Evolution of long-distance students' mobility: the role of the air transport service in Italy

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Abstract

This paper studies the impact of the air transport service on university accessibility. Relying on the population of Italian airports and Italian traditional universities in the period 2003-2012, we find that improving air transportation connectivity (travel speed, presence of airports alternatives, presence of low cost carriers) increases the accessibility to university for long-distance students-i.e., students living on a distance of at least 300 km from the university of attendance. Second, we find that the evolution of the air transport service has played a role in facilitating higher education accessibility. Over the last decade, the air transport service has moderated the negative impact of the distance on universities' attractiveness, providing to long-distance students more university alternatives.

Keywords: Air transport; Accessibility; Higher education, Low-cost carriers; Italy, Gravity model

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1. Introduction

In the last decades, the evolution of transport services have profoundly transformed the mobility and accessibility towards urban and rural areas, especially considering long-distance trips (Garmendia et al., 2011). Air transportation and high–speed railways have indeed connected far-distant areas, boosting their accessibility by creating opportunities for people to move or even migrate in different regions (Román and Martín, 2014). To the extent that a higher concentration of highly–skilled human capital is commonly associated with positive externalities, such as more population, employment growth, income and ability to innovate at the area of destination (e.g., Carlino et al., 2007; Glaeser, 2005), it is today crucial to identify the characteristics of the transport service that drive its mobility.

In order to investigate the role played by transport services in facilitating highly-skilled human capital mobility, this paper aims to investigate the co-evolution of the university system and air transport services over time, wondering whether the characterizing features of the transport service and its evolution impact on students' accessibility to universities. Academic institutions are indeed propitious sites in raising local highly-skilled human capital levels attracting students from outside the region (e.g., Varga, 2000) increasing their role of major trip attractors over time (Lovejoy and Handy, 2011) Notwithstanding previous studies have already studied the attractiveness of students living in close proximity to the university of attendance (e.g., Zhou, 2012; Limanond et al., 2011, Bilbao Ubillos and Fernández Sainz, 2004), long-distance students' mobility has remained a quite neglected issue.

Relying on the sample of 48 airports of 75 private and public universities in Italy over the period 2003-2012 we investigate whether air transport characteristics influence the long distance mobility of first-time first-year university students (more than 300 km from their households) departing from each Italian province. Italy represents an interesting case to be analysed as the social-economic divide that characterizes the country (*Southern regions vs. Norther regions*) have led students from the South to move away from their households relocating in Northern areas, which offer more job opportunities, better social status and livelihoods (Bacci et al., 2008; Ciriaci, 2014). Consistently with the literature on spatial interaction analyses, we investigate the effects of air transport services using a competition destinations model (e.g., Sá et al., 2004; Cattaneo et al. 2015) where our level of observation is each province (origin) – university (destination) flow of students.

Our results document that air transportation plays a role in increasing the accessibility of students to universities. After controlling for the characteristics of human capital attraction at both the origin and destination level, such as the value added per capita, the quality of life in specific areas and crucial university determinants (legal status, size, reputation, internationalization, scholarships, discipline orientation), we find that travel speed increases the flow of students (300 km far away from the home province) moving towards a university. Moreover, the presence of airport alternatives offering the same origin-destination route taking no more than 15 minutes is positively correlated to university attractiveness. Crucially, the presence of low-cost carrier (LCC) is found to be important to increase long-distance accessibility to higher education. The prices offered by LCC services are indeed affordable for students. Finally, we find that the evolution of transport services have decreased the negative effect of the distance on the flows of students over the last decade. Despite the deterrence effect played by the distance factor, air transport service provides students the chances to choose among more different universities by increasing university accessibility.

This paper continues as follows. Section 2 presents a state of art overview of the literature on the role of transport and university attractiveness to students. Section 3 briefly describes the Italian air transport system and the Italian higher education system. Section 4 focuses on the methodology, the data and the descriptive statistics. Section 5 presents the empirical results and Section 6 concludes the paper.

2. Literature background

2.1. Transport infrastructure and areas' accessibility

Among the different impact of airports (direct, indirect, induced) the catalyst effect associated to the economic development of areas is considered to be the most important function nowadays (Percoco 2010, York Aviation 2014). The economic activity of the area, such as export activities, tourism, and the location decision of firms, are facilitated by the fact that airports facilitate regional accessibility to regions, allowing residents and non-residents to travel and relocate in different areas (Bråthen and Halpern, 2012). In recent years scholars of transportation have devoted considerable attention to investigate the concept of accessibility, intended as "*the ease of reaching desired destinations given a number of available opportunities and intrinsic impedance to the resources used to travel from the origin to the destination*" (pp. 143, Bocarejo S and Oviedo H, 2012). Particularly, when considering passenger transport, accessibility relates to the extent to which the transport system enables individuals' mobility from origins to destinations (Geurs and van Wee, 2004).

Former literature found that the increased transport accessibility of different modes positively affect economic performance of territories at the destination level. For instance, air transport accessibility is responsible for increasing economic productivity in Japan in the period 1995-2000, mainly in agglomerated areas such as the Tokyo metropolitan region (Yamaguchi, 2007). Railway networks strongly improved accessibility to areas in the 19th century, thereby being positively related to municipal population growth (Koopmans et al., 2012). Also road transport infrastructures are recognized to increase regional economic development, as in the case of the construction of the M25 London Orbital Motzrway (Linneker and Spence, 1996). On the other side, based on the concept of mobility-related exclusion, defined as the process by which insufficient mobility in a society prevents people to be part of the economic, political and social life (Kenyon et al., 2002), transport accessibility is recognized to mitigate social exclusion. In the specific case of education, nowadays there is growing awareness that transport has increasingly become more important to access tertiary education (Kenyon, 2010). Adequate transport and related infrastructures are indeed positively associated to access to and achievement in higher education. In this respect, Kenyon (2011) shows that exclusion of UK students from academic activities is largely due to the fact that institutions are not accessible. For this reason, we aim to contribute to the current literature investigating whether a specific mode, the air transpor, increases the accessibility to universities for long-distance students (students living at least more than 300 km from the academic institution), therefore increasing academic institutions' attractiveness inside the higher education system.

