Students' mobility attitudes and sustainable transport mode choice

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Abstract

Purpose

This study explores the propensity of university students to use different sustainable transport modes, taking into account individual and specific trip characteristics, as well as students' psychological traits (i.e. attitudes).

Methodology

Using the transport mode preferences of 827 students who responded to a travel survey, a two-step analysis is conducted. The first step examines the effects of individual characteristics, travel experience, and origin or destination features on students' stated preferences (i.e. self-selected values assigned to personal attitudes). The second step analyses students' travel mode choices, given their intrinsic mobility attitudes.

Findings

The results suggest that informing students about environmental issues increases their propensity to use sustainable mobility, leading to an average decrease in private transport usage

of 5.8%. Interestingly, improving the public transport service and promoting sustainable transport mobility have different impacts on individual campus areas. For campuses located in the city centre and in the historical hamlet, improvements in public transport are found to decrease solo driving by 3.3% and 5.3%, respectively. In suburban areas, this value increases to 9.5%.

Originality

This work makes two contributions to the literature. First, it focuses on an unexplored setting, namely, that of a multi-campus university, with districts located in three different areas. This is used to explain how students are influenced by their travel experience and the cultural framework in which they are embedded. Second, the two-step analysis leads to a deeper understanding of the differences between attitudes and 'intrinsic attitudes', and their relative influence on the preferred alternative.

Keywords: mode choice; sustainability; multi-campus university; transport mode; higher education

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1. Introduction

European legislation is currently proposing several programmes to increase the use of sustainable transport modes in order to limit CO_2 emissions caused by passive means of transport (European Commission, 2016). For example, the Urban Mobility Package (2013)[1] aims to accelerate sustainable urban mobility plans and to implement new sustainable transport modes. This topic is attracting greater academic attention, as scholars focus increasingly on sustainable mobility (e.g. Dong, Ma, and Broach, 2016; M.V. Johansson, Heldt, and Johansson, 2006; Zhou, 2014) in order to propose policy suggestions that can help institutions promote the so-called 'non-driving-alone' solutions (Zhou, 2016).

In the past decade, the literature has focused on university students' travel behaviour (e.g. Limanond, Butsingkorn, and Chermkhunthod, 2011; Páez and Whalen, 2010; Rotaris and Danielis, 2014; Whalen, Páez, and Carrasco, 2013; Zhou, 2012), as students represent a significant percentage of a regions' travelling population (Khattak, Wang, Son, and Agnello, 2011), with important characteristics. For example, compared with other categories of passengers, students are known to be more flexible with respect to the variety of transport modes they use (Limanond et al., 2011; Whalen et al., 2013): their class schedules are not fixed, attendance is often non-mandatory (E.M. Delmelle and Delmelle, 2012). Furthermore, policies encouraging shared, public, and active transport modes (e.g. walking and cycling) aimed at university students have a positive impact in the short term (e.g. reducing air pollution, congestion, and related health consequences) and in the long term (e.g. shaping students' attitudes towards a future responsible and eco-friendly commuting choice) (Limanond et al., 2011; Shannon et al., 2006).

When implementing sustainable policy decisions, universities and local and regional stakeholders need to consider several factors (Soria-Lara et al., 2017). Among these, the structure of the local physical environment is recognized as having a crucial influence on the

choice of travel mode (e.g. Cervero, 2002; Dong et al, 2016; Rodríguez and Joo, 2004). This influence inevitably increases the interest in the specific geo-localization of a university and its facilities in the area where they are located. However, the literature on students' accessibility has considered only universities as a whole, without focusing on their distribution across territories. Indeed, not all universities have a large campus established in a homogeneous area, especially in some university systems, such as those in Italy (Goglio and Parigi, 2016; Rotaris and Danielis, 2014). Being more spread out enables projects that favour sustainable transport modes, which vary according to the campus's location, but at the same time, can be promoted and implemented by a single athenaeum.

Therefore, this study investigates a representative sample of students enrolled at the University of Bergamo. This university, located in the north of Italy, is an appropriate framework for a number of reasons. First, its campuses are situated in three different areas, facilitating an understanding of students' transport preferences based on territories' characteristics. The three areas are as follows: 1) the historical hamlet, located in the old city centre, with some controlled traffic zones and a few expensive paid car parks; 2) the city centre, which is more easily accessible by public transport and, similar to the historical hamlet, is characterized by scarce paid car parks; and 3) the industrial district, located in a suburban area, which is well equipped with free car parks, but is less accessible by public transport. Second, the university hosts various faculties, including humanities, law and economics studies, and engineering. This is not a negligible distinction, because students attending different faculties (e.g. engineering and social sciences) are known to have different attitudes and personalities, which can affect their mobility patterns (e.g. Kafetsios, Maridaki-Kassotaki, Zammuner, Zampetakis, and Vouzas, 2009; Kim, Schmöcker, and Fujii, 2016; Sánchez-Ruiz, Pérez-González, and Petrides, 2010). Many scholars have indeed highlighted that psychosocial factors (associated with students' disciplinary attitude) can influence students' preferred means

of transport (e.g. Bamberg, Hunecke, and Blöbaum, 2007; Heinen, Maat, and Wee, 2011; V.M. Johansson et al., 2006; Kerr, Lennon, and Watson, 2010; Şimşekoğlu, Nordfjærn, and Rundmo, 2015). Third, the University of Bergamo faced 12.9% growth in enrolled bachelors and masters students in the period 2008–2015, as compared to a decrease of 13.6% in the Italian system overall.[2] This countertrend allows the authors to properly account for the transport factors related to this growth. An increase in the number of enrolled students can introduce positive impacts to the community and to the university itself. However, negative externalities can also arise in terms of transport, generally because the local infrastructure is inadequate. As such, analysing students' transport mode choices at a growing university would favourably help policymakers to understand the factors that contribute to adopting sustainable transport.

Relying on an online survey conducted on 827 students (6% of the entire student body) at the University of Bergamo during September 2012, this study estimates students' travel mode choices among various levels of sustainable alternatives at a multi-campus university. In doing so, the study considers not only territorial and individual characteristics, but also students' psychological traits.

The reminder of this paper is organized as follows. The next section briefly introduces previous studies on students' transport mode choices. Section 3 describes the research design and methodology, and Section 4 reports preliminary results. Section 5 presents the outcomes of the empirical analyses and the relative policy implications. Finally, Section 6 summarizes the conclusions.

