of them in terms of costs, long term sustainability and effects on users' costs. Building local airports could be the solution whereas, for example, the geographical context (islands, inland remote areas, etc) would make other alternatives much more costly. On the other side, underpopulated regions, remote but not inaccessible by road transport, could be better served with improved (if needed also subsidised) land services connecting them with the closest operating airport. Finally other transport modes (rail or coach services) could assure the required accessibility levels.
The paper, through the modeling of air and land transport generalized costs in Italy, aims at clarifying these conditions for a sample of areas.
The remainder of the paper is organized as follows. In the next section we present and discuss the Italian areas considered, section 3 provides a short description of the model used. In section 4 we discuss the results of the simulation in the selected areas. In conclusion, we derive policy indications from the case studied and indicate guidelines for future research.

2. Areas considered

In order to define our sample, we started from the analysis of the current context in Italy that includes 47 airports, both with scheduled traffic and not open. Among them, two airports have been recently opened (Crotone and Comiso). Italy has been divided into 371 homogeneous zones and for each of them we compute the access time by car[3] to the closest airport (operating or not) and to the closest airport with scheduled services, if different.

[3] We considered only access by car since local airports do not have any public transport service. As pointed out by Humphreys and Ison (2005), internationally private car is the main mode to access airports, this is true in particular for low volume airports that do not have the minimum level of demand to justify public transport services.

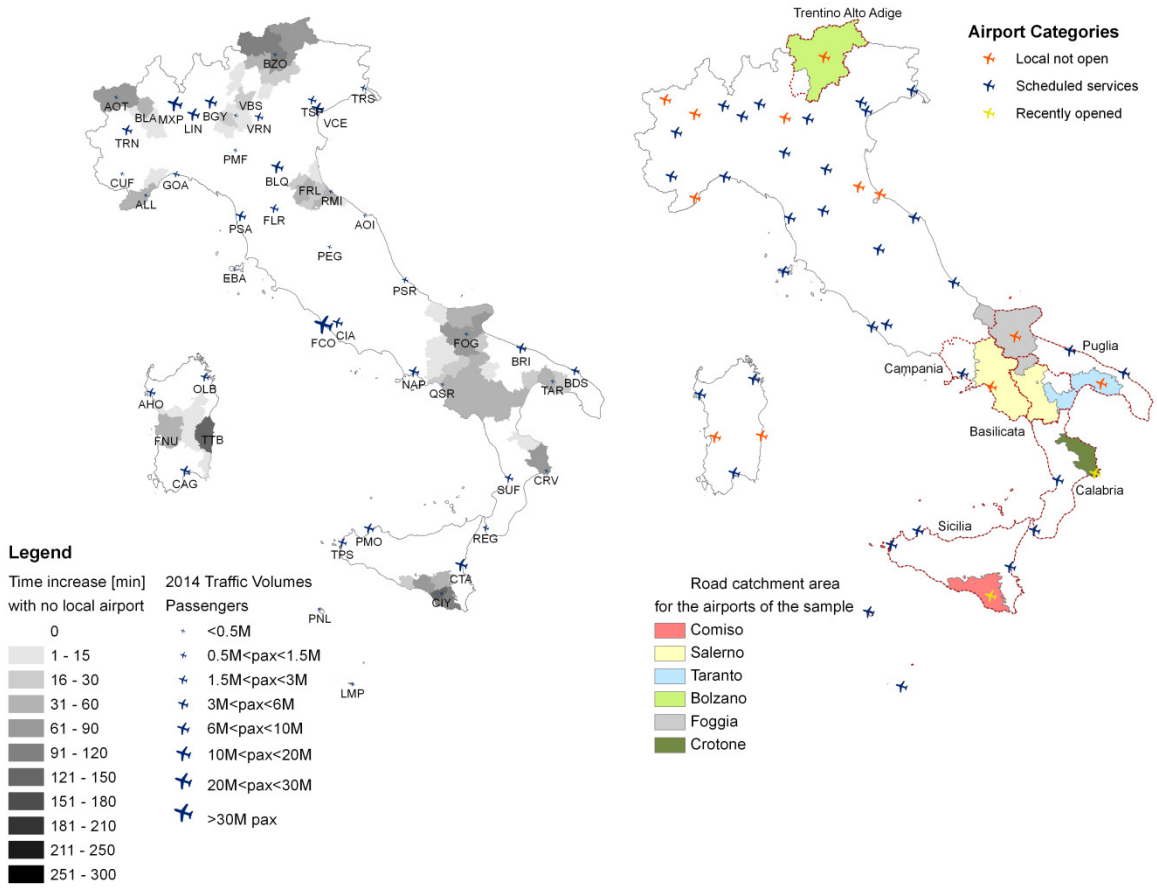


Figure 1 - Travel time increase to reach the closest airport with scheduled services (on the left-side map) and areas of the sample (right-side map) considered (Source: our elaborations, for traffic volumes ENAC 2014)

Figure 1 represents the increase in travel time for all the Italian zones due to the absence of the existing but closed local airport[4]. Excepting few cases, the areas benefited by these potential new airports are relatively limited and the extra-time needed to reach the closest main airport is quite small. Additionally, Redondi et al. (2013), evaluating the role played by small airports (less than 1 – 2 Million passenger per year) in European connectivity, show for Bolzano and Foggia no loss and for Crotone a relatively small connectivity loss generated by their closure. However, there are also large areas not served (Alto Adige and Basilicata regions, mainly) or areas with significant population (Taranto, Southern Sicilia, Rimini, Brescia).

Using the extra-time values, we focused the analysis on a sample of six areas[5], five located in the south of Italy and one in the North. Each area could potentially gravitate on a local airport but it is also in the catchment area of an already operating airport, as shown in the Table 1. According to OneWorks et al. (2010), excluding Sicilia (2.3 pax/inh), the mobility index (passengers carried per inhabitant) for the other four southern areas is 0.9 pax/inh, the lowest nationwide.

[4] Or to the closure of the recently opened Crotone's and Comiso's airports.

[5] We did not consider the Sardinia case since it has a specific PSO program and due to the fact that air transport actually represents the main alternative to reach the area.

	Local airport			*Airport with scheduled services*		
Region	*Airport*	*Population in the road catchment area*	*Passengers [2014]*	*Closest operating airports*	*Passengers [2014]*	*Main carriers [2013]*
Basilicata	Taranto [TAR] Foggia [FOG] Salerno [QSR]	810.159 804.623 2.010.307	885 5.351 2.245	Napoli [NAP]; Bari [BRI]	5.917.256 [NAP]; 3.664.337 [BRI]	FC [NAP] LCC [BRI]
North of Puglia	Foggia [FOG]	804.623	5.351	Bari [BRI]; Pescara [PSR]	552.116 [PSR]; 3.664.337 [BRI]	LCC [PSR] LCC [BRI]
South-west of Sicilia	Comiso [CIY]*	645.829	328.027	Catania [CTA]	7.217512 [CTA]	FC [CTA]
South of Campania	Salerno [QSR]	2.010.307	2.245	Napoli [NAP]	5.917.256 [NAP]	FC [NAP]
Central part of Calabria	Crotone [CRV]*	291.517	65.793	Lamezia Terme [SUF]	2.414.277 [SUF]	LCC [SUF]
Trentino Alto Adige	Bolzano [BZO]**	944.091	57.660	Verona [VRN]	2.755.171 [VRN]	FC [VRN]

Table 1 - Sample considered (Sources: for passengers figures ENAC 2014, for population our elaborations, for dominant carrier OAG 2013); *air transport supply not included in the model, **PSO not included in the model

Basilicata region, with low levels of population and density, is located between two bigger regions (Puglia and Campania) that, through their active airports, provide connections at a reasonable driving distance for the majority of the region. In particular, in the western part, the province of Potenza gravitates mainly on Napoli (NAP) airport while the province of Matera is closer to the airport of Bari (BRI).