2.2 Long-distance students' mobility

From a classical perspective students' mobility is likely to increase if the present value of the benefits to attend a specific university is greater than the monetary costs to reach and attend it. In this choice, benefits are associated to various factors associated to both the university and the area of destination. At a *university-level*, mainly institutions' quality (Long, 2004), reputation (Marginson, 2006) and the level of internationalization (Cattaneo et al. 2015) play a crucial role in students' decision. At a local-level, students' choice is driven by different socio-economic characteristics (Ciriaci 2014) such as the economic conditions of the destination area and the presence of consumer amenities (e.g. theaters, museums). On the other side, costs mainly refer to tuition fees (Allen and Shen, 1999), to those associated to transport and, for relocating students, housing. Generally, these costs increase with the distance and are among the most important determinants of university choices (e.g., Long 2004, Alm and Winters, 2009). They can indeed discourage students' participation to HE and even lead students to choose less quality universities in the case the high quality ones are too far from their family home (Gibbons and Vignoles, 2012).

Nevertheless, the literature predominantly focuses on the accessibility to universities considering short-term distance path, even if students' mobility have significantly increased in the last decade (e.g., Cattaneo et al. 2015; Ciriaci 2014). For instance, Bilbao Ubillos and Fernández Sainz, (2004) find that more frequent underground train services and lower bus fares are factors attracting new university students in the surrounding areas of Bilbao. In the US context, an analysis on the spatiotemporal commuting patterns of students at the University of Idaho shows seasonable and gender differences in commuting choice (Delmelle and Delmelle, 2012), which are highly affected when reducing barriers to use active modes, such as reducing the travel time by bus and bicycle (Shannon et al., 2006) or changing parking regulation (Rotaris and Danielis, 2014). In fact, transport modality is a complex issue to analyze, being influenced by several factors, as demographic, attitudinal, spatial-use issues and environmental factor (Lavery et al., 2013; Whalen et al., 2013). Visualizing students' travel behaviour using GIS, Kamruzzaman et al. (2011) find that home location relative to the demand responsive transport is the most important factor of students' mobility at the University of Ulster, Jordanstown campus. Other studies focus on the travel behaviour of students living in colleges located in rural areas. Focusing on a small Thai college (130 students), Limanond et al. (2011) show that vehicle access affects on-campus students' mode choice but not the total distance they travel.

However, given the increased long-distance mobility of young generation, and particularly of university students, it is essential for universities' sustainability not only to monitor the factors increasing the attractiveness of students located in close proximity, but also for those coming from more distant areas. This is particularly crucial in periods of significant cut to government funding for higher education systems, as in Southern European countries (EUA 2014), where attracting students become more and more important to receive additional tuition fees.

For these reasons, focusing on long-distance students' mobility and grounding on the concept of mobility-related exclusion, this paper aims to investigate the effect of air transport service on higher education accessibility. In particular, this study refers to the concept of infrastructure-based accessibility and considers on the main characteristics of the air transport service (e.g., travel time, speed, service availability, presence of LCC).

3. The Italian framework

In this section we present the peculiarities characterizing the air transport service and the higher education system in Italy over the last decade, highlighting why Italy is an interesting setting where to investigate the impact of air transportation on universities' attractiveness to students.

3.1 The Italian air transport system

Includere paragrafo trasporto aereo in Italia integrando, se utile, parte LCC sottostante. Da farsì appena torna Paolo: per submission ERSA eliminare questa sotto-sessione.

In the European context, LCCs' services is recognized to have widened social inclusion and increased access to areas (Smyth et al. 2012), by profoundly changing the geography of transport services, the competition in the air transport sector and ultimately how people travel. Dobruszkes (2013) shows how LCCs have played an important role in launching new routes, count for more than 35% of domestic air service as in the case of Italy (35%) and UK (37%).

Thanks to low-cost airlines, many secondary airports experienced high traffic growth as in the case of Italy (Campisi et al., 2010).

3.2. The Italian higher education system

The Italian higher education system is composed by 95 institutions[1], including 11 long-distance-learning institutions, 6 doctoral universities (e.g., IMT Institute for Advanced Studies Lucca, Sant'Anna School of Advanced Studies), 3 universities for foreigners (University of Foreigners of Perugia, of Reggio Calabria, and of Siena) and 75 traditional universities (both public and private). Specifically, all 11 distance-learning institutions and 3 new traditional universities were created in the last decade. Focusing only on the set of 75 universities, as to avoid universities operating in specific market niches, universities are uniformly geographically distributed across the Italian peninsula (Fig.1): 30 universities are located in the North, 19 in the Centre and 26 are in the South (including the Islands).

[FIGURE 1]

During the last decade, the Italian higher education system has increasingly undergone important changes with respect to the financial sustainability of universities. Indeed, it was affected by a significant decrease (-13%) in total enrolled students in the period 2003-2012 accompanied by an important reduction in the state-allocated funds to each institutions (CNVSU, 2011). In particular, the *Ministry of University and Research* (MIUR) reduced state-allocated funds - *Fondo di Finanziamento Ordinario* (FFO) of 9% adjusting for inflation in that period. Due to the reduction in financial sources, identifying all the factors affecting universities' attractiveness to students has become crucial to ensure the pursuit of their daily core activities and long-term survivability (Christopherson et al. 2014). Consequently, this paper investigates whether the air transport service has affected the accessibility to all Italian traditional universities in the last decade.

4. Research design

4.1 Methodology and variables description

In order to investigate the effects of air transport service, we relies on a spatial interaction model in the form of a gravity model, where origins are represented by students' home and

[1] The *Rome – Link Campus University* is not considered because it was accredited as a university in the second half of 2011 (decree no. 374 of September 21, 2011).

destinations are universities. Further, to avoid the misspecification of the model in defining the process of destinations' choice we follow the previous literature including an additional factor assessing the presence of competition or agglomeration forces among destinations. This leads us to use a competing destination model (e.g., Fotheringham et al., 2001)[2].
In formulas:

$$F_{i,j,t} = O_{(\mathrm{Prov}_{i,t})}\, D_{(Univ_{j,t};\mathrm{Prov}_{j,t})} f(c_{i,j}) \quad (1)$$