2. Literature Review

2.1 University students' mobility

There are several reasons why the mobility of university students has proved to be an interesting topic for scholars. From a higher education perspective, investigating students' behaviour is essential in a context where universities must increasingly compete for students in order to attract financial resources (e.g. Cattaneo, Malighetti, Meoli, and Paleari, 2017; Long, 2004; Teixeira, Rocha, Biscaia, and Cardoso, 2014; Wilkins, Shams, and Huisman, 2013). Notwithstanding several university-level factors that might increase the attractiveness of a university to students (e.g. prestige, internationalization, or tuition fees), scholars have largely ignored the costs associated with transport services (Cattaneo, Malighetti, Paleari, and Redondi, 2016). However, these costs are some of the most crucial determinants of university choice (e.g. Alm and Winters, 2009; Kenyon, 2011; Long, 2004) and a major reason discouraging enrolment or the continuation of studies at distant universities (Gibbons and Vignoles, 2012; Kenyon, 2011).

From a transport perspective, university students are recognized as an important part of the travelling population. At the same time, they have several unique travel behaviours (Khattak et al., 2011), owing to greater flexibility (Limanond et al., 2011) and more alternatives from which they can benefit (Whalen et al., 2013). University students' mobility has become increasingly important as universities, known as big trip attractors (Whalen et al., 2013), try to develop a more sustainable environment (e.g. Balsas, 2003; E.M. Delmelle and Delmelle, 2012; Gombert-Courvoisier, Sennes, Ricard, and Ribeyre, 2014; Hancock and Nuttman, 2014; Lo, 2015; Miralles-Guasch and Domene, 2010; Pàez and Whalen, 2010; Shannon et al., 2006; Van Weenen, 2000), given the increasing air pollution and traffic congestion caused by students' car usage (Klöckner and Friedrichsmeier, 2011; Limanond et al., 2011; Rotaris and Danielis, 2014). Therefore, the need to develop management policies that are more student-oriented is currently a priority for higher education institutions.

2.2 Towards students' sustainable transport modes

Several policies promote university students' sustainable mobility, including an increase in parking fees (or reducing parking permits) and improving public transport services (e.g. in terms of safety, punctuality, convenience, and coverage). These policies have been studied and suggested for numerous universities in different case studies, including at the University of Western Australia (Shannon et al., 2006), the University of Idaho in the US (E.M. Delmelle and Delmelle, 2012), the Suranaree University of Technology (Limanond et al., 2011), the University of Trieste in Italy (Rotaris and Danielis, 2014), the Deakin University in Australia (Hancock and Nuttman, 2014), the University of Beirut (Danaf, Abou-Zeid, and Kaysi, 2014), the University of North Carolina at Greensboro (Sultana, 2015), and the University of Coimbra in Portugal (Cruz, Barata, Ferreira, and Freire, 2017). Dedicated programmes have also been promoted by scholars to discourage the use of private means of transport rather than active modes (e.g. cycling and walking), as in the case of the Ohio State University (Akar, Fischer, and Namgung, 2013), the McMaster University in Canada (Lavery, Páez, and Kanaroglou, 2013; Whalen et al., 2013), and the Aristotele University of Thessaloniki in Greece (Pitsiava-Latinopoulou, Basbas, and Gavanas, 2013). In this regard, analysing the University of Michigan-Flint, Rybarczyk and Gallagher (2014) highlighted that the efficacy of these programmes can be enhanced by increases in street lighting and in traffic enforcement. Zhou (2012, 2014, 2016) suggests that a cheaper and more frequent transit system at the University of California -Los Angeles- would allow students to reach bus stops more easily. Interestingly, given the trend to reduce carbon-intensive travel activity, carpooling programmes are often proposed as sustainable incentives as well, as in the case of the University of Maryland (Erdoğan, Cirillo, and Tremblay, 2015).

To the best of the authors' knowledge, the above-mentioned policies are all based on studies that focus on single-campus universities. An exception is the work of Rotaris and Danielis

(2014), who identify five different campuses at the University of Trieste. Each location has its own characteristics, such as the number of parking lots and the availability of public transport services. Notwithstanding the importance of discerning between locations (e.g. Dong et al., 2016; Rodríguez and Joo, 2004), the authors do not examine the individual traits (physical and psychological) of the students enrolling in each of the different faculties (e.g. engineering and social sciences). These aspects play an important role in students' transport mode choices. For instance, engineering students are found to be more aware of environmental issues than are students enrolled in the social sciences (Kim et al., 2016). As such, analysing students' attitudes, that is, the subjective importance that individuals assign to a specific item (M.V. Johansson et al., 2006), may help to explain why people implement eco-friendly behaviour (e.g. P. Whannell, Whannell, and White, 2012; Willis, Manaugh, and El-Geneidy, 2015), which, in turn, is known to be a determinant of transport mode choice. Therefore, investigating people's attitudes towards, for instance, safety and comfort, is crucial in transport mode choice studies, because this can aid policymakers in promoting the use of sustainable transport modes (Bopp, Kaczynski, and Wittman, 2011; Duque, Gray, Harrison, and Davey, 2014; Fürst, 2014; M.V. Johansson et al., 2006; Klöckner and Friedrichsmeier, 2011; Schwanen and Mokhtarian, 2005).

Therefore, this study aims to contribute to the present literature by investigating different levels of students' sustainable transport mode choice in a multi-campus university framework. Here, the authors consider territorial characteristics, both at the origin and at the destination, as well as individual characteristics. In the latter case, these include physical (e.g. sex and age) and psychological characteristics (e.g. attitudes towards safety, comfort, and, in particular, sustainability).

3. Data and Methodology

3.1. Data collection

The data used in this study were collected in an online survey conducted on students of the University of Bergamo during September 2012 using the *Qualtrics Online Survey Software*. The survey investigates students' transport mode choices from private (cars and motorcycles), shared (carpooling), public (buses, trams, and trains), and active (cycling and walking) transport options. An invitation to participate in the online survey was sent by email to all students enrolled at the University of Bergamo at the beginning of September 2012. Students were asked to complete a form anonymously on their transport preferences before 15 October 2012. The choice of an online survey was governed by several advantages that this method provides. For example, in addition to convenience in terms of cost and time (e.g. Evans and Mathur, 2005; Wright, 2005), the method enables the elimination of the so-called 'interviewer-bias' (e.g. Evans and Mathur, 2005) and provides access to a greater number of individuals. In particular, using the university's email system, an online survey can be used to obtain information from students who do not attend the university every day or who want to protect their anonymity.

3.2. Survey structure and validity

The survey is divided into two main sections. The first section includes questions on a respondent's profile (i.e. age, sex, and field of study), whereas the second identifies students' intrinsic attitudes to mobility (e.g. safety, comfort, and sustainability) and maps respondents' transport mode choices.[3] Overall, the response rate is 9%, which, after cleaning, yielded 827 responses (6% of the 14,341 students enrolled at the University of Bergamo).[4] The majority of respondents (460) attend the campus located in the historical hamlet. The campuses located in

the city centre and in the industrial district are represented by 30% and 14% of the respondents, respectively.