In the southern part of Campania, Salerno's airport could represent an alternative to Napoli since it could serve a relevant catchment area (Table 1) due to its location close to the non-tolled highway A3 connecting Campania, Basilicata and Calabria.

Puglia is one of the largest region in terms of population and its airport system, managed by a publicly owned subject, includes two main airports, one serving the northern part of the region (Bari) the other the southern one (Brindisi). Two minor airports, currently with nearly no traffic, are also present (Foggia and Taranto).

In Sicilia, Catania in the south-east and Palermo in the north-west of the region, have historically played a major role for the connectivity of the island. In the last five years, Trapani airport has gained importance in the western area of the region thanks to the presence of Ryanair, which established a base there. Finally, in 2013 a new airport, Comiso, opened in the southern part of the region, whose catchment area partially overlaps with that of Catania. This new airport contributes to seasonal summer traffic while, for the rest of the year, passenger may opt to drive a little bit more to reach Catania and its wider and more frequent supply.

Trentino Alto Adige, despite being one of the richest region of the country (its GDP per capita doubles that of the other five southern areas), is the only one in the north of Italy with no scheduled commercial traffic in its airport. The only service currently offered from Bolzano's airport is a PSO towards Rome while the airport of Trento hosts only private tourist flights. The vicinity to the

airport of Verona (nearly 1h 30min) or Venice, but also to Milan's airports, partially justifies the lack of domestic flights, together with the limited dimension of both urban areas. Moreover, there are many coach services providing seasonal service during winter towards the main Italian northern airports.

Calabria region has currently three airports with scheduled services. Lamezia Terme is the main one due to its location in the middle of the region that attracts passengers from both the northern and the southern areas. Reggio Calabria is used mainly by passengers in the south or by users from Sicilia on the other side of the channel. Crotone's traffic trends are influenced by the vicinity of Lamezia airport (less than 100 km), but also by the presence of low cost carriers, such as Ryanair that has recently started to provide services. In addition, in order to assure a certain level of connectivity, in 2014 the Ministry of Transport established the possibility of PSO services from Crotone, notwithstanding no carrier took part to the tender.

Finally, among the local airports of the sample, Salerno (initially with Air Dolomiti and then with Alitalia[6]) and Foggia (first with MyAir and then with Air Dolomiti) have already experienced several attempts to stimulate scheduled services by means of start-up aids, which resulted very costly in terms of public funds. These trials however entailed scarce results in passengers terms in part due to runways infrastructural limits[7] which prevent the use of large aircraft thus excluding, for example, low cost carriers, in part due to the close vicinity of two important airports, Napoli and Bari, that provide better services in terms of destinations and frequencies.

3. Approach and computation of the generalized cost

3.1 Model description

Travel choices depend on travel costs and on the perception of its components. In air transport, door-to-door travel cost can be split into three sub-sections, namely ground access to the airport, air travel, and egress from the destination airport.

Many factors may contribute to ground access mode choice (Kouwenhoven, 2008), in particular travel time and travel cost to access an airport are two central elements affecting travelers' choice (Skinner, 1976; Harvey, 1986). However, other factors more difficult to define, contribute to individuals' decisions regarding their trips to and from the airports: travel time reliability (Koster et al., 2011; Tam et al., 2011), passengers' socioeconomic and demographic characteristics, trip purpose and destination (Chang, 2013; Hess and Polak, 2005; Tsamboulas and Nikoleris, 2008; Gupta et al., 2008; Akar, 2013), available transport modes together with their user-friendliness (Jou et al., 2011; Cirillo and Xu, 2010; Alhussein, 2011), departure and arrival time to the airport.

In addition to air services, from every zone it is possible to use other ground transport, such as private car, train and coach (or a combination of them) to reach the final destination.

Starting from a sample of zones located in the road catchment areas of six local airports (Figure 1), we calculate the generalized costs[8] (hereafter GC) to access all the Italian zones[9]. To do that we use

[6] The agreement foresaw two daily flights to Milan Malpensa (from Monday to Friday) and a daily flight to Rome Fiumicino (from Monday to Sunday); it costed 4 M€/year to the airport manager and lasted nearly one year and a half. During this period the passengers increased from 5.163 in 2010 to 24.631 in 2011 and then decreased to 8.797 once the deal was stopped by Alitalia due to its unviability.

[7] The runway length of Foggia's airport is capped at 1440m while the length of Salerno's airport is 1650m. Ryanair operates Boeing 737-800 aircraft while EasyJet uses mainly Airbus A319-100 and Airbus A320-200. Both the typologies require a minimum runway of 1900m.

[8] In transport economics, the generalized cost is the sum of monetary and non-monetary costs perceived by the user to perform a certain trip (Zofio et al., 2014)

a multimodal transport model, which takes into account 2013 public service timetables to simulate the entirety of the Italian long distance transport industry including car, train, air and coach services. For a detailed description of the model see Beria et al. (forthcoming). For the purposes of this paper, the model is used limitedly to the generalized cost calculation, thus excluding the modules of modal choice and network assignment.

3.2 Generalized cost by transport mode

According to Nichols (1975), generalised costs measure depends firstly on distance and time and they represent a translation of this key accessibility variables into economic costs (units prices).
As different individuals perceive differently the cost components of a trip, the model includes three stylized demand segments: the *Business traveller* (which has a higher value of time thus tend to prefer faster modes), the *Economy traveller* (which tends to reduce monetary costs accepting longer travel time and uses public transport to access/leave stations or airports) and the *Families* (which considers a group of 3 people that can share the cost of a private car to access/leave stations or airports). The following table summarizes the characteristics of the segments (Beria et al., forthcoming):

	Value of time [€/h]	N° of people in the group	Car unit cost [€/km]	Toll perception coefficient	Public transport fare
Business	30	1	0,35	40%	full cost
Economy	6	1	0,25	60%	low cost
Family	6	3	0,25	60%	low cost

Table 2 - Assumptions for the stylized passengers

In the following we will consider only *Economy travelers*, partly because they have lower transport alternatives, and partly because they are more willing to switch airport/mode in exchange of lower costs accepting travel time increases.
The GC by car derives from the usual definitions (Ortuzar and Willumsen, 1990) and it is calculated for a single road edge using the following formula:

$$GC = aD + bTN + cP$$

where D is the distance [km], T is the travel time [h] which considers the average speed allowed on that specific arc, P is the toll, N is the number of people in the car, a represents vehicle operating costs (€/km) and it varies according to the different user profiles (business, economy, family), b is the value of time (€/h) and c is the tariff perception (%).
For collective transport modes, the GC formula becomes:

$$GC = (bT + cP)N$$

and the univocal price/tariff P of a specific route is:

$$P = p_0 + \rho d$$

where d is the distance and ρ is a component proportional to distance, plus a fixed component independent from distance p_0. The parameters p_0 and ρ are calculated on the basis of real tariffs extrapolated from transport operator websites; they vary according to the type of service, purchasing period and presence of competition. The GC is computed both for those relationships

[9] We considered 371 sub provincial zones, each one identifies a traffic catchment area that generally represents a homogeneous aggregation of Municipalities on the base of their population

with direct services and for those where "hubbing" is possible[10]. The following table summarizes the assumptions made for each transport alternative.