- $F_{i,j,t}$ is the flow of first-year enrolled students at the bachelor's and 5-year degree ("*Ciclo Unico*") level from province *i* to university *j* in year *t*, excluding international students.
- $O_{(\mathrm{Prov}_{i,t})}$ represents the socio-economic characteristics of the province of origin *i*. As factors known to influence students' attractiveness, we include the value added per capita (*Value added per capita*) in year *t* as a control for economic disparities (Glaeser 2008) and the quality of life to account for the fact that the decision to move in some areas might be driven by consumer amenities (Florida 2002). The quality of life of the province is measured considering the annual position in the ranking produced by the main Italian financial newspaper, *Il Sole 24 Ore* as $(\textit{Quality of life ranking})^{-1}$. Further, to include a mass indicator in the gravity model, we rely on the population of university first-year, first-time enrolled students at a province level (*Student population*).
- $D_{j,t}$ represents the characteristics of the university of destination ($Univ_{j,t}$) and the province wherein the university is located ($Prov_{j,t}$) in year *t*. Following the former literature on universities attractiveness to students (e.g., Cattaneo et al. 2015; Sà et al. 2004), university characteristics refer to the size of the university (mass indicator at the destination level) as the total number of registered students *(Student population)*; the prestige of the university measured as the inclusion of a university in the ARWU (Academic Ranking of World Universities) international ranking[3] (*Prestige*); the internationalization level calculated as the percentage of international students (Cattaneo et al., 2015) (I*nternationalization*); the fact that a university is private (Teixeira et al., 2014) (*Private*); the financial aid schemes that ensure the right to

[2] For a detailed explanation of the index see Cattaneo et al. (2015).
[3] This indicator has been shown to be the most suitable measure of university excellence (Saisana et al., 2011).

education measure as the number of scholarships provided per enrolled student at the regional level (*Scholarship per student*). Further, according to the nature of competing destination model (Fotheringham et al., 2001) and the confirmation that universities' attractiveness is influenced by the level of competition under which each institution operates, we control for the distance-weighted characteristics of attractiveness of all university competitors (*Competitors' proximity index)* as in Cattaneo et al. (2015). Finally, a set of dummy variables is included to control for the presence of specific disciplines offered by each university (arts and humanities, medical sciences, natural and technical sciences, and social sciences).

As in the case of the province of origin, we additionally include two indicators, the value added per capita and the quality of life, to account for socio-economic disparities among areas.

(3) $$F_{i,j,t} = O_{(\mathrm{Prov}_{i,t})}\, D_{(Univ_{j,t};\mathrm{Prov}_{j,t})} f(d_{i,j} | \, Air\ transport_{i,j})$$

- $f(d_{i,j} | \, Air\ transport_{i,j})$ is an impedance function depending on the features the transport network considering mobility from province *i* to university *j*. Specifically, it includes the Euclidean distance between the origin and the destination for each flow of students (*Distance*), the travel speed measured as the ratio between travel time, (the sum of the flight time, the time from the origin to the airport of origin and the time from the airport of destination to the university), and the Euclidean distance (*Travel speed*). A dummy variable equal to 1 to identify origin-destination routes where at least a low-cost carrier operates (*LCC presence*) and, lastly, a dummy variable to isolate the effect of an alternative airport offering the same route of the closest airport at the province of origin *i* taking no more than 15 minutes (*Presence of airport alternatives*).

4.2 Sample and data sources

This paper investigates the impact of air transport srvices and their evolution on universities' attractiveness to students focusing on 75 Italian universities active in the period 2003 -2012. All long-distance-learning institutions (11), doctoral universities (6) and universities for foreigners (3) are excluded to only focus on traditional universities, thus avoiding universities operating in market niches.

To gather data we rely on difference sources. At a province level, we collect information from ISTAT *(The Italian National Institute of Statistics)* for calculate the value added per capita and *Il Sole 24 Ore* for the quality of life ranking.

The characteristics of universities, such as the number and the origin of students, the presence of specific disciplines, are made available by the MIUR (*The Italian Ministry of Education, Universities and Research*). We then complement the collection of information relying on the website of the ARWU ranking (www.shanghairanking.com) to measure university prestige.

With respect to air transport variables, we use OAG data contains variable on scheduled flights.

4.2.1 Descriptive statistics

In the Italian higher education system an yearly average of 206,025 are first-time, first year students (2003-2012) moving across the Italian peninsula to reach their university of destination, where 14% of them (28,728) are long-distance students, namely those located at least 300 km distant from the university of destination. In the period 2009-2012, the average percentage of long-distance first-time, first year students is 17%, implying an increasing mobility in highly skilled human capital over the last decade. While the portion of long-distance students has been quite steady over the last decade for Southern universities (average value of 4%), those located in the North have assisted to an important growth, from an average value of 19% in the period 2003-2007 up to 34% in 2010 and 2011 (2008-2012 average value is equal to 28%).

Figure 2 shows the relationship between the variation in travel time and universities' students enrollment in the period 2003-2012 in order to preliminary show through descriptive data whether the evolution of air transportation in Italy is correlated to that of universities' attractiveness. In particular, circles represent universities located in the North of Italy, triangles are for universities located in the Centre, while crosses stand for Southern universities.

[FIGURE 2]

The figure shows that at the decrease of the variation in travel time (higher accessibility) the variation in enrollment increases[4], suggesting that the evolution of air transport service might has an effect in facilitating students choosing and reaching more distant universities. Considering the four quarters, universities in the top left quarter show that an increase in the percentage variations of enrollments is correlated to a decrease in the travel time in the period 2003-2012, where the University of Aquila and the LUM Jean Monnet university in the South show an increase in enrollment of long-distance students (higher than 4%) accompanied by a reduction in the air transport accessibility time to reach them. On the other side, considering the top right quarter, there are universities in the North that are able to increase their attractiveness (variation in enrollments closer to 2% as the Polytechnic University of Turin and the University of Eastern Piedmont – Vercelli) in spite an increase in the accessibility time. This is mainly due to the agglomeration forces that have been arisen in the last years in the higher education sector (Cattaneo et al., 2015). Universities in close proximity to others have been considered more attractive and are responsible for the development of clusters of higher education. In the next section, a multivariate competing destination model is performed to investigate this relationship taking into account several determinants of university attractiveness to students.