A validity check is used to test whether the data are representative of the population in terms of campuses attended. As in Zhou (2016), the expected number of students from each district (E_i) is computed and compared with the observed number (O_i). Specifically,

$$E_i = N_r \cdot b_i,$$

where N_r and b_i represent the number of respondents (827) and the percentage of the total number of students on each campus, respectively. Table 1 shows the comparison between the observed number of respondents, the total student population, and the expected number of respondents. The observed values (O_i) are very close to the expected values (E_i), and the *Chi-square* test suggests that the data are not statistically significantly different from the population of reference.

Table 1 – Observed and expected respondents per district location

Campus	**Student population**	**% Population (b_i)**	**Respondents (O_i)**	**Respondents (%)**	**Expected Respondents (E_i)**
Industrial District	2,081	15	117	14	120
City Centre	4,756	33	250	30	274
Historical Hamlet	7,504	52	460	56	433

3.3. Methodology

Studying transport mode choice in real life is complex, because it requires dealing with individual preferences (M.V. Johansson et al., 2006), which are, in turn, influenced by individual characteristics. In this study, *Safety*, *Comfort*, and *Sustainability* are considered as preferences that may impact transport mode choice; these preferences are called 'attitudes' in the literature (e.g. Akar et al., 2013; Bopp et al., 2011; M.V. Johansson et al., 2006). M.V.

Johansson et al. (2006) define an attitude as the subjective importance that an individual assigns to a specific item. Based on this definition, this study tries to disentangle the components of the values attributed to *Safety*, *Comfort*, and *Sustainability*, namely, the attitudes influenced by individual characteristics, travel experience, and origin or destination features, as well as those of 'intrinsic attitudes', considered to be the tendency or predisposition of individuals to a specific concept (LaPiere, 1934).

For this purpose, the analysis is conducted in two different steps. First, three two-limit Tobit regressions are performed to understand the effects of individual characteristics, travel experience, and origin or destination features on students' stated preferences (i.e. self-selected values assigned to personal attitudes) for *Safety*, *Comfort*, and *Sustainability*. Second, in trying to understand which factors influence the sustainable transport mode choices of students at a multi-campus university, the analysis relies on multinomial logit regressions,[5] which include the unexplained parts of *Safety*, *Comfort*, and *Sustainability* ('intrinsic attitudes'). Statistically, these are represented by the residuals from the two-limit Tobit analyses.[6] The chosen reference case is driving solo, denoting the choice to travel to university by a private means of transport, such as a car or a motorcycle. This is compared to three levels of increasingly sustainable transport modes (i.e. shared, public, and active modes). At the first level, the shared solution implies the use of a private car that is shared with other students. The second level includes public transport services. These are motorized forms of transport but can accommodate a considerable number of people, thus reducing the level of released pollution per capita. Furthermore, these are generally powered by lower polluting fuels. Finally, the third level considers active mobility (i.e. moving by bicycle or walking). This mode of transport does not release any air pollutants and is acknowledged as having positive health benefits for people (e.g. Pucher, Buehler, Bassett, and Dannenberg, 2010; Saelens, Sallis, and Frank, 2003; Sælensminde, 2004).

To perform the analysis, this study first considers the University of Bergamo as a whole, and then conducts the same multinomial regression analyses for the three specific Bergamo campuses in order to take into account the different infrastructures of each district (Figure 1).

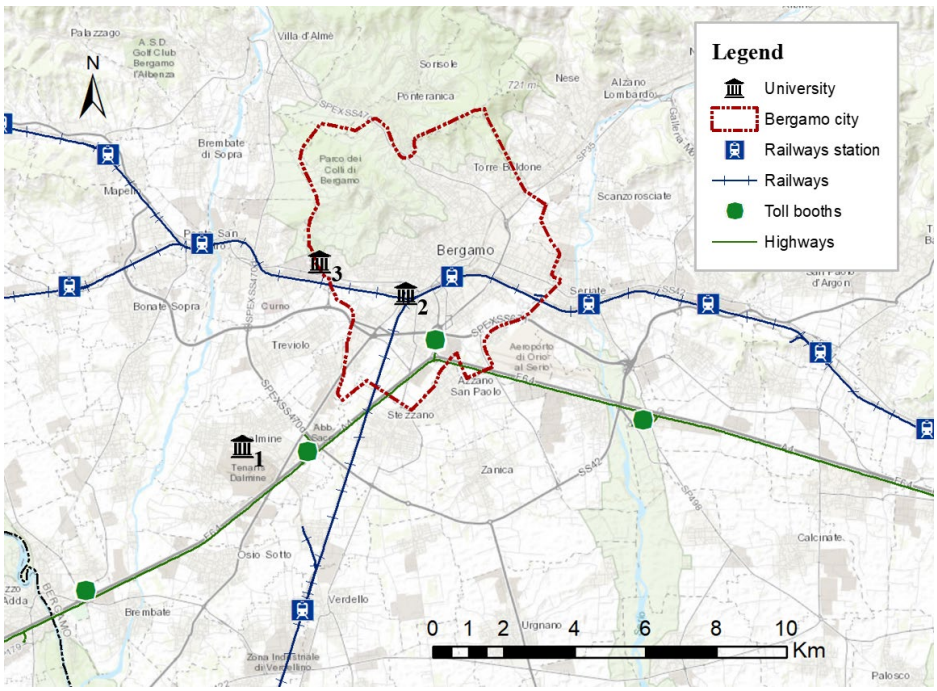

Figure 1 – Transport infrastructures around the campuses of the University of Bergamo (1-industrial district; 2-city centre; 3-historical hamlet)

The separation of the analysis into two steps is crucial, both from a methodological point of view and from a policymaker's perspective. Indeed, the two-step analysis prevents the double counting of characteristics that may affect both attitudinal factors and transport mode choice. Further, considering 'intrinsic attitudes' enables the proposal of effective policy decisions (Schwanen and Mokhtarian, 2005) that may impact students' eco-friendly behaviour in the medium/long term. Currently, policy implications are based only on observable characteristics that may be effective in the short term as temporary solutions.

3.4. Definition of the variables

As independent variables, the individual characteristics of the respondents, such as sex (*Male*) and age (*Age*), and other variables referring to the trip and the mode of transport are considered.[7] These variables are defined as follows:

- *Comfort* is a five-point Likert-scale variable, based on the question '*How much does comfort influence your transport mode choice?*' Here, a value of one indicates a very low influence and five indicates a very high influence;
- *Sustainability* is a five-point Likert-scale variable, based on the question '*How much does the ecology of a means of transport influence your choice?*' Here, a value of one indicates a very low influence, and five indicates a very high influence;
- *Safety* is a five-point Likert-scale variable, based on the question '*How much does safety influence your transport mode choice?*' Here, a value of one indicates a very low influence and five indicates a very high influence;
- *Traffic Congestion* is the ratio between the maximum time and the average time (without traffic) taken to travel from the town of origin to the university district by car. To gather this information, the travel times from the town of origin to the university districts during daily peak hours are recorded for a month using *Google Maps*;
- *Distance* is the road distance in kilometres from the municipalities where students live to the destination university district;
- *Public Availability* is a five-point Likert-scale variable, based on the question '*How would you rate the availability of public transport service to reach the university?*' Here, a value of one is 'absent', and five is 'very efficient';
- *Private Availability* is a three-point Likert-scale variable, based on the question '*How would you rate your car/motorbike availability?*' Here, a value of one represents 'not available' and three denotes 'totally available'.