	Origin zone	Access to the airport / station	On board	Hubbing	On board	Egress from the airport / station	**Destination zone**
CAR	*CAR*						
COACH SERVICES	*COACH SERVICE*			if possible	*COACH SERVICE*		
TRAIN SERVICES	*PUBLIC TRANSPORT*			if possible		*PUBLIC TRANSPORT*	
AIR SERVICES	*PUBLIC TRANSPORT*			if possible		*PUBLIC TRANSPORT*	

Table 3 - Assumptions for the calculation of the generalised cost

3.1.1 Generalized cost by car

The model includes the entire national road network (subdivided in highway, provincial road and main connections at the sub-provincial level) including the geometric characteristics of the road (number of lanes, intersections, etc.) and the average speed (from 20 to 120 km/h) allowed on the base of endogenous (type of road) and exogenous (orography and urban contest) elements. The cost is calculated considering the shortest path length (excluding congestion).

3.1.2 Generalized cost by coach

The timetable database contains a complete description of Italian long-distance coach services (average winter weeks of 2013/2014), including the services towards the airports. All information on routes, stops and frequency derive directly from the websites of the coach companies[11]. The GC is computed both for those relationships with direct services and for those where interchanges between bus services are possible.

3.1.3 Generalized cost by rail

The database includes the timetable of Italian rail services, including the majority of regional services (average winter week of 2014). Simulations are based on all the long distance services provided by both Trenitalia and NTV.
The generalized cost has been calculated following three steps as described in Table 3, moreover the GC considers both direct services and services which foresee an interchange (for example regional service plus intercity services).

3.1.4 Generalized cost by air

The generalized cost has been calculated considering 140 domestic routes (average spring week of 2013) derived from the OAG database. The model also includes two different passenger profiles, full service and low cost, according to the type of carrier used. The components of the GC follow the scheme in Table 3, as for coach and rail services. Also for air transport interchanges are possible in intermediate airports when no direct flight is available.

[10] This is true for air service but also for coach and train services whereas respectively interchanges at the station or at the bus stops allow to reach indirectly other destinations. Intermodal interchanges are not included in this phase
[11] 391 long distance bus lines operated by 80 different operators

4. Discussion of the results and policy implications

4.1 Italian long distance transport

Before analyzing the results, some peculiarities of the Italian long distance transport sector should be considered:

- High speed rail network: in the last decades the core structure of the network has been opened. In 2012 a new operator, NTV SpA, has entered the market offering high speed services in competition with the incumbent Trenitalia SpA. As a consequence, on the route between Milan and Rome, high speed services have gained increasing market shares with respect to the air sector forcing airlines to reduce fares (Bergantino et al., 2015a) or to leave the route[12];
- Rail transport Public Service Obligation: historically there are more than 150 Intercity services mainly on North – South routes which are regulated in terms of fares, timetables, seats, etc. Beyond the direct services, PSO on night services also require to interchange in Rome (or Bologna) with a high speed service at a regulated fare;
- Highway network: the majority of highways are located in the central and northern regions (more than 4500km), only two highways, the non-tolled A3 on the west-coast and the tolled A14 on the east-coast, serve also the southern areas;
- Coach services: there are many operators which historically provide North – South connections and connections to Rome from all the southern regions. The biggest ones are located in Puglia and Calabria regions, reflecting the internal migration stratification. Many operators provide only a route. However the biggest ones use a hub & spokes scheme to distribute the passengers in the southern zones, more dispersed. Since 2014 long distance coach services are liberalized;
- Air transport: large increase of supply also on domestic flights due to the 90s liberalization. In particular low cost carriers[13] have 45,75% of market share and offer domestic routes also from many secondary airports;
- Air transport Public Service Obligation[14]: historically there are PSOs to connect minor islands to the main land but also PSOs from northern regions (Valle d'Aosta and Trentino Alto Adige);

Finally, in order to better analyze the results presented in the next sections, Table 4 provides data concerning the 2013 context for the areas of the sample in terms of available rail PSOs, number of long distance coach operators based in the region and destinations available from the closest operating airport.

[12] Ryanair closed its service from Bergamo (BGY) to Rome Ciampino (CIA), EasyJet recently announced that starting from November 2015 will no longer serve the route Milan Linate – Rome Fiumicino.

[13] According to Enac (2014), Ryanair, with over 26M, ranks first in terms of passengers carried in 2014 in Italy followed by Alitalia and Easyjet. Alitalia ranks first and Ryanair second for domestic traffic, the contrary happens for international traffic with EasyJet ranking third in both the cases.

[14] These PSOs are managed by the Ministry of Transport while Sardinia region has its own PSO scheme from its three airports to the main land.

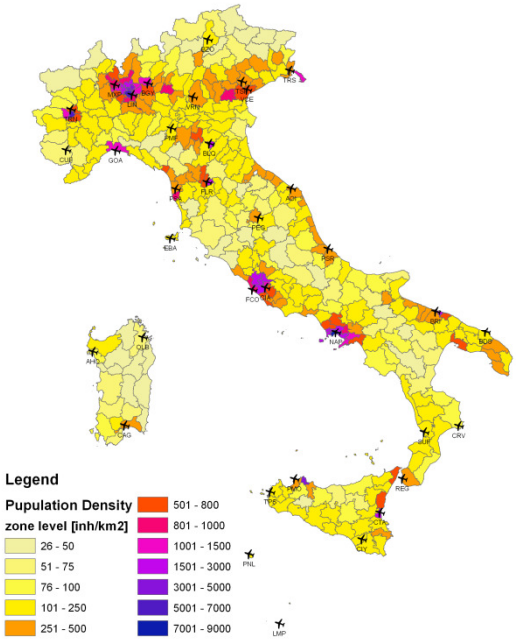
Region	N° daily rail PSOs	N° domestic destinations available from the operating airport on a weekly base	N° long distance coach operators
Calabria	36	8 [SUF]	12
Campania	54	13 [NAP]	11
Sicilia	21	13 [CTA]	5
Puglia	33	16 [BRI], 3 [PSR]	7
Trentino Alto Adige	2	10 [VRN]	0
Basilicata	22	16 [BRI], 13 [NAP]	13

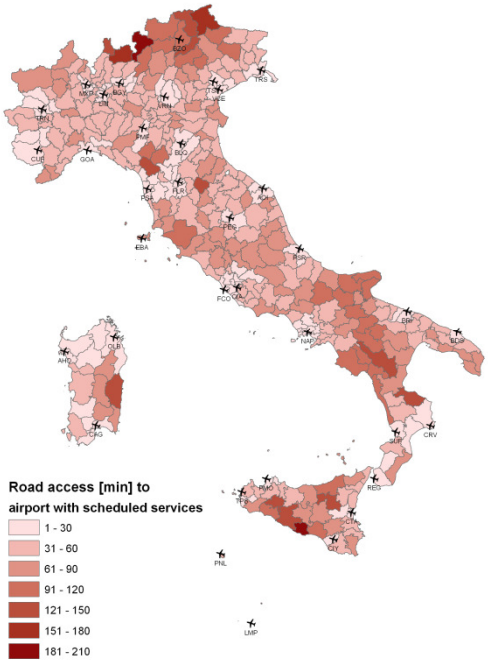
Table 4 - Characteristics of the regions in the sample (Source: our elaborations on Trenitalia and OAG timetables, coach operators websites)

In terms of coach operators, Basilicata (and in part Campania) has the highest value however the majority of them serve only one route while the ones in Puglia, Calabria and Sicilia provide many routes with a high frequency according to a hub & spokes scheme. In terms of rail PSO, the highest value for Campania results from the sum of its direct services and the ones to Sicilia and Puglia. Finally, excluding Pescara's airport, the other airports allow to reach a good number of domestic destinations thus not only Milan and Rome but also other important areas (Bologna, Venezia, Genova, etc).