Focusing on the accessibility to universities and the characteristics of the air transport service, Figure 3 reports the average time to university from each province and the number of intra-national routes for each Italian airport in year 2012, where darker provinces mean that people would take more time to reach all Italian universities in year 2012. The figure suggests that, on average, the higher is the number of Italian routes available in a specific airport the less time people located in the provinces around the airport take to reach all universities. For instance, given the high number of Italian routes at the two airports located in Rome, the Fiumicino airport (30 Italian routes) and the Ciampino airport (7 Italian routes), the average accessibility to Italian universities is high for people living in Rome. At the same time, the long-distance mobility in the province of Bari is facilitated by the Italian connections of the Bari Karol Wojtyla airport (18). Similarly, in the Northern provinces, those benefiting from a high number of Italian connections (Malpensa and Linate airports in Milan and the Orio al Serio airport in Bergamo) are the provinces of Bergamo and Brescia. On the contrary, the scarce availability of Italian routes disadvantages mobility at the provinces of Grosseto, Siena, Arezzo and Perugia, all located in the Centre of Italy.

[4] Results are the same when excluding % variation in enrolments higher than 4% (the figure is available upon request).

[FIGURE 3]

Considering the variation in time of accessibility and air transport characteristics, Figure 4 represents the change in the average time to university from each province and the variation in the number of Italian routes in the period 2003-2012. Darker provinces indicate provinces where the time to reach all Italian universities increases over time. Notably, the increase in numbers of intra-national connections favors provinces like Bergamo, where the Bergamo Orio al Serio airport registers 77 more national routes, Cagliari advantaged by the implementation of 39 new routes at the Cagliari international airport Elmas and Trapani, due to the activity of the Trapani airport (20 more Italian routes), among others. In other cases, it is clear that in some provinces the average time to reach universities decreases thanks to the improved activity of airports located in surrounding provinces, as for the province of Modena, Reggio Emilia and Parma which benefit for the activity of the Bologna Guglielmo Marconi airport (44 further Italian routes). Further, the evolution of the transport service seems not to have improved the accessibility to universities as in the case of the Pisa international airport and those located in the Northern-East provinces of the peninsula. In order to better understand which are the determinants of transport service able to affect the accessibility to universities, the next section provides the results of a multivariate analysis controlling for several determinants of students' attractiveness. Multicollinearity is not a concern because the variance inflation factor is well-below the critical cut-off of ten.

[FIGURE 4]

5. Results

The results of the estimated competing destination model are presented in Table 2. A potential selection problem arises in our estimation since the characteristics of the having an eligible air route-i.e., *a route that can be operated by the air transport service*, might be correlated to the characteristics that influence the flows of students. We therefore implement a two-stage Heckman selection procedure. In the first stage, we estimate the likelihood of having an eligible route based on the observable characteristics of the air transport service at the origin and the destination; in the second stage, we predict the determinants of attractiveness of each university, including the inverse Mills ratio extrapolated from the first stage as a regressor.

The first stage of the model is the probability to have an eligible route on a specific origin-destination pair, where an eligible route is identified as that registering a travel speed higher than 150 km/h and the ratio between flight time and total time higher than 50%[5]. The dummy variable "eligible route" is equal to 1 when routes have these characteristics.

We run the first stage using a logit model for panel data (2003-2012) including three different set of determinants: 1) the size of the closest airport to the province of departure and the closest to the university of arrival; 2) the minimum time from the centre of the province of origin and the airport of departure, and the minimum time from the airport of arrival and the university of destination; 3) the total number of intra-national flights at the airport of departure and the airport of arrival. Table 1 shows the estimated results.

[TABLE 1]

Results suggest that the probability to have an eligible route is positively related to the size of the closest airport at both the origin and destination level (at a 1% significance level), while it decreases when the travel time from the household (centre of the province) to the airport and that from the airport to the university of destination decreases. However, the number of intra-national flights at the two airports (origin-destination) is not a predictor.

After assigning an inverse Mills ratio to all origin-destination pairs, we run the second step of the Heckman procedure[6] using a competing destination model. Specifically, we linearize equation (3) relying on a Poisson pseudo maximum likelihood (PPML) technique which allows to avoid problems associated to the usual OLS-log transformation (Silva and Tenreyro, 2006) by log-transforming all the variables with the exception of the dependent one. As we are investigating the effect of air transportation, the analyses are limited to *distance* higher than 300 km, a threshold allowing to exclude short-distance origin-destination trips which are more likely performed considering other transport modes. Table 2 reports the results of the estimates.

[TABLE 2]

[5] The analyses were also performed considering the range 125-175 km/h for travel speed and for 40-60% for the ratio flight time/total time, reaching the same results. We respectively choose 150km/h and 50% as two reasonable thresholds.

[6] We apply the bootstrapping procedure to obtain consistent estimates of the standard errors.

Our findings document that notwithstanding attractiveness to students are known to decrease with the distance, flows are also positively and highly significantly correlated to travel speed. After considering the difficulties for some students to reach the airport from their home province or the fact that some universities are not well-served by air transport services, faster routes are associated to higher flows of students. Despite the deterrence effect of the distance factor, the air transportation system plays a role in connecting students to universities. This is additionally facilitated by the presence of airport alternatives in close proximity (where the same route is performed considering a total travel time no higher than 15 minutes) to the closest airport to students' home province. Alternatives indeed imply higher air service connectivity which increases the probability to reach a specific destination exploiting some different air transport connections.

Our findings also suggest that the presence of low-cost carriers leads to greater opportunities for students, which can move across the Italian peninsula having more choices and at lower costs. In addition to the role that LCCs play boosting economic performance by facilitating the flows of labour migrants, knowledge, business connectivity and investments, and tourism (Williams and Baláž 2009), this result shows how their geographical coverage they may significantly facilitate the distribution of highly-skilled human capital across areas.

Further, the coefficient of the Mills ratio is significant and positive, implying that unobserved factors that make an eligible route more likely tend to be associated with a higher attractiveness to students as we expect implementing the two-step procedure.

At a province level, additionally to the expected positive effect of the mass indicator (*Student population*) indicating the emission capacity of the origin, findings suggest that students move towards richer places increasing their expectation of social-economic growth in the future. At the same time, the quality of life plays a role. Predictably, students move from areas of lower quality towards those having more developed consumer amenities, a well-recognized practice when considering Italian graduates (Ciriaci 2014).