- *Pollution* stands for the average level of carbon monoxide of students' municipalities of origin, measured in micrograms per cubic meter. To measure the levels of carbon monoxide, daily information about its concentration in the atmosphere were collected for a month from *ilmeteo.it*, a website of Italian weather conditions.

Following the theory that the faculty attended could impact students' attitudes (e.g. Kim et al., 2016; Tikka, Kuitunen, and Tynys, 2000), two dummy variables are considered in the first step of the analysis, representing the field of study (i.e. *Engineering* and *Law & Economics*), where the faculty of humanities represents the reference case. In the multinomial logit regressions, the analysis considers the sizes of parking lots (*Parking Lots*), measured in squared kilometres, within a range of 500 m from the university location. The availability of parking lots is acknowledged to have a strong impact on students' choices of transport modes (e.g. E.M. Delmelle and Delmelle, 2012; Shannon et al., 2006).

4. Preliminary Results

The results of the descriptive analysis suggest that 4% of students go to university using an active mode (cycling or walking), 7% use carpooling, and 56% rely on public transport. Therefore, sustainable transport modes are used by 77% of students in the sample. The remaining 281 students prefer to travel by car or motorcycle. Interestingly, there is heterogeneity in the share of each transport mode according to the districts to which students are traveling. In particular, 58% of students (68 out of 117) whose districts are located outside the city centre use private modes of transport, 23% use the first level of sustainable transport (carpooling), and none travel by bicycle or on foot. The city centre and the historical hamlet have similar percentages of students using the highest level of sustainable transport mode. Public transport is used predominantly for the campus located in the historical hamlet (70% of

the sample), and it is preferred by 117 students out of 260 in the case of the city centre university campus (see Figure 2). Figure 3 shows the percentages of sustainable transport modes (shared, public, and active mobility) used in the municipalities around the University of Bergamo.

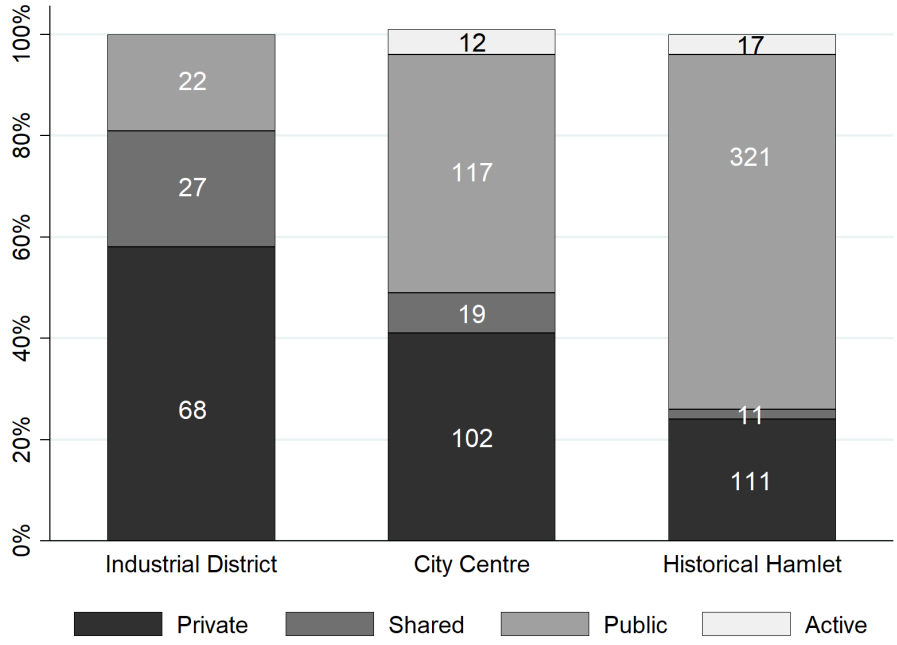

Figure 2 – Share of University of Bergamo's students using each transport mode per district location

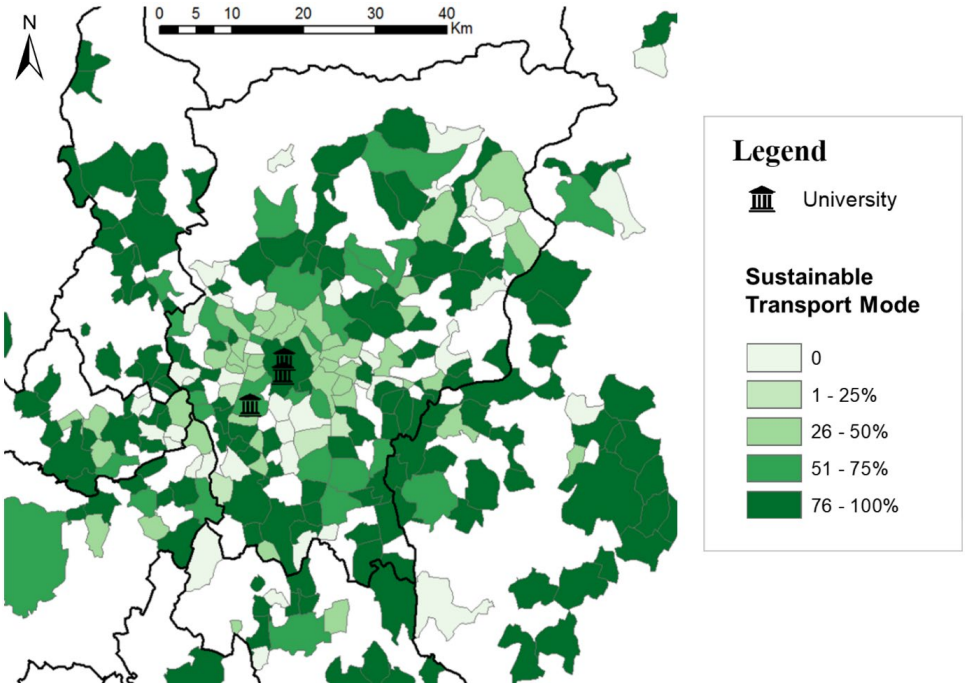

Figure 3 – Percentage of sustainable transport mode use around the University of Bergamo

With regard to the variables representing students' attitudes, *Comfort* is, in general, more important to students, with an average value of 3.17. This is followed by *Sustainability* and *Safety*, with average values of 2.39 and 2.66, respectively (see Figure 4). These values vary slightly by faculty. Specifically, engineering students consider comfort and safety to be more important, with values of 3.55 and 2.70, respectively, but show the lowest value for the *Sustainability* variable. Humanities students care more about the ecology of the means of transport (2.58) and prefer feeling safe to being comfortable. Finally, law & economics students have the lowest average score on *Safety*, whereas their scores for the other variables fall between those of the engineering and humanities populations.