4.2 Population and accessibility to airports

As shown in the Table 5 (right figure) the airports currently active in Italy are accessible by the vast majority of population within 60 minutes. Moreover, as shown by the density distribution of population, all the zones with the highest levels of density are in the catchment area of an operating airport.





Access time [min] to the closest airport with scheduled services	*n° zone*	*Population 2011*
<30 min	99	24,414,216
30 – 60 min	156	23,638,587
60 – 90 min	74	7,702,255
90 – 120 min	27	2,489,981
>120 min	15	1,177,927

Table 5 – 2011 Population density in the 371 zones (left-side map) and time to access by car (right-side map) the closest airport with scheduled services (Source: our elaboration on National Institute of Statistics –ISTAT 2011; our estimations)

The areas of the country with the worst access time are mainly those with low population, which are, in general, in dispersed villages or mountainous territory. In our sample, the only area without a problem of land accessibility to alternate airports is that of Taranto (very near to Brindisi and Bari) and Crotone (near to Lamezia Terme), while in Southern Sicily (partially solved by Comiso airport), Basilicata and Northern Calabria, Foggia province and Trentino Alto Adige in the North high access times exist.

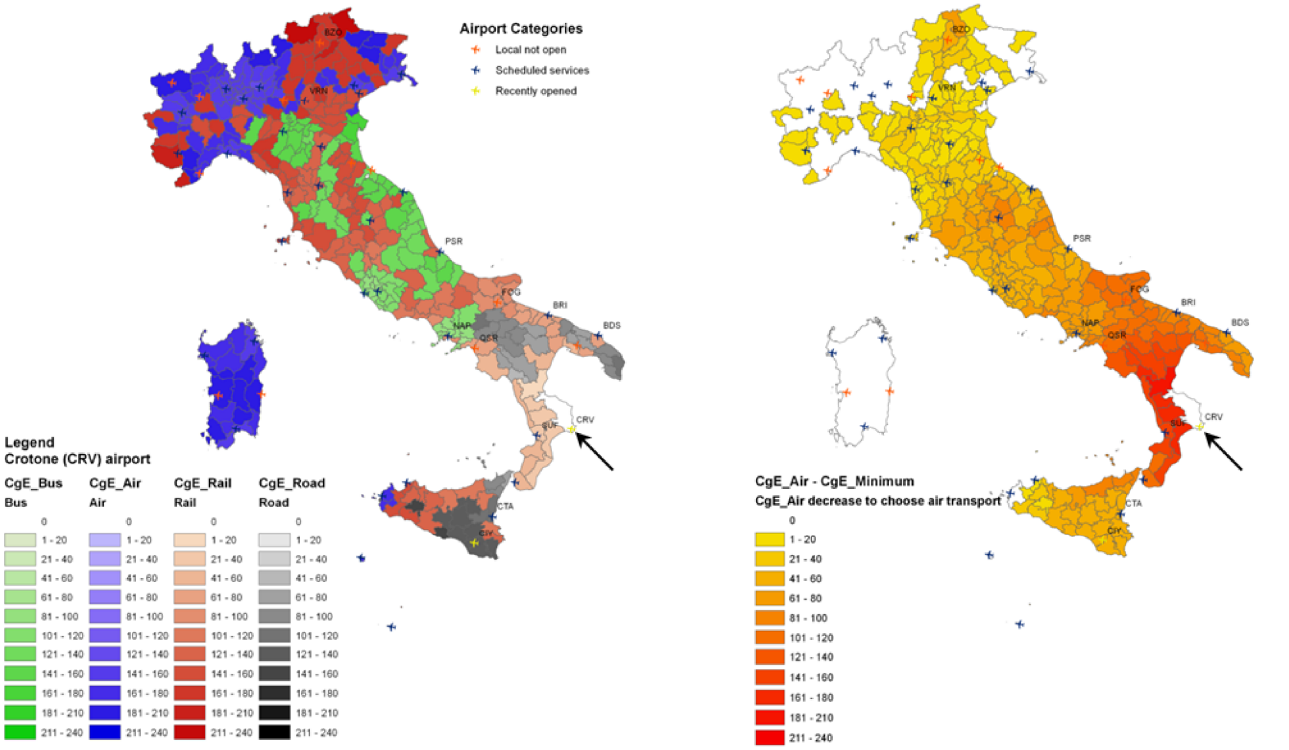
4.3 Accessibility of the study areas

The following charts consider the GC to reach all the Italian zones from the six areas of the sample for an average working day in 2013. For each zone we considered the four transport modes and the corresponding average GC to reach the areas potentially impacted by a local airport. We then select the minimum value which represents the lowest average generalized cost to reach the study areas from the other zones of the country.

Afterwards we compare this value with the generalized cost by air transport in order to define how much should the air generalized cost decrease in order to make it the most favorable alternative. Of course, this value could only suggest which areas could benefit more from an improvement in the air transport system: in lighter zones, the difference of cost between air services and the best transport alternative is already low, thus these areas are more likely to become better served by air services, if existing. These improvements could, for example, come from land-side accessibility at the origin and/or destination airports, fares reductions or waiting times decrease for those

connections which require hubbing, new or higher frequency to new/established destinations, etc. For each case we compute also the number of zone reached by different transport mode together with the average generalized cost in order to provide a general overview of the cost paid by passengers.