Considering the characteristics of universities of destination, the results are in line with the former literature (e.g., Cattaneo et al. 2015, Sà et al. 2004), suggesting that universities attractiveness to students is more pronounced for bigger, reputable, more internationalized and private universities. The presence of regional financial schemes does not play a uniform role, but only when considering province-university distances higher than 500 km, suggesting that students pay more attention to regional subsidies when the distance from their household is considerable, thus implying increasing costs to education. Further, as positive values of the

Competitors' proximity index implies the presence of competition forces among universities while negative ones suggest agglomeration forces, the results show that competition forces are in place when students are from provinces that distance lesser than 600, after which universities located in close proximity to others start to become more attractive to students (agglomeration forces). Dummies for disciplines indicate that the long-distance attractiveness of universities having art and humanities is negative, while universities having courses in social science and medicine attract more students (for distance higher than 500 km).

Lastly, in order to evaluate the evolution of air transportation in increasing university accessibility for long-distance students, Table 3 reports the results of the PPML regression including a time trend variable which ranges from 1 for students flows in 2003 to 10 in 2012 (*Time-trend*).

[TABLE 3]

In our estimation the trend variable is negatively associated to students' flows consistently with the fact that overall attractiveness of universities to students throughout the Italian higher education system has been decreased during the last decade, mainly after the recent financial crisis. An interaction term between the time-trend and the distance (*Time-trend X Distance*) is therefore included to understand whether, taking constant the distance over time, long-distance mobility of students has increased over the time horizon considered. The estimates show that the interaction term is positive and significant suggesting that for flows of students higher than 300 km the negative effect of the distance on students' attractiveness has been moderated over time.

We argue that during periods characterized by lower levels of demand for higher education, the evolution of air transport service has played a role in increasing the number of universities that students might choose. As the choice of a university is guided by an investment decision, it has become increasingly important to not only attend university but also to attend a more valuable university in a wealthier framework, which is probably not in close proximity to the household. Considering the Italian North-Centre divide, where students and graduates were used to move from poorer southern regions to wealthier northern regions in (Fratesi and Percoco 2009), air transport service has inevitably improved highly-skilled interregional migration flows facilitating transfer from the South to the North and *vice-versa*.

6. Conclusion

Recent studies have largely investigated students' accessibility to universities, mainly focusing on short-term students' mobility (e.g., Bilbao Ubillos and Fernandez Sainz 2004; Delmelle and Cahill Delmelle 2012; Lavery and Kanaroglou, 2013), even if universities have increased the portion of students coming from more distant areas in the last decades. A need to better understand the accessibility determinants of long-distance students' flows has recently arisen as air transport service may impact on the attraction of students towards specific areas and be consequently responsible for the relocation of highly skilled human capital in these areas (Ciriaci 2014).

Filling a void in the literature, we analyses the role played by the air transport service on long-distance students' mobility in the Italian higher education system in the period 2003-2012. Relying on a competing destination model, we find that air transport service has played a significant role in enhancing universities' accessibility. After controlling for all the factors affecting universities' attractiveness to students at a province (e.g., value added per capita, quality of life) and university level (e.g., size, reputation, internationalization) we find that that air transport travel speed, the presence of airport alternatives and the fact that a *O-D* route is operated by a LCC increases the flows of long-distance students towards universities. Furthermore, the fact that flows of students decrease at the increase of the distance is found to be moderated over time. This advocates that the evolution of the air transport service has played a role in facilitating higher education accessibility.

This paper suggests several avenues for further research. First, it is known that high-speed trains is the best transport mode for medium distance trips (Román et al. 2007) and a valid alternative to air transportation. Despite this work focuses on distances higher than 300 km and accounts for routes having air transport travel speed higher than 150 km/h and the ratio between flight time and total time higher than 50%, we acknowledge that high-speed trains might play a role in serving universities. Although this is out of scope of the paper, it could be interesting to model the contemporaneous presence of alternative modes (train and air) for travel between pair. Second, future works could investigate the impact of the presence of public service obligations (PSO) mechanisms, where carriers are required to offer special discounts or low fares to residents in specific areas (Williams and Pagliari 2004). Since 1993, air carriers have indeed been awarded to serve specific routes with the aim to particularly secure provision of air service to students. Due to the important spread of PSOs during the last decade in Europe (Smyth et al. 2012) , it would be interesting to understand whether such mechanisms play an important role in serving the higher education system.

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Figure 1. Geographical distribution of Italian universities

Macro-areas are identified by different colours. Northern provinces are in darker grey; central provinces are in light grey; and southern provinces are reported in white. Circles represent the geographical distribution of the 75 universities at the national level.

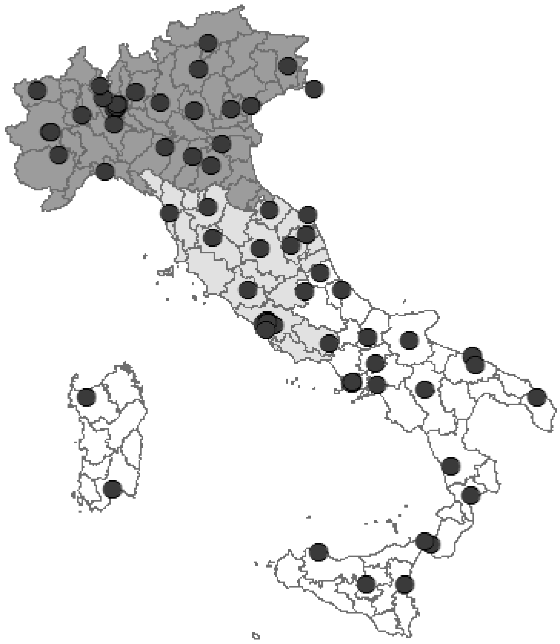

Figure 2. Scatter plot of universities' accessibility and growth

The circles represent universities in the North of Italy, triangles indicate universities in the Centre, and Southern universities are identified by crosses. Variations refer to the period 2003-2012.