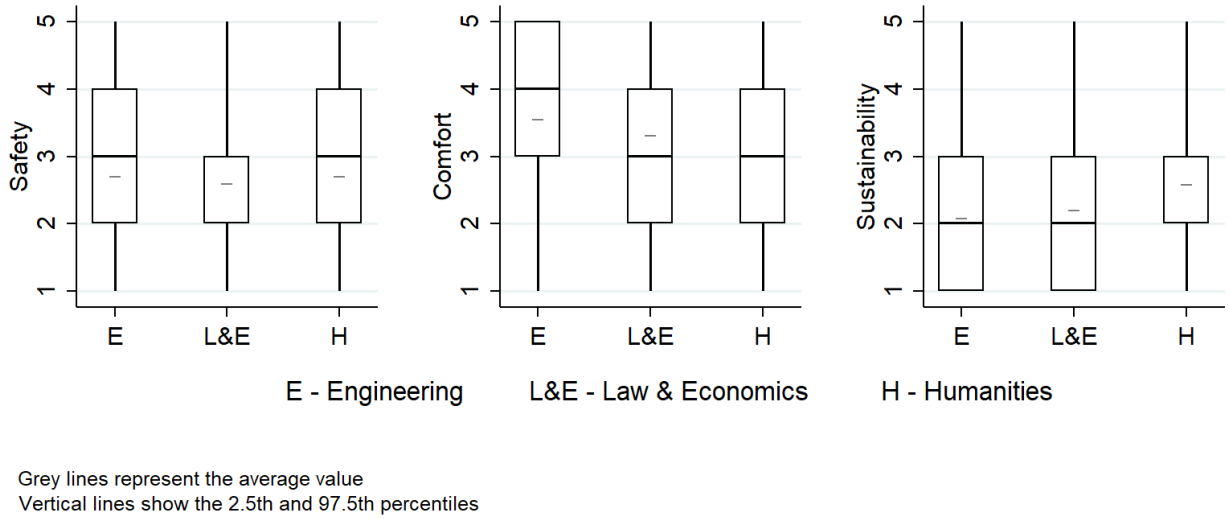

Figure 4 – Stated preferences towards safety, comfort, and sustainability

Table 2 shows the descriptive statistics of the data. The sample is 77% female. Despite an age range of 19 to 63 years of age, only 7% of respondents are over 28 years old, and the average age is 23. The average distance is about 25 km, ranging from 1 to 133 km. Only 83 students live further than 50 km from the university location, and 29% of the respondents travel from outside the province of Bergamo. Traffic congestion causes an average travel time increase of 13%, and only in rare cases does traffic lengthen the travel time by more than 30% (24 cases out of 827). The availability of public and private transport modes have average values of 3.8 and 2.2, respectively, indicating high availability of both sustainable and non-sustainable transport modes. For public transport modes, only 46 students report not having a public transport service in their town that can connect them to the university, and 40 evaluate public transport as being scarce. Similarly, 80% of students can use a private transport mode to travel to university. The level of carbon monoxide is heterogeneous, with an average value of 371.237 $\mu g/m^3$, ranging from a minimum of 100.600 $\mu g/m^3$ to a maximum of 702.600 $\mu g/m^3$. As shown in Figure 5, the municipalities with the highest levels of carbon monoxide are concentrated next to the city of Bergamo and are moving closer to the provinces of Milan and Monza Brianza (to the West of Bergamo). Finally, the *Parking Lots* variable specifically

represents the availability of parking at the three university campuses. The industrial district has the largest parking area (3.492 km^2), followed by the historical hamlet (1.144 km^2) and the city centre (0.339 m^2).

Table 2 – Descriptive statistics of variables

	Mean	Std. Dev.	Min	Max
Male	0.334	0.472	0	1
Age	23.267	4.739	19	63
Safety*	2.661	1.283	1	5
Comfort*	3.174	1.337	1	5
Sustainability*	2.392	1.230	1	5
Traffic Congestion	1.128	0.719	1	1.562
Distance	25.137	19.159	1.250	132.997
Public Availability	3.805	1.097	1	5
Private Availability	2.192	0.738	1	3
Pollution	371.237	86.857	100.600	702.600
Parking Lots	1.232	0.985	0.339	3.492
Industrial District	0.141	0.349	0	1
City Centre	0.302	0.460	0	1
Historical Hamlet	0.556	0.497	0	1

*To ease interpretation, the table considers the stated preferences' value

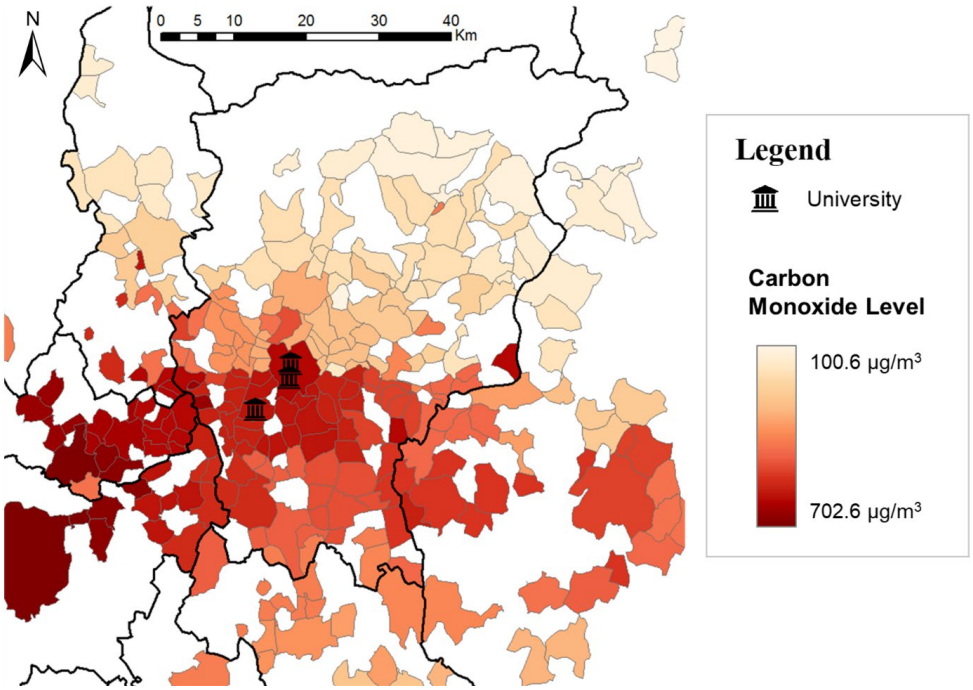

Figure 5 – Carbon monoxide levels of municipalities around the University of Bergamo