4.4 Crotone



Transport mode	*n° zone reached by transport mode*	*Average Generalized Cost [euro]*
Road	35	100
Rail	154	128
Air	104	164
Bus	76	127

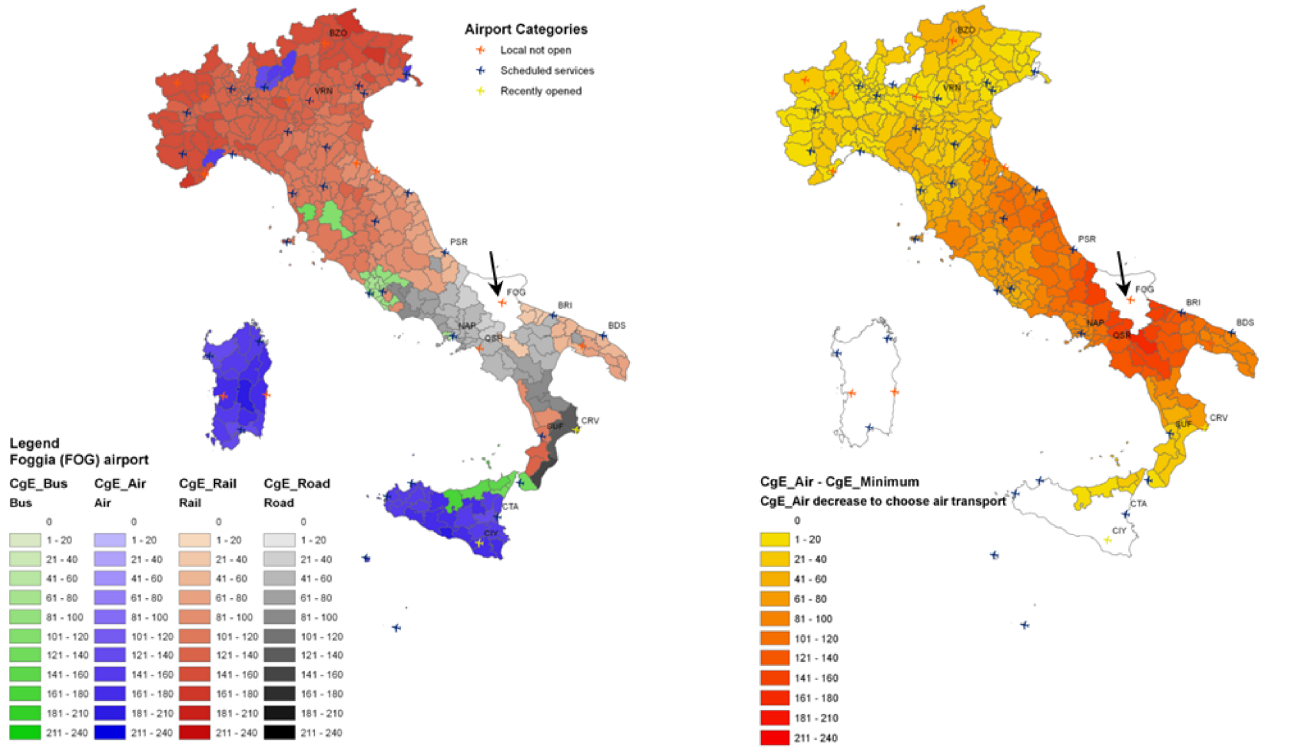
Table 6 - Minimum GC to reach the other zones from Crotone's airport area of influence (left-side map) and difference between the GC by air and the minimum GC (source: our elaborations)

In 2013 the airport of Crotone was still closed[15] and air transport supply was limited to Lamezia Terme and Reggio Calabria airports. Table 6 shows that the best option to reach Crotone substantially varies according to the origin. The role of coach services reflects the presence of many operators that provide frequent and low cost services in particular towards Rome, Naples and the centre of Italy. Rail services suffer the low quality of the infrastructure that translates in scarce level of services in particular on the east coast of the region. In order to assure a minimum level of rail connectivity, there are many PSO rail services (Table 4) both departing from the region (like the Reggio Calabria – Rome) or from/to Sicily. Finally the airport of Lamezia provides an alternative towards further destinations thanks to the presence of low cost and full service carriers. The airport registered increasing volumes in the last decade thanks also to its location, close to the non-tolled

[15] Ryanair currently serves 3 routes (Rome Ciampino, Pisa and Milan Bergamo) while Air Baltic provides a seasonal service to Milan Malpensa once a week.

A3 highway, which connects directly the airport through a dedicated junction, and an important railway junction a few kilometers away used by trains crossing and linking the two coasts of the region together with the north-south PSOs services.
Land-side access to the airport is currently provided by two coach operators serving four routes that also connect the area of influence of Crotone's airport which, on the other hand, is served by one single route. Increasing the number of routes and/or services together with the frequency, could reduce the GC to access Lamezia's airport.
In general, the average GC for any mode is quite high, especially towards the north of Italy. This is in part due to the characteristics of the area with inadequate road and rail networks but also to the low population, distributed in small villages generally in mountainous zones, which make less viable any relevant rail supply. The comparison with the air transport GC shows some areas where it could represent an alternative if its cost decreases with respect to the rail services. Nonetheless since air service is already the cheapest alternative to the big areas of the North (Milano, Torino, Genova), the demand to justify a new route should be relatively high (this, for example, could be the case of Verona). In other cases, the vicinity of the destinations (like Catania or Napoli) together with a low level of demand may not justify an air route while other transport alternatives (like train services with intermediate stops to serve many medium-small municipalities) could be more viable.

4.5 Foggia

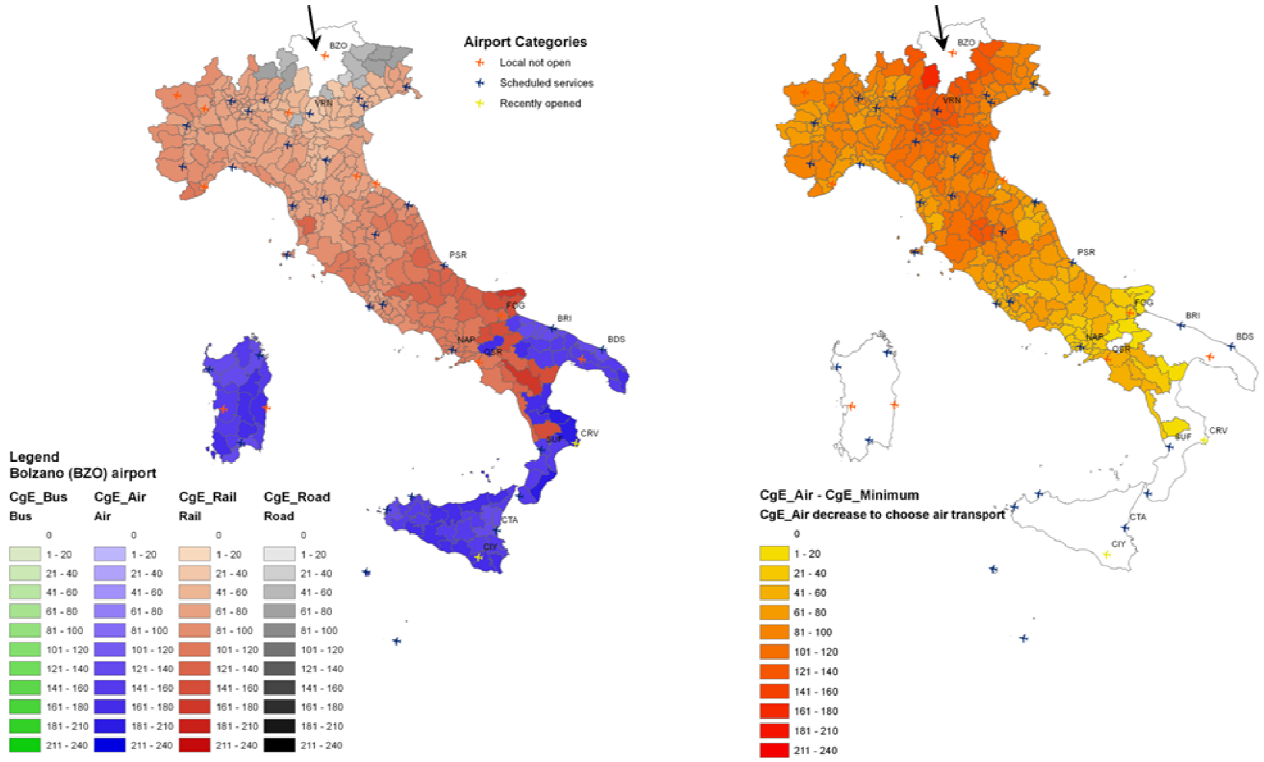


Transport mode	*n° zone reached by transport mode*	*Average Generalized Cost [euro]*
Road	44	64
Rail	244	115
Air	53	153
Bus	21	101

