The role for carsharing in medium to small-sized towns and in less-densely populated rural areas

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ABSTRACT

The recent strong growth of carsharing (CS) has taken place worldwide mainly in the large cities. We discuss whether there is a potential role for CS in medium to small-sized towns and in less-densely populated rural areas. In large cities CS is provided by large profit oriented firms, capable of offering efficient and flexible services, using the most advanced technologies with highly differentiated and customized prices. In lower density areas and small-to-medium size cities the challenges are much greater. The lower demand resulting from a complex of unfavorable factors (higher car ownership level, larger parking availability, low public transport service, fewer or absent taxi service and so on) requires a different business model for the provision of CS: more socially oriented, with a greater involvement of local municipalities and public transport operators to offer a service, most likely at favorable prices. The paper reports the results drawn from a survey on the potential demand for CS conducted in the Friuli Venezia Giulia region, Italy, a region characterized by small-sized towns and less-densely populated rural areas where CS is not currently offered. It is found that there is a not negligible demand (3.7% of the population holding a driving license) and that the likely users would be the ones that are better informed about CS, environmentally conscious and young. They would be more frequent among students or unemployed people, rather than among professionals, as in the more urban environments. It is also found that CS would mostly be used for non-commuting and longer trips.

1. Introduction

This paper discusses whether there is a potential role for Carsharing (CS) also in medium to small-sized towns and in less-densely populated rural areas. Although so far CS has proven to be a successful alternative to the private car in large cities, there is most likely a need for the introduction of this service also in smaller towns and rural areas. The scarce literature so far devoted to this topic (Perschl and Posch, 2016) has pointed out that CS in lower density areas is likely to face greater challenges than in large cities, mainly because the lower demand makes a profit oriented CS supply unviable.

This paper, having reviewed in Section 2 the recent trends in the CS demand and the main business models implemented, in Section 3 discusses the main challenges of implementing a CS service in low-density areas. The remaining part of the paper is devoted to presenting the results of a research focused on the potential demand in the Friuli Venezia Giulia (FVG) region, Italy, a region characterized by medium to small-sized towns and low-densely populated rural areas where the carsharing service is not provided yet. Section 4 describes the region. Section 5 reports an estimate of the potential CS demand, distinguishing by city size. Section 6 summarizes the results of an econometric analysis aimed at identifying the characteristics of the potential CS users in the FVG region.

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2. Recent carsharing trends and business models

CS has exhibited high growth rates in many countries. Recent estimates for the Americas report that "as of January 1, 2015, there were 20 active programs in Canada, 23 in the United States (U.S.), one program in Mexico, and one in Brazil, totaling approximately 1,529,811 CS members sharing 22,134 vehicles." (Shaheen et al., 2015). As of May 2015, Car2go, a subsidiary of Daimler AG which started operating in Germany in 2008 and which is probably the largest CS company in the world, operates over 13,000 vehicles with over 1,000,000 customers. As of February 2016, Car2go provides CS services in 30 cities worldwide (Austin, Düsseldorf, Hamburg, Vancouver, San Diego, Amsterdam, Vienna, Madrid, Washington, D.C., Portland, Oregon, Berlin, Toronto, Calgary, Cologne, Stuttgart, Seattle, Minneapolis–Saint Paul, Columbus, Denver, Munich, Milan, Montreal, Rome, Florence, Frankfurt, New York City, Stockholm, Turin, Arlington in Virginia, and Prato).[1] As it can be seen most cities are large cities (above 400,000 people), with the exception of Prato, Italy (near Florence). Car2go offers exclusively Smart Fortwo vehicles and features one-way point-to-point rentals. Users are charged by the minute, with hourly and daily rates available. The service forgoes the typical centralized rental office, and cars are user-accessed wherever parked via a downloadable smartphone app.