5. Results and Discussion

Table 3 presents the results of the two-limit Tobit regressions with robust standard errors. Interestingly, *Age* positively affects all of the stated preferences considered. Specifically, five additional years of age increases the importance given to *Safety*, *Comfort*, and *Sustainability* by around 0.230, 0.175, and 0.275 points, respectively. Even without examining the extent to which age enhances attitudes towards sustainability, literature interestingly explores the effect of education on individuals' eco-friendly behaviour. Assuming that older students have studied for a larger number of years, the outcome is confirmed by scholars who show that people with more years of schooling have a greater awareness of environmental issues (Ostman and Parker, 1987; Scott and Willits, 1994). Although distance from the place of study affects the importance students place on *Safety* (+0.009), *Traffic Congestion* positively affects the interests of respondents only in terms of the sustainability of the transport mode used (+2.084). The availability of private and public transport modes have opposite influences on *Comfort*; students served by a better public transport service place a lower importance on comfort (-0.140), whereas private availability has a positive effect on comfort (+0.634). Furthermore, having a car available results in students being less concerned about the sustainability of the means of transport (-0.321). Interestingly, living in a municipality with a high concentration of carbon monoxide increases the importance students place on *Safety* and *Sustainability.* This result suggests that the environment where people live affects their psychological traits. In these terms, prior studies have shown that experiencing environmental pollution leads to eco-friendlier behaviour (e.g. Finger, 1994; Nilsson and Küller, 2000). Finally, *Engineering* and *Law & Economics* have interesting influences on students' preferences. Specifically, the weights placed on *Comfort* increase by 0.500 and 0.288 points, respectively, for these students relative to *Humanities* students. In contrast, students from the humanities consider the sustainability aspect more than their colleagues in engineering and law & economics do by

0.624 and 0.511 points, respectively. This confirms that the field of study may impact individuals' awareness of environmental issues (Kim et al., 2016).

Table 3 – Two-limit Tobit regression results with robust standard errors

	Safety	**Comfort**	**Sustainability**
Male	0.203	-0.084	-0.016
	(0.143)	(0.150)	(0.139)
Age	0.046***	0.035**	0.055***
	(0.016)	(0.017)	(0.019)
Traffic Congestion	-1.400	-0.990	2.084**
	(0.905)	(0.938)	(0.964)
Distance	0.009**	-0.002	0.000
	(0.004)	(0.004)	(0.004)
Public Availability	-0.073	-0.140**	0.025
	(0.063)	(0.068)	(0.064)
Private Availability	0.079	0.634***	-0.321***
	(0.096)	(0.100)	(0.096)
Pollution	0.002**	0.001	0.002**
	(0.001)	(0.001)	(0.001)
Engineering	0.095	0.500**	-0.624***
	(0.211)	(0.217)	(0.211)
Law & Economics	-0.041	0.288*	-0.511***
	(0.151)	(0.156)	(0.152)
Constant	0.818	1.384**	0.688
	(0.601)	(0.619)	(0.636)

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parenthesis.

After estimating the stated preferences for *Comfort*, *Sustainability*, and *Safety,* the respective intrinsic attitudes' values (the residuals of the two-limit Tobit regression) are added to the multinomial logit analysis in order to compute their effects on the levels of sustainable transport mode choice. Table 4 shows these regression results, where the private transport mode is used as the reference case.[8] With regard to individual characteristics, *Age* is negatively associated with the use of sustainable transport modes, especially in the case of carpooling and public transport services. Older students are indeed recognized to be less likely to use alternative modes. This is mainly because they are more independent, and regularly use their own cars, needing to be flexible for potential job opportunities and household responsibilities (Zhou, 2012). Moreover, this result suggests that even though the importance of *Safety*,

Comfort, and *Sustainability* increase with age (see Table 3), students prefer travelling via a comfortable rather than a sustainable mode of transport. This finding is consistent with the values assigned by students to their stated preferences. Indeed, as shown in Figure 4, the value given to *Comfort* is nearly one point higher than that given to *Sustainability* on the five-point Likert scale (3.17 and 2.39, on average, respectively).

Table 4– Multinomial regression results with robust standard errors

	Shared Mode	**Public Mode**	**Active Mode**
Male	0.419	0.214	-0.153
	(0.320)	(0.224)	(0.456)
Age	-0.254***	-0.118***	0.024
	(0.066)	(0.034)	(0.033)
Safety	-0.082	0.090	0.059
	(0.145)	(0.099)	(0.208)
Comfort	-0.06	-0.710***	-0.468**
	(0.128)	(0.099)	(0.212)
Sustainability	0.167	0.493***	0.709***
	(0.147)	(0.096)	(0.203)
Traffic Congestion	0.109	-0.100	-0.867
	(2.156)	(1.763)	(4.186)
Distance	0.015	0.042***	-0.139*
	(0.009)	(0.008)	(0.075)
Public Availability	-0.106	0.584***	0.336*
	(0.127)	(0.106)	(0.199)
Private Availability	-1.001***	-2.495***	-1.766***
	(0.283)	(0.190)	(0.363)
Pollution	-0.003	0.004***	0.014*
	(0.002)	(0.001)	(0.008)
Parking Lots	0.290**	-0.483***	-0.825***
	(0.136)	(0.105)	(0.237)
Constant	7.106***	4.510***	-3.268
	(1.889)	(1.070)	(3.887)
Observations		827	
Pseudo R-squared		0.336	

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parenthesis.

The majority of the variables related to trip characteristics are significant. In particular, when distance and public transport service availability are considered as determinants of the choice of transport mode, the use of buses and trains is preferred to private cars or motorcycles. On the other hand, as the availability of private transport to students increases, the probability

of going to university using a sustainable mode of transport decreases, thus confirming the results of Danaf et al. (2014) and Limanond et al. (2011). *Distance*, usually defined in the literature as a major incentive for using private transport (Shannon et al., 2006), is a strong negative determinant of using an active transport mode; the longer the home–university trip, the lower the probability is that students choose to travel to campus by bicycle or on foot. Of the factors, *Parking Lots* is found to influence all levels of the sustainable transport modes considered in the sample; when the square metreage of parking increases (decreases), the probability of preferring to travel to university by car increases (decreases). This is consistent with the findings of previous studies in the literature (e.g. Erdoğan et al., 2015; Rotaris and Danielis, 2014; Zhou, 2014; Whalen et al., 2013), where the availability of parking and parking permits increase the probability of driving to the university. Additionally, the variable related to the pollution level of a student's municipalities of origin (*Pollution*) has a positive impact on the use of both public (+0.004) and active (+0.014) transport modes. Evaluating the effects of *Pollution* on attitudes and mode choice, it is clear that experiencing environmental pollution affects both attitudes towards sustainability and intrinsic attitudes, which leads to a sustainable transport mode choice. Indeed, the level of pollution in the municipality of origin has a positive effect on the public and active mode choices (Table 4) and on the students' attitudes towards sustainability (Table 3). These results corroborate the theory that experiencing pollution leads to eco-friendlier behaviour (e.g. Finger, 1994; Nilsson and Küller, 2000), and the theory that the environment has a crucial influence on travel mode choice (e.g. Cervero, 2002; Dong et al, 2016; Rodríguez and Joo, 2004), documenting the importance of considering the impact of environmental characteristics (both individual and geographical) in transport mode choice.