Table 7 - Minimum GC to reach the other zones from Foggia's airport area of influence (left-side map) and difference between the GC by air and the minimum GC (source: our elaborations)

The airport of Foggia is located between the airport of Bari and Pescara. In the same area there is the eastern rail line which connects the north of Italy with the south, in particular many Intercity services under a PSO scheme provide many connections towards Turin, Milan and Bologna with the possibility of using high speed services at a regulated fares changing train in Bologna. Coach services have the lowest cost towards Rome, Siena and the northern part of Sicilia. However, despite the presence of large operators, this mode does not prevail towards the northern destinations. This is probably due to the higher travel time needed by coach transport with respect to rail services, reasonably effective. Private transport dominates towards closest destination, this is in part due to the absence of a railway network that effectively connects the other regions with adequate regional services. Despite the vicinity of Bari and Pescara airports, air transport is the cheapest alternative only to the islands and few other areas of the country, nonetheless the difference with the minimum cost shows, in many cases, small gaps suggesting zones where air transport could be an alternative (in particular destinations in the North).

4.6 Bolzano



Transport mode	*n° zone reached by transport mode*	*Average Generalized Cost [euro]*
Road	13	59
Rail	264	83
Air	85	152
Bus	0	

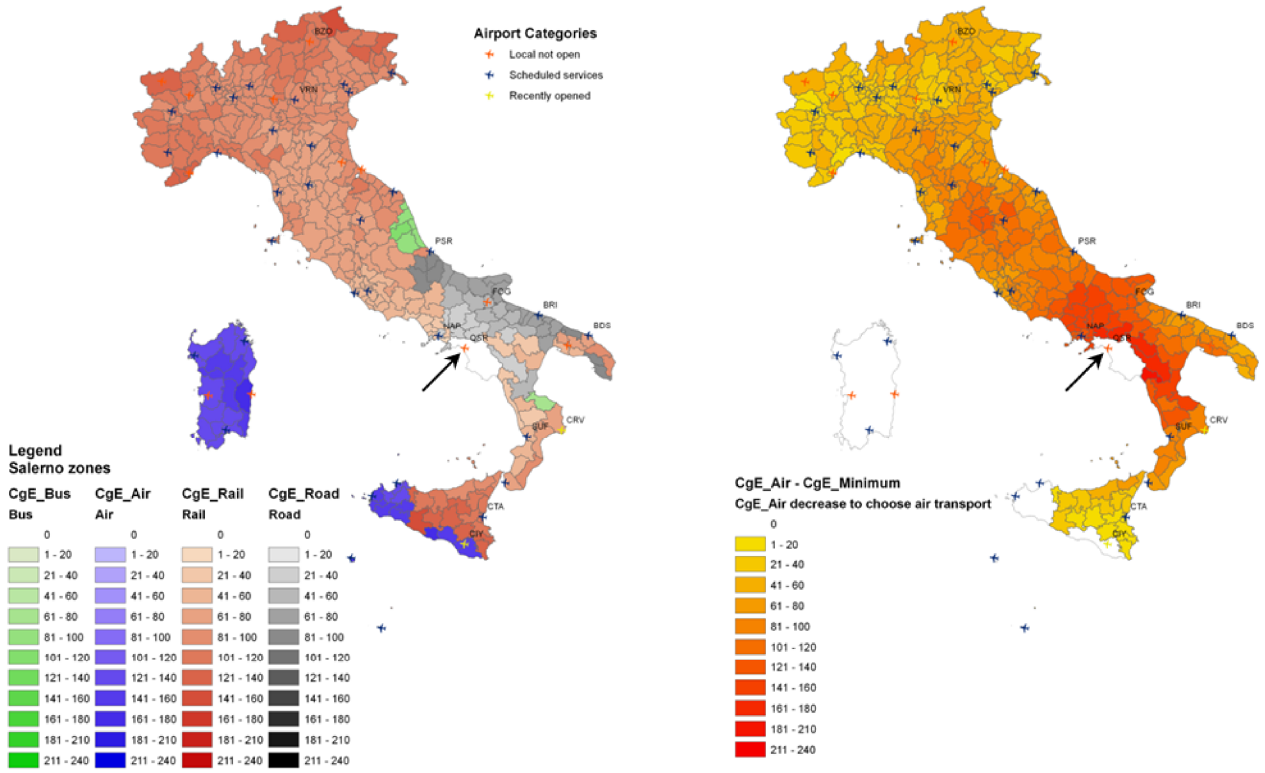
Table 8 - Minimum GC to reach the other zones from Bolzano's airport area of influence (left-side map) and difference between the GC by air and the minimum GC (source: our elaborations)

Bolzano is the only airport in the sample which has currently a PSO scheme[16] to Rome (three daily flights). It serves a rich, mountainous[17] area with two cities (Bolzano and Trento) and many smaller villages, in particular in the northern part. The A22 highways, connecting Italy to Austria through the Brenner Pass, provides a good alternative to reach the airport of Verona by car or through a frequent bus system that serves the main part of the region providing links also to the airports of Bergamo and Milan Malpensa. Rail transport represents the prevailing alternative even if more than an interchange could be needed to reach the furthest area of the country. The vicinity of Verona's station allows to interchange with many services both on the medium-long and short distance while a rail PSO to Rome (one service a day in each direction) provides connections at a regulated fare. This good level of rail services reflects in the lower average GC with respect to the previous cases analyzed. To the contrary, no long distance coaches are present to date, probably due to the better rail services available and to a lower migration rate from these area to the rest of the country. Air transport dominates on the furthest destinations although with a high average cost; the comparison with the minimum GC evidences how air transport could represent an alternative only towards Napoli and few other areas in the south. However the dispersed distribution of population along the valleys and mountainous areas could make not viable any service outside a PSO scheme. Seasonal charter services to ski destinations that could potentially be provided from Bolzano, are already offered from Verona's airport.

[16] Since the scheme started 2014, we did not include it in our model

[17] Airport operations are restricted due to the limited length of the runway (1294m) and the location of the airport in an urbanized and mountainous area.