The successful business model run by Car2go, previously tested in various countries (for a history, see Shaheen et al., 2015), was soon adopted by many competitors (DriveNow, Stadtflitzer, Moebius, Choimobi Yokohama, see Shaheen and Cohen, 2015). In Italy, Enjoy, a joint company by Fiat, Trenitalia and Eni, started offering CS services in Milan in December 2013 (either red Fiat 500 or 500 L cars). As of February 2016, they have 644 cars in Milan, 600 cars in Rome, 200 cars in Florence, and 400 cars in Turin. In July 2015, they started offering for sharing 150 Piaggio MP3 scooters in Milan too.

The one-way point-to-point (also termed free-floating) CS system which, at least in Italy, thanks to its flexibility, greatly contributed to its popularity, is not the only business model in use, although it represents the last, technologically most advanced, and economically most successful business model. As often reported, the first reference to CS in print is the Selbstfahrergenossenschaft carshare program that got underway in Zürich in 1948, organized in a housing cooperative and which consisted of a club in which members shared the cost of a car, which was quite a luxury at the time. It was a privately shared service, which was based on friendship and not on official agreements (Schoenbeck et al., 1992; Shaheen et al., 2015).

In fact, several business models are possible, differing in four main aspects: 1) who owns and maintains the car; 2) what the aims of the organization offering the CS service are; 3) which operation model is implemented; and 4) who the targeted users are.

Since in the last decades CS has become a profitable business, most of the CS vehicles available in the modern cities are owned and maintained by a specialized CS firm. Interestingly, in Europe, the main firms offering CS services are subsidiaries of car manufacturing firms (e.g., Daimlers' Car2go, Volkswagen's DriveNow, and Fiat's Enjoy): promoting their own car is seen as an added value to the commercial profit. However, non-profit-oriented private community\organizations (clubs), as in the case of the housing cooperative Selbstfahrergenossenschaft, are also possible albeit nowadays less common.[2] A third possibility is that CS is offered by state-sponsored, municipally-owned companies. In Italy such companies were the ones that launched the first CS services. They are coordinated by the Car Sharing Initiative (ICS, Iniziativa Car Sharing), promoted and financed by the Ministry of the Environment and Territory (Ministero dell'Ambiente e del Territorio)[3] and managed by municipally-owned companies. As of February 2015, ICS coordinates 11 such companies, offering CS in 12 large and medium-sized towns (Bologna, Brescia, Florence, Genoa, Milan, Padua, Palermo, Parma, Rome, Scandicci, Turin e Venice) for a total of 666 cars, more than 22,500 users and 447 parking places. A forth type of company offering CS services are the rail or public transport operators, directly or via subsidiary companies. They operate with cars located close to the train or bus stations, with the aim of providing an extra-service to their users (Steininger and Bachner, 2014). Finally, private individuals might decide to share their own private car with other persons (peer-to-peer CS).

Different providers have different aims. The modern large CS providers operating in large towns view CS as a commercial activity, which should make profits (or at least not lose money). Non-profit oriented, State-supported organizations pursue wider environmental, economic and social aims. For instance, they might want to increase the accessibility of low-income people who do not have the means to buy, park or maintain a private car or a second\third car in the case of larger families. Moreover, these organizations might pursue specific transportation goals, such as reducing parking needs or increasing rail or public transport attractiveness, which is typically the case when CS is offered by transport operators. In fact, these motivations might co-exist and the distinction between profit and social motives might be blurred, as in Italy where the Municipalities invite CS specialized firms, via a public tender, to organize the CS service in their city. They do so for wider environmental, transport-related and socio-economic reasons and use the tender to propose an economically viable deal to private CS firms. Setting the tender, they bargain on the type of cars to be offered (with a recent tendency to require electric cars) and on the rules of parking in the city centers (permissions and costs). If a city has a weak potential CS demand base, it does not cost much to allow CS cars to be parked in the city center (restricted traffic area). This represents an implicit subsidy to CS companies and users. The parking cost differential between parking a private car and parking a CS car can provide a strong incentive to use the CS service.

Operationally, CS is of two main types: roundtrip or one-way. Roundtrip CS means that the user has to collect the car from a CS station (on-street or off-street parking place) and return it to the same station. One-way CS does not require it. One-way CS can be station-based or free-floating. The former requires that the car is left in a parking place belonging to the CS organization. Free-floating

[1] It is no longer active in Ulm, Lyon, London, Birmingham, South Bay, Los Angeles, Eugene, Oregon, Copenhagen, and Miami.