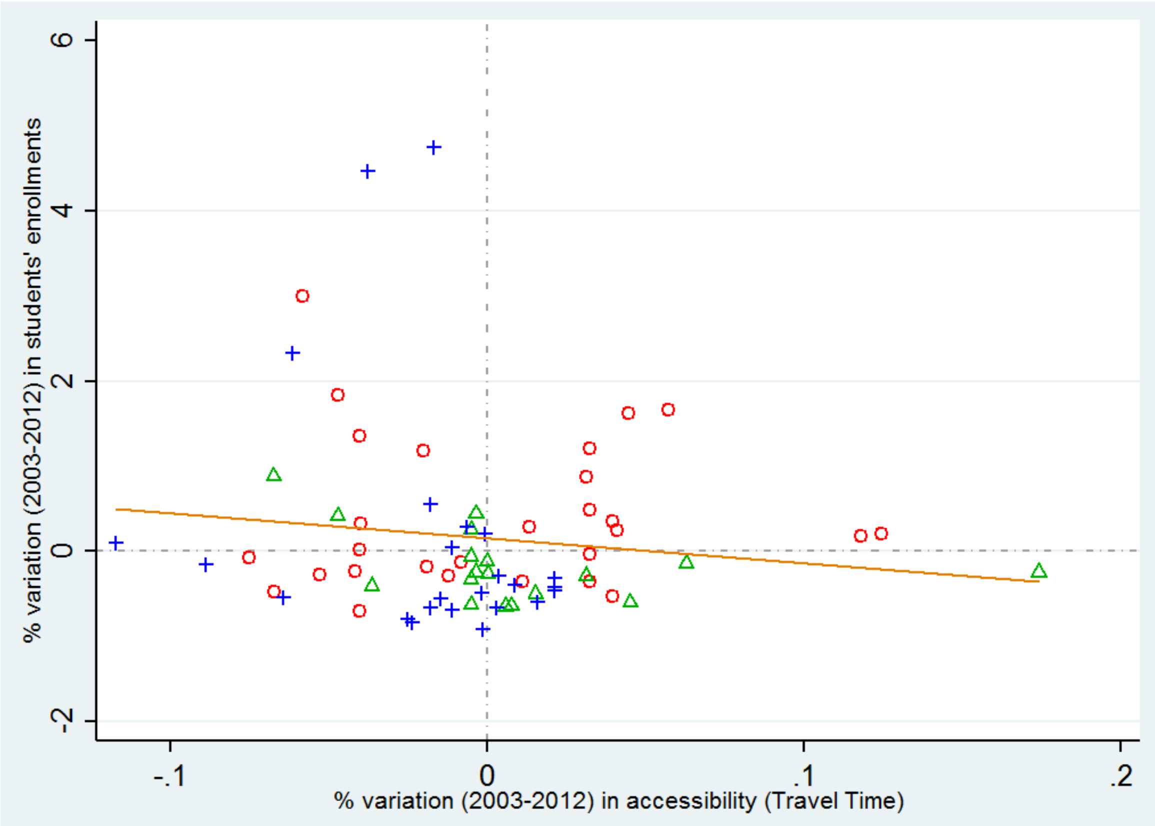

Figure 3. Average time to university (by province) and Italian air routes availability (by airport)

Darker provinces are those registering higher times to reach all Italian universities in year 2012. Red bars represent total amount of Italian routes for each Italian airport in 2012.

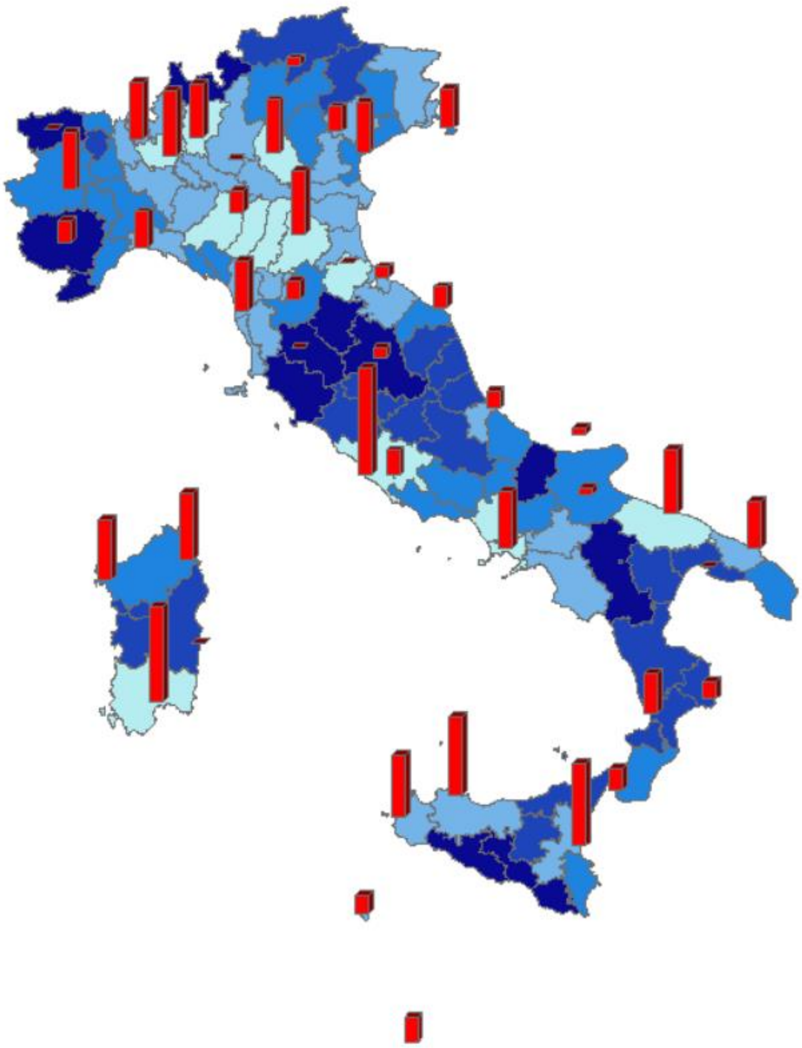

Figure 4. Variation in the average time to university (by province) and variation in Italian air routes availability (by airport)

Darker provinces are those registering the higher percentage variation in time to reach all Italian universities in the period 2003-2012. Red bars represent the variation of Italian routes in each Italian airport in the same period.