4.7 Salerno



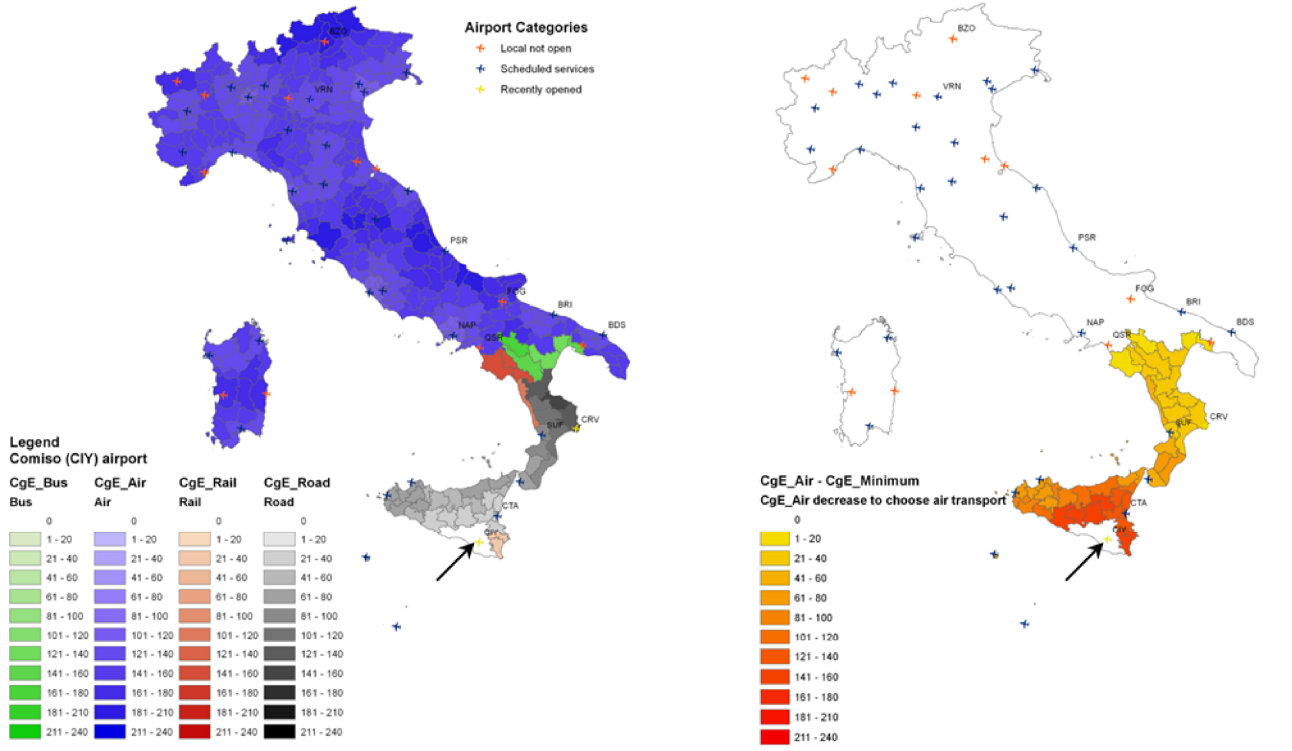
Transport mode	*n° zone reached by transport mode*	*Average Generalized Cost [euro]*
Road	57	61
Rail	246	104
Air	48	140
Bus	7	97

Table 9 - Minimum GC to reach the other zones from Salerno's airport area of influence (left-side map) and difference between the GC by air and the minimum GC (source: our elaborations)

Rail services connect the majority of the zones, due to the presence of many PSO services (Table 4) going to the north of Italy (for example Salerno – Torino) but also due to the high speed line departing from Salerno to Rome, Bologna, Venice, Milan and Turin. The presence of the non-tolled highway A3 provides an alternative towards Calabria and to the adjacent Basilicata region. Moreover, car represents the cheapest alternative to many zones in the south. Despite the presence of many operators, coach services are the best alternative only towards part of the Abruzzo region evidencing the absence of good and reliable rail services on transversal relationships. The nearby airport of Napoli provides connections to the rest of the country nonetheless, as the difference between air GC and minimum GC shows, air transport could represent a relatively cheaper alternative compared to rail service towards the main cities of the north. Moreover, Napoli's airport is well connected by buses and coaches up to the southern part of the region (Salerno's area) and to the western zones of Basilicata region, weakening the effect of possible direct flights from Salerno.
Despite several attempts to promote the airport of Salerno, its infrastructural limits together with the vicinity of Napoli's airport (managed by a different operator) and the launch of the high speed services have contributed to the failure of any initiative. Nonetheless, Napoli's airport has a series of physical constraints due to its location within the city that entails noise pollution problems and

congestion on the road network connecting it thus limiting its capacity. In this context Salerno, once extended its runway, could play a complementary role due to its potential catchment area and since it is close to many tourist destinations that could favor the low-cost segment.

4.8 Comiso



Transport mode	*n° zone reached by transport mode*	*Average Generalized Cost [euro]*
Road	36	68
Rail	6	101
Air	319	143
Bus	5	148

Table 10 - Minimum GC to reach the other zones from Comiso's airport area of influence (left-side map) and difference between the GC by air and the minimum GC (source: our elaborations)

The airport of Comiso has started to provide scheduled services in the second half of 2013. It has now 4 European and two domestic (Pisa and Rome Fiumicino) destinations offered by Ryanair while Alitalia flies to Milan Linate. The absence of Alitalia to Rome means that Comiso is out of the international network of Alitalia. Even not including Comiso in our simulations (Table 10), air transport still represents the main alternative to reach the majority of Italian zones thanks to the high number of destinations available from Catania's airport. Comiso, differently from Salerno, is controlled by the same shareholders of Catania, thus it could play a complementary role in the south-eastern area of the island even if users will have lower alternatives in terms of destinations and frequencies. In order to increase its supply, the airport has recently submitted for European Commission approval a 1.6M€ plan to provide start-up aids to carriers offering flights towards further 3 domestic and 3 European destinations. The air dominance comes from structural factors. Coach services, even if relatively numerous from the region in particular to the North of Italy and Rome, play a role only towards part of Basilicata and the eastern part of Puglia (where no rail or air services exist). Rail service is the best alternative only from the zone of Salerno, probably due to the