Intrinsic attitudes are found to significantly impact students' transport mode choices. The only exception is *Safety*, which does not seem to be relevant in the case of the University of Bergamo. This result could be explained by the multiple meanings that 'feeling safe' could

represent. As stated in M.V. Johansson et al. (2006), safety may include both personal and traffic traits. While the former would increase the use of private transport, especially cars, the latter would promote the use of public transport, specifically in the case of trams and trains. In contrast, the attitude towards *Comfort* is significant and interesting. The effect of comfort on transport choice is a controversial issue. On the one hand, a common belief is that comfort is one of the main reasons why students choose to drive their own car, rather than using more sustainable transport modes (e.g. Kaplan, 2015). On the other hand, public transport provides travellers with an opportunity to rest, work, or even move around (M.V. Johansson et al., 2006), making it the more comfortable than driving. In addition, there is no consensus in the literature on how comfort impacts the mode choice between a car and a bus service. Using cycling as the base case, Whalen et al. (2013) shows how comfort is decisive in the choice of both a car and a bus service. The results of the present study confirm the hypothesis of Kaplan (2015), showing that when the propensity towards *Comfort* increases, people tend to prefer private means of transport. In contrast, the attitude towards *Sustainability* works as a positive incentive to use buses or trains or to travel to the university using an active mode of transport. This result improves on the findings of M.V. Johansson et al. (2006), who limit the effects of the attitude towards sustainability to a choice between levels of sustainable transport modes, without considering the impact of solo driving. Consistent with the theory of planned behaviour (e.g. Bamberg and Schmidt, 1998), this finding shows that students' use of sustainable modes of transport is a direct outcome of their intentions (Klöckner and Friedrichsmeier, 2011).

Next, the study considers each university campus separately, applying the same analyses (Table 5). Although some results are homogeneous across the three districts, important differences become evident. With regard to the industrial district outside the city centre, *Pollution* and *Private Availability* are no longer significant factors influencing the choice of private transport mode compared to that of the first level of sustainable transport modes.

Furthermore, the results suggest that males use public transport more often than females do. This result is of great interest to scholars investigating whether gender affects transport mode choice, especially in the case of sustainable modes. Polk (2003) shows that females are more sensitive to environmental issues and, thus, are more prone to reducing their use of cars in favour of sustainable transport modes. This result corroborates the findings of Akar et al. (2013), Danaf (2014), E.M. Delmelle and Delmelle (2012), and Zhou (2014; 2016), who show that, *ceteris paribus*, women tend to consider the alternatives to driving solo as less valid. Furthermore, *Traffic Congestion* is significant and positive in terms of students' choices between public and private modes of transport. This result is influenced by the availability of trains and trams, which allow students coming from the suburbs to reach the university in the industrial district by crossing the city of Bergamo, without being subjected to the typical congestion characterizing the area. In the historical hamlet, *Sustainability* assumes greater importance, having a positive influence on all levels of sustainable transport. In addition, within this framework, the more congested the journey, the lower the probability is of choosing to use carpooling. This result is reasonable, because carpooling generally increases the time and, sometimes, the distance travelled, because the driver has to collect other students. For students attending this campus, *Safety* influences their choice of transport mode, and is significant when choosing between private cars and carpooling. Specifically, as the humanities students' intrinsic attitudes towards *Safety* increase, the probability of choosing to drive solo is higher. Accordingly, the topic of 'trust' when dealing with carpooling is crucial (e.g. Furuhata et al., 2013), because people tend not to trust individuals other than family members (e.g. Mayer, Davis, and Schoorman, 1995). Trust certainly affects students' perceptions of feeling safe when choosing carpooling as a transport mode.

Unlike in the other areas, students attending lectures in the city centre register a positive influence of *Traffic Congestion* on the use of active transport modes. The more congested the

traffic, the higher the probability is that a student attending the university in this district will choose to avoid the traffic and opt to cycle or walk. Along with the impact of congestion on the attitude towards sustainability (Table 3), this outcome corroborates the findings of Lavery et al. (2013), who report that people who consider limiting their travel by car in order to improve the quality of the environment are more likely to use sustainable transport modes.

Table 5 – Multinomial regression results by university campus location

	Industrial District		**City Centre**			**Historical Hamlet**		
	Shared Mode	**Public Mode**	**Shared Mode**	**Public Mode**	**Active Mode**	**Shared Mode**	**Public Mode**	**Active Mode**
Male	0.585	1.417*	0.202	0.015	1.008	0.852	0.167	-1.068
	(0.553)	(0.828)	(0.556)	(0.461)	(0.755)	(0.641)	(0.324)	(0.760)
Age	-0.341**	-0.147	-0.280**	-0.532***	-0.129	-0.225	-0.084***	0.037
	(0.150)	(0.254)	(0.118)	(0.125)	(0.155)	(0.159)	(0.027)	(0.039)
Safety (res.)	0.067	-0.199	0.207	0.002	0.167	-0.563*	0.149	0.046
	(0.268)	(0.463)	(0.229)	(0.224)	(0.431)	(0.308)	(0.156)	(0.312)
Comfort (res.)	-0.328	-1.208***	0.135	-0.961***	-0.886	-0.087	-0.744***	-0.453
	(0.239)	(0.309)	(0.185)	(0.213)	(0.754)	(0.238)	(0.157)	(0.311)
Sustainability (res)	-0.188	0.995***	-0.098	0.834***	0.335	0.931***	0.562***	0.980***
	(0.318)	(0.296)	(0.252)	(0.217)	(0.633)	(0.341)	(0.153)	(0.289)
Traffic Congestion	4.199	11.099***	-4.325	2.975	14.316**	-13.909***	-2.278	-6.441
	(4.184)	(4.144)	(5.090)	(3.828)	(6.490)	(5.085)	(1.890)	(6.157)
Distance	0.074**	0.093**	0.012	0.088***	-0.638*	-0.010	0.024***	-0.101
	(0.031)	(0.045)	(0.023)	(0.021)	(0.343)	(0.016)	(0.007)	(0.062)
Public Availability	0.262	1.964*	-0.025	0.688***	0.324	-0.212	0.351**	0.123
	(0.301)	(1.016)	(0.211)	(0.203)	(0.454)	(0.295)	(0.140)	(0.254)
Private Availability	-0.917	-2.714***	-1.000**	-2.852***	-1.544**	-1.832***	-2.514***	-1.809***
	(0.560)	(0.545)	(0.456)	(0.480)	(0.730)	(0.560)	(0.266)	(0.481)
Pollution	-0.005	0.002	-0.003	0.005*	0.076	0.001	0.007***	0.012
	(0.005)	(0.005)	(0.004)	(0.003)	(0.062)	(0.004)	(0.002)	(0.009)
Constant	7.549*	-4.661	8.765**	11.617***	-28.919	8.720*	4.511***	-1.447
	(3.856)	(7.372)	(3.593)	(2.938)	(28.130)	(5.243)	(1.250)	(3.787)
Observations	117		250			460		
Pseudo R-squared	0.427		0.463			0.360		

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Robust standard errors are in parenthesis.