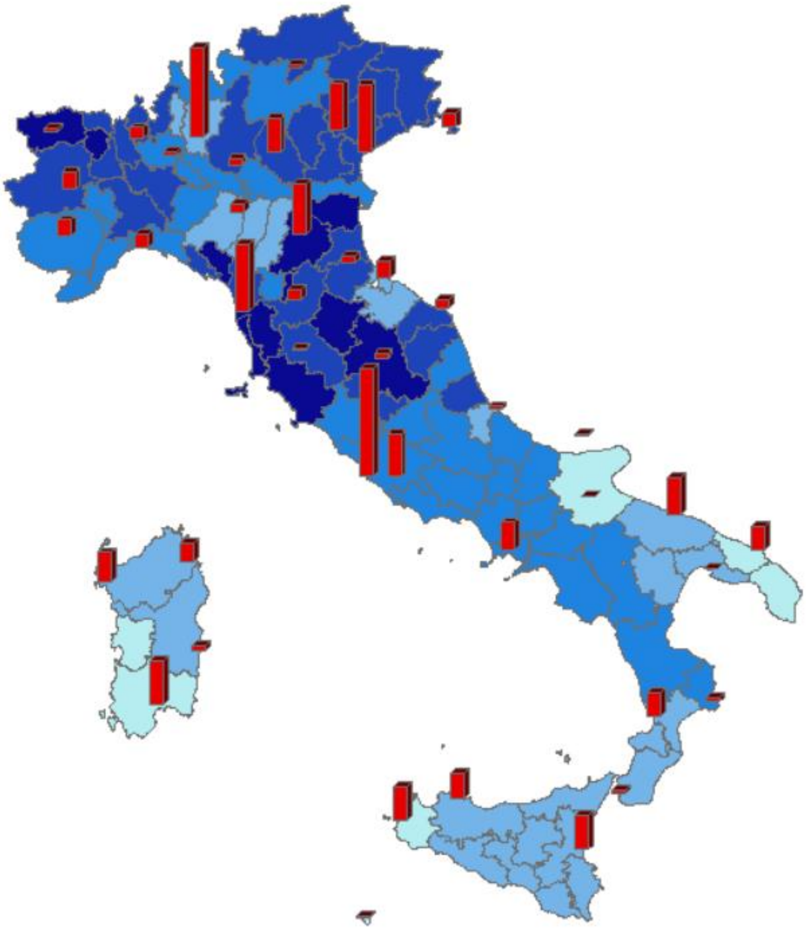

Table 1. Probability of having an eligible route

The table shows the results of a probit model estimated with the maximum likelihood method (first stage) for panel data. The dependent variable is one for origin-destination routes having the travel speed higher than 150 km/h and the ratio between flight time and total time higher than 50%.Standard errors are in parentheses. ***, **, and * indicate significance at the less than 1%, 5%, and 10% levels, respectively.

Variables	Eligible route
Airport size (departure)	2.270***
	(0.193)
Airport size (arrival)	0.997***
	(0.226)
Time from the closest airport and the centre of the province of origin	-0.393***
	(0.053)
Time from the closest airport and the univ of destination	-0.235***
	(0.053)
Total number of Italian flights at the airport of departure	0.007
	(0.005)
Total number of Italian flights at the airport of arrival	0.001
	(0.007)
Log likelihood	-1144.2152
Chi-square	436.14***
Observations	3,167
Number of Province-University pairs	329

Table 2. Second step - Air transport determinants of long-distance students' university accessibility

This table reports the results of the PPML model estimated to investigate the role of air transport on universities' attractiveness. The sample consists of 75 universities observed during the period 2003-2012. Each regression controls for time and province fixed effects. Standard errors are in parentheses. ***, **, and * indicate significance at the less than 1%, 5%, and 10% levels, respectively.

PPML model	d>300km	d>400km	d>500km	d>600km	d>700km	d>800km
Distance	-1.243***	-1.442***	-1.998***	-2.199***	-3.005***	-2.925***
	(0.065)	(0.065)	(0.092)	(0.143)	(0.217)	(0.346)
Travel speed	-0.040	0.060	0.676***	0.816***	1.132***	1.033***
	(0.067)	(0.074)	(0.088)	(0.112)	(0.134)	(0.163)
Presence of airport alternatives	0.218***	0.220***	0.254***	0.169***	0.132***	0.156***
	(0.025)	(0.024)	(0.026)	(0.031)	(0.034)	(0.041)
LCC presence	0.129***	0.134***	0.153***	0.246***	0.320***	0.365***
	(0.026)	(0.025)	(0.027)	(0.028)	(0.029)	(0.034)
Lambda parameter (Mills ratio)	0.304*	0.363**	0.425**	0.937***	1.003***	1.173***
	(0.172)	(0.160)	(0.171)	(0.198)	(0.241)	(0.266)
Quality of life (origin)	-0.094***	-0.092**	-0.090*	-0.166***	-0.128**	-0.137*
	(0.033)	(0.040)	(0.055)	(0.056)	(0.059)	(0.076)
Quality of life (destination)	0.103***	0.125***	0.106***	0.127***	0.052	-0.019
	(0.021)	(0.022)	(0.023)	(0.028)	(0.033)	(0.039)
Value added per cap. (origin)	0.611	0.640	0.506	0.572	0.272	-0.049
	(0.454)	(0.464)	(0.483)	(0.523)	(0.546)	(0.631)
Value added per cap. (destination)	1.870***	1.504***	0.903***	0.469***	0.832***	0.673**
	(0.074)	(0.083)	(0.102)	(0.157)	(0.207)	(0.312)
Student population (origin)	0.311**	0.343***	0.317**	0.187	0.002	0.037
	(0.124)	(0.126)	(0.141)	(0.172)	(0.201)	(0.239)
University features						
Student population	0.818***	0.809***	0.805***	0.745***	0.734***	0.729***
	(0.017)	(0.017)	(0.019)	(0.021)	(0.026)	(0.030)
Prestige	0.468***	0.532***	0.623***	0.728***	0.724***	0.707***
	(0.038)	(0.037)	(0.038)	(0.039)	(0.044)	(0.050)
Internationalization	7.324***	7.538***	8.425***	7.626***	7.360***	7.145***
	(0.405)	(0.422)	(0.460)	(0.516)	(0.625)	(0.662)
Regional scholarship per student	-0.097	-0.070	0.367***	0.159*	0.358***	0.568***
	(0.093)	(0.086)	(0.083)	(0.092)	(0.106)	(0.122)
Private	1.292***	1.340***	1.317***	1.118***	1.055***	0.950***
	(0.051)	(0.052)	(0.050)	(0.041)	(0.046)	(0.053)
Competitors' proximity index	-0.216***	-0.172***	-0.044***	0.011	0.081***	0.163***
	(0.014)	(0.015)	(0.016)	(0.019)	(0.027)	(0.054)
Art and Humanities	-0.081***	-0.097***	-0.141***	-0.277***	-0.421***	-0.495***
	(0.024)	(0.026)	(0.029)	(0.037)	(0.036)	(0.040)
Medical Sciences	-0.043	-0.021	0.116***	0.244***	0.445***	0.529***
	(0.029)	(0.031)	(0.035)	(0.042)	(0.044)	(0.044)
Natural and Technical Sciences	0.037	0.110**	0.070	-0.077	-0.228***	-0.273***
	(0.050)	(0.050)	(0.051)	(0.050)	(0.060)	(0.065)
Social Sciences	0.584***	0.677***	0.694***	0.909***	1.732***	1.582***
	(0.072)	(0.073)	(0.086)	(0.130)	(0.269)	(0.273)
Constant	-27.156***	-23.237***	-14.194***	-8.755*	-3.565	-0.706
	(4.643)	(4.827)	(4.987)	(5.251)	(5.961)	(7.776)
Observations	50,625	44,694	34,513	24,443	17,647	12,632
R-squared	0.571	0.617	0.663	0.660	0.679	0.671