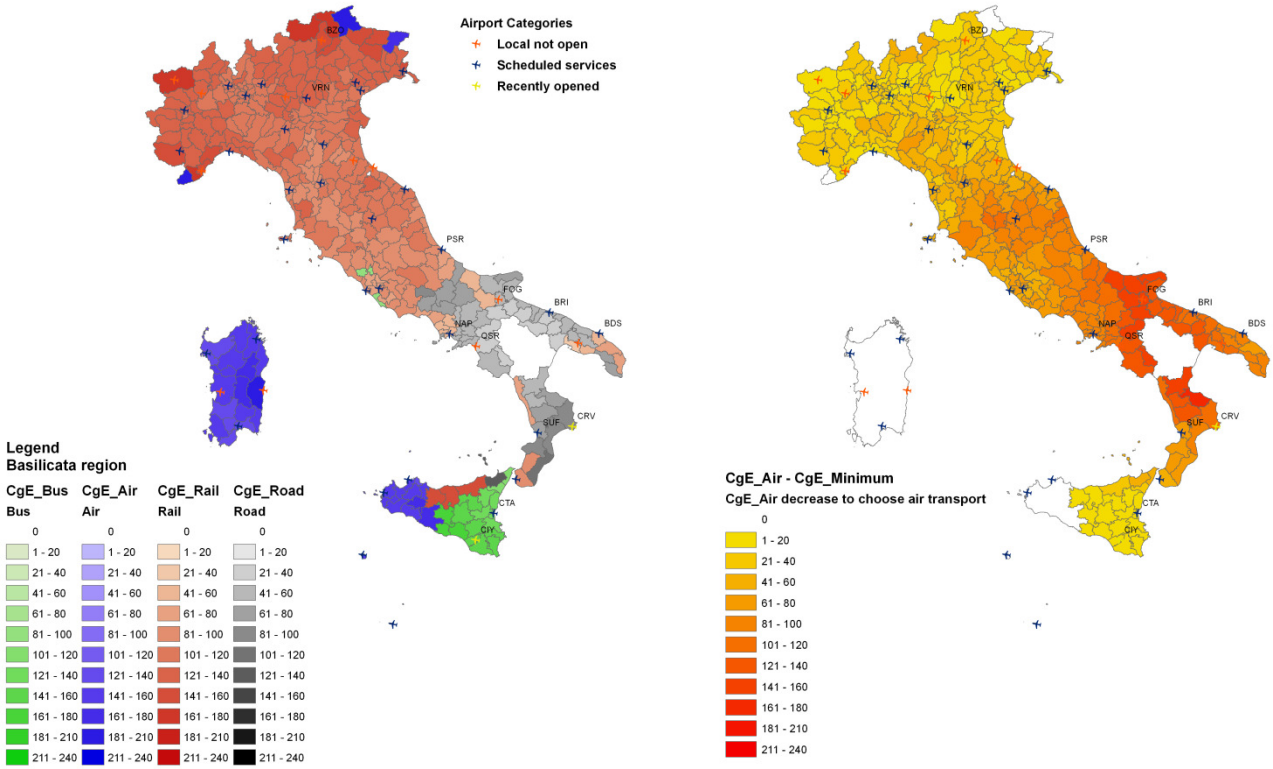
presence of PSO with regulated fares. Another strength of the air transport from this area is the broad and effective network of bus connections to Catania's airport and, since its opening, Comiso's airport, that widens their catchment areas. Bus services connect Catania also to furthest areas of the region with the highest number of routes and frequencies available from the closer zones while Comiso has services mainly from its surroundings.

	Catania									Comiso			
Route	1	2	3	4	5	6	7	8	9	1	2	3	4
Route length [km]	6	85	105	180	70	190	105	155	145	105	25	45	45
N° one-way services per day	47	12	18	1	7	14	9	11	9	9	1	2	4
N° municipalities served	1	2	2	2	4	5	3	5	7	3	2	3	3

Table 11 - Bus services towards the airport of Catania and Comiso (Source: our elaborations on operator's websites)

Nonetheless, the GC from southern Sicily to the rest of the country is high, in part reflecting the low level of local road infrastructure, in part because of its distance. In this sense, further services from Comiso could play a role reducing transport costs.

4.9 Basilicata



Transport mode	*n° zone reached by transport mode*	*Average Generalized Cost [euro]*
Road	52	56
Rail	261	110
Air	32	151
Bus	19	138

Table 12 - Minimum GC to reach the other zones from Basilicata region (left-side map) and difference between the GC by air and the minimum GC (source: our elaborations)

In transport terms, Basilicata region could be theoretically divided in two parts. The western one gravitates mainly on Salerno and Napoli for, respectively, rail services and air services. The eastern part relies mainly on Foggia for rail services and Bari for air connections. Table 13 shows the number of bus services available from the region towards the two airports showing a relatively better connection from the eastern part to Bari's airport.

	Napoli	Bari	
Route	51	64	69
Route length [km]	175	65	165
N° one-way services per day	2	5	2
N° municipalities served	3	3	7

Table 13 - Bus services towards the airport of Napoli and Bari from the region Basilicata (Source: our elaborations on operator's websites)

The absence of efficient and reliable rail infrastructure increases the probability of using the private mode to reach the closest destinations. As shown in Table 12, even with inadequate regional services (in terms of frequency, travel time and reliability), rail transport is the dominant mode due to the relatively proximity to Salerno which has both PSO and high speed services or Foggia which offers many PSO services to Milano, Bologna and Torino (Table 4). Coach services, although costly in GC terms, dominates towards the majority of Sicilia zones.
In this case, land-side improvement to reach the airport of Napoli, where flights to Catania and to the North are available, could make air services a good alternative. Towards the North, in particular, the relatively small difference between the minimum and the air GC together with the large potential catchment area of Salerno's airport may justify some routes from there.

5. Conclusion

Since the level of transport infrastructure increased in the last decade (high speed rail network, highways, etc) and new services are offered due to the opening of markets previously closed (coach and rail high speed services) or restricted (air services) entailing also a reduction of fares, different alternatives are now available to policymakers to define possible strategies to improve accessibility levels in some Italian areas. The paper, using a detailed measure of generalized cost for economy user for the Italian domestic transport, analyses the conditions of long distance transport for a group of selected areas, and focuses in particular on the potential role of their local airports. Some strategies, here analyzed only qualitatively, might be applied.
Firstly, PSOs could be applied to offer selected routes otherwise financially unviable. This kind of policy has drawbacks: it has a cost and might be effective only to connect main cities or hubs, for example Milan and Rome. Low demand routes could be unsustainable anyway resulting in high fixed costs and empty airports.
Investing in local airports, whose accessibility impact could be marginal under certain conditions, should be considered taking into account also the transport alternatives already available together with the higher level of direct destinations and frequencies from the closest airport with scheduled services. Nonetheless, as shown by Bergantino and Capozza (2015b), whereas inter-modal competition is limited, due to, in particular, an inadequate railway system, airlines exploit market captivity for price discrimination. This situation is likely to happen in remote regions or regions with a lower level of infrastructure.

Modal alternatives, including combinations of different transport modes, introduce trade-offs between cost, journey time, reliability and different levels of service. For example, coach services can have a higher level of accessibility and can be cheaper although they are slower and less comfortable than railways (in particular where high-speed services are available).

Investing in land-side infrastructure[18], for example improving the national road system or increasing public transport connections towards major airports, can reduce the cost to access the origin or destination airports and represents a more effective approach to improve accessibility as also pointed out by Redondi et al. (2011).

The six cases considered suggest that PSOs could make sense only in limited cases, because other alternatives already exist and the remoteness of Italian regions is never absolute (except Sardinia, not considered here). The existence of good ground services to the main airports (as in the case of Trentino Alto Adige region) together with good rail services make the benefit of any realistic investment into new airports rather marginal. Improving land-side accessibility to Napoli's and Bari's airports in terms of frequency could be the first step to increase Basilicata accessibility. Crotone's scarce catchment area together with the number of destinations available from Lamezia's airport suggest a marginal role for Crotone in improving domestic accessibility. Foggia's and Salerno's airports due also to their potential catchment areas could have a complementary role with respect to Bari and Napoli, Basilicata will also benefit from this scenario. Finally Comiso, due to its location (south of Sicilia), shows the important role of air transport suggesting PSO as a possible solution to increase accessibility levels.

Further analyses should be performed to give a more definite answer to the opportunity of applying the mentioned strategies. Scenarios assuming land-side (road network or public transport improvements in terms of travel speed, reliability, etc) or/and air-side (increase of frequency, destination, competition) changes could be simulated to formulate quantified improvement proposal taking into account the costs and benefits of the alternatives.

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[18] Private car to access airports is the dominant mode due to its flexibility, convenience, travel time, its door to door service and low marginal cost (Humphreys and Ison, 2005) thus improving road can strongly increase the accessibility.

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