5.1. Policy implications

To understand the policy implications of the results of this study, it is important to emphasize those variables that influence university students and their travel mode choices. Given the strong impact of distance and parking lots as determinants of private transport, policymakers use these findings to enhance sustainable transport. Indeed, because a scarcity of parking spaces available to students would lead to a greater use of sustainable transport modes, dedicating one

squared kilometre for residential use would decrease the probability that students drive alone to the university by 4.5%, and increase the number in favour of public (+6.0%) and active (+1.5%) modes of transport.

Additionally, public availability and the ecological importance of the means of transport positively influence the sustainable transport mode choices of buses and trains with respect to cars at all three university locations. Because public transport availability plays an important role in determining the use of sustainable transport, providing a better public transport service would reduce the use of cars by 5.5%, increasing the probability of using busses or trains by 7.6%. Furthermore, based on the importance of the *Sustainability* attitude, informing students about environmental issues would help to increase the proportion of all sustainable transport modes (+5.1% and +1.1% for public and active mode, respectively), thus decreasing private transport usage by 5.8%. Addressing specific sustainable programmes on this topic would have an impact in the short term, influencing students' choices of transport to the university, and in the long term, because students are recognized as 'future transport decision makers' (Kim et al., 2016). Interestingly, the results also suggest that improving the public transport service and promoting sustainable transport mobility have different impacts when considering the campus areas separately. In the case of faculties located in the city centre and in the historical hamlet, an improved public transport service would lead to a reduction in private mobility of 3.3% and 5.3% respectively. In the case of the industrial district, this decrease is 9.5%. These outcomes should not be neglected by policymakers, who should consider increasing the bus service networks towards areas located further from the city centre.

6. Conclusion

Our work sheds light on the factors affecting the choice of sustainable transport modes of students attending a growing Italian university, namely, the University of Bergamo. Because investigating people's attitudes is considered crucial in transport mode choice studies, this study performs a two-step analysis in order to develop policy suggestions that address the promotion of sustainable transport modes (e.g. Bopp et al., 2011; M.V. Johansson et al., 2006; Schwanen and Mokhtarian, 2005). First, three transport features that may influence students' mobility (*Safety*, *Comfort*, and *Sustainability*) are identified and analysed to understand which individual and local characteristics impact students' stated preferences. Second, the unexplained values of *Safety*, *Comfort*, and *Sustainability* are used to estimate the probability of choosing a private or a sustainable (shared, public, or active) transport mode to travel to university. This two-step analysis allows the authors to disentangle the components of students' stated preferences into 1) attitudes strictly related to students' individual characteristics and experiences, and 2) 'intrinsic attitudes'.

The results show that, in terms of stated preferences, students are more interested in the safety and the ecology of the transport mode if they experience a more polluted environment. Interestingly, differences emerge across attended faculties; engineering and law & economics students consider *Sustainability* (*Comfort*) to be less (more) important than humanities students do. The results of the coefficients of students' intrinsic attitudes in the second step of the analysis show that in a growing university, with campuses located in different areas, the higher the propensity towards comfort, the lower the probability is of choosing a sustainable transport mode. In contrast, the more students there are who care about the sustainability of a means of transport, the more they travel by carpooling, buses, trains, or active transport. The main factors that increase students' choices of private modes are distance and parking lot availability. Oppositely, both public availability and the ecological importance of the means of transport

have a positive effect on the sustainable transport mode choices of buses and trains, with respect to cars, at all three university locations.

This study shows that informing students about environmental issues helps to increase the proportion of all sustainable transport modes, driving a decrease in private transport usage. Additionally, improving the public transport service may have a significant impact, especially when considering the campus areas individually, up to a decrease in private transport choice of 9.5%.

This study does not come without limitations that offer avenues for future research. Although the structure of the transport infrastructure around the University of Bergamo has not radically changed during the period under investigation, implementing a longitudinal set of surveys might provide similarities and differences with our results, while exploring the changing behaviour of students over time. Furthermore, along with the pressure on local policymakers with regard to cost-effective policies, and on university managers who need to attract students from different locations (and other countries) at the highest level of accessibility, it would be intriguing to examine the variation in students' transport mode choices when simulating a different scenario, that of aggregating all the university campuses in a single location in the city centre.

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[1] Further information is available at https://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en.
[2] Data are gathered from the Ministero dell'Istruzione, dell'Università e della Ricerca (http://statistica.miur.it).
[3] The survey question on transport mode choice: '*Which means of transport do you use to go to university?*'.
[4] According to Smith (1979), a sample size (N) is considered reasonable when the number of respondents is higher than $n = Z^2 \cdot S^2 / d^2$, where Z is the normal variate, equal to 1.645 for a confidence interval of 90%; d is the accuracy level, usually set at 5%; and S is the standard deviation. The value of S is equal to $\sqrt{p \cdot (1 - \mathrm{p})}$, where p is the estimated transit rate of students in the Bergamo area, which according to the ISTAT (Istituto Nazionale di Statistica) commuting data set of 2011 is around 0.50. Given that n is 271, the study sample size is sufficiently large to estimate the transport mode choices of students at the University of Bergamo.
[5] To evaluate whether the multinomial logit regression can be used, the independence of irrelevant alternatives (IIA) condition is tested, which has to be met when using this model (e.g. Greene, 2012). The results of the Hausman–McFadden test show that the null hypothesis H_0, which states that the odds (alternative/outcome j vs alternative/outcome k) are independent of other alternatives, cannot be rejected and, therefore, the condition is satisfied.
[6] The same approach is used as that in Pollock, Chen, Jackson, & Hambrick et al. (2010).
[7] Although cost is recognized as one of the main variables influencing people's transport mode choice, it is omitted from this analysis. There are two reasons for this. First, cost would be strictly correlated with distance, especially for private and shared transport alternatives. Secondly, public transport for students of the University of Bergamo has a fixed price of 200€ per year. Given the lack of information about trip frequency, this makes it difficult to uniformly compute a unitary cost.
[8] Hereafter, all comments should be interpreted in relation to the reference case, that is, the private transport mode.