Table 3. Second step - The impact of air transport evolution on long-distance students' university accessibility

This table reports the results of the PPML model estimated to investigate the role of the evolution of air transport on universities' attractiveness. The sample consists of 75 universities observed during the period 2003-2012. Each regression controls for time and province fixed effects. The interaction term between the *distance* and the *time trend* is also included. Standard errors are in parentheses. ***, **, and * indicate significance at the less than 1%, 5%, and 10% levels, respectively.

PPML model	d>300km	d>400km	d>500km	d>600km	d>700km	d>800km
Distance	-1.477***	-1.689***	-2.335***	-2.690***	-3.489***	-3.568***
	(0.073)	(0.084)	(0.132)	(0.201)	(0.304)	(0.489)
Travel speed	-0.071	-0.002	0.664***	0.816***	1.159***	1.079***
	(0.066)	(0.076)	(0.088)	(0.112)	(0.135)	(0.165)
Time trend	-0.327***	-0.305***	-0.339***	-0.487***	-0.467**	-0.642**
	(0.071)	(0.083)	(0.108)	(0.147)	(0.207)	(0.304)
Distance X Time trend	0.054***	0.051***	0.055***	0.077***	0.072**	0.092**
	(0.009)	(0.011)	(0.015)	(0.020)	(0.029)	(0.043)
Presence of airport alternatives	0.205***	0.212***	0.253***	0.168***	0.134***	0.161***
	(0.024)	(0.024)	(0.026)	(0.031)	(0.034)	(0.041)
LCC presence	0.147***	0.144***	0.157***	0.253***	0.323***	0.366***
	(0.025)	(0.026)	(0.027)	(0.028)	(0.029)	(0.034)
Lambda parameter (Mills ratio)	0.245	0.369**	0.421**	0.945***	0.962***	1.131***
	(0.155)	(0.160)	(0.170)	(0.198)	(0.240)	(0.263)
Quality of life (origin)	-0.055	-0.062	-0.066	-0.153***	-0.130**	-0.145*
	(0.035)	(0.040)	(0.054)	(0.056)	(0.059)	(0.075)
Quality of life (destination)	0.119***	0.129***	0.105***	0.129***	0.057*	-0.018
	(0.021)	(0.022)	(0.023)	(0.027)	(0.033)	(0.040)
Value added per cap. (origin)	0.738*	0.706	0.532	0.703	0.248	-0.034
	(0.444)	(0.462)	(0.482)	(0.528)	(0.542)	(0.627)
Value added per cap. (destination)	1.841***	1.541***	0.937***	0.506***	0.842***	0.700**
	(0.075)	(0.083)	(0.101)	(0.157)	(0.206)	(0.310)
Student population (origin)	0.300**	0.314**	0.286**	0.165	0.023	0.052
	(0.120)	(0.125)	(0.139)	(0.168)	(0.199)	(0.238)
University features						
Student population	0.808***	0.813***	0.806***	0.745***	0.734***	0.727***
	(0.017)	(0.017)	(0.019)	(0.021)	(0.026)	(0.030)
Prestige	0.512***	0.517***	0.615***	0.718***	0.716***	0.701***
	(0.035)	(0.037)	(0.039)	(0.039)	(0.044)	(0.050)
Internationalization	6.960***	7.192***	8.154***	7.295***	7.083***	6.838***
	(0.401)	(0.418)	(0.449)	(0.496)	(0.598)	(0.621)
Regional scholarship per student	0.011	-0.080	0.395***	0.202**	0.413***	0.650***
	(0.082)	(0.087)	(0.084)	(0.093)	(0.107)	(0.125)
Private	1.262***	1.332***	1.311***	1.108***	1.047***	0.944***
	(0.050)	(0.052)	(0.050)	(0.041)	(0.046)	(0.053)
Competitors' proximity index	-0.197***	-0.179***	-0.046***	0.010	0.081***	0.163***
	(0.014)	(0.015)	(0.016)	(0.019)	(0.027)	(0.054)
Art and Humanities	-0.082***	-0.099***	-0.145***	-0.281***	-0.429***	-0.506***
	(0.024)	(0.026)	(0.029)	(0.037)	(0.036)	(0.040)
Medical Sciences	-0.029	-0.023	0.116***	0.244***	0.449***	0.535***
	(0.029)	(0.031)	(0.034)	(0.042)	(0.044)	(0.045)
Natural and Technical Sciences	-0.001	0.101**	0.067	-0.082*	-0.234***	-0.279***
	(0.048)	(0.050)	(0.051)	(0.050)	(0.060)	(0.065)
Social Sciences	0.563***	0.671***	0.697***	0.915***	1.735***	1.590***
	(0.072)	(0.073)	(0.086)	(0.129)	(0.270)	(0.273)
Constant	-26.580***	-22.471***	-12.459**	-7.190	-0.552	3.212
	(4.637)	(4.869)	(5.011)	(5.248)	(6.144)	(8.101)
Observations	50,625	44,694	34,513	24,443	17,647	12,632
R-squared	0.606	0.618	0.665	0.662	0.682	0.674