[2] Coop. Car Sharing Trentino (http://www.carsharing.tn.it/)

[3] ICS was created within the Decree dated March 27, 1998 with the aim of supporting the supply of CS services at a local level, to develop a national organizational and technological standard, to reduce the environmental impact of car traffic. In 2005 the financial endowment has been 10 million euros.

CS allows the user to leave the car in any parking place within a given area. The flexibility, the managing difficulty and costs, and the technological requirements differ largely among these operational models, as discussed at great length in the CS literature (e.g., Ciari et al., 2014).

The forth feature which can be used to differentiate among business models are the targeted users. A CS service provider might offer the CS service to everyone that is interested (neighborhood residential). It might set the tariffs targeting specific community members such as low-income families or business employees, acting as a substitute to the firm's own fleet by providing group tariffs or specific cars. It might tailor its service to specific groups (tourists, students, hotel guests); or, finally, it might set up a service specifically designed and offered to rail or public transport users. Of course, there might be an overlap among the various users.

A further possible fifth aspect, which could be used as a criterion to define the business models, is the distance that a CS car can make or the geographical area of the CS service. We decided not to specify this because it represents a defining difference between CS and car rental. CS is mostly a short-term, short distance use of a rented car, whereas car rental is convenient for long-distance, multiple-days use.

Table 1 provides an illustration of how the proposed criteria apply to some common CS business cases.

Table 1
Common CS business cases.

Who owns and maintains the car	Profit-oriented CS firm	University- sponsored CS	Municipally-owned company	Rail or public transport operators	Non-profit-oriented private community	Private person
Operational model	Roundtrip or one-way (station-based or free-floating)	Station-based roundtrip	Station-based roundtrip	Station-based roundtrip	Station-based roundtrip	Roundtrip
Targeted users	Everybody	Students and employees	Everyone	Public transport users	Community members	Friends
Aims	Profit, advertising	Environmental, parking, accessibility, transportation goals	Environmental, economic and social	Increase public transport attractiveness	Environmental, economic and social	Economic
Known examples	Car2Go, Enjoy, Autolib, MultiCity, DriveNow	e-vai (Univ Padua); Io-guido (Univ. Parma); Zipcar (Yale, Stanford, Berkeley)	ICS (Italy), Coop. Car Sharing Trentino	e-vai (Milan), Flinster DB (Germany)	Selbstfahrer-genossenschaft (Zurich, 1948)	P2P

The second column identifies the most successful CS models recently implement in many cities worldwide. Although such a model is mostly privately operated, at least in the Italian case, the municipalities have played a decisive role in promoting and financing such a model. Columns 3–5 list four business models in which State- or municipally-controlled or at least partially public-financed organizations help promoting and organizing CS. The last two columns report mostly privately-run and non-business oriented CS, among a group of private people or just between two persons, with social and economic motives.

But carsharing providers have not experienced only successful business stories, the most cited causes of failure being: poor financial management and planning, inadequate marketing, lack of support from local governments, and too small project scale, rather than vehicle utilization or customer convenience.

3. CS in the low-density areas

As the CS literature documents, most of the growth of CS has so far taken place in large cities. Such growth has not only been quantitatively very important, but the CS service has also improved over the years, as competition has put a pressure on prices and increased vehicle differentiation.[4]

The open question we would like to discuss in this paper is, however, whether there is a potential role for CS also in the medium to small-sized towns and in the less-densely populated rural areas.

In order to understand the geographical scale of the issue, let us review some statistics. It is estimated that in 2010, urban areas are home to 3.5 billion people, or 50.5% of the world's population (United Nations, 2011). OECD distinguished between small urban areas, medium-sized urban areas, metropolitan areas and large metropolitan areas, providing the following statistics. In the OECD[5] countries 10.1% of the population lives in small urban areas, 21% in medium-sized urban areas, 15.9% in metropolitan areas and 49.7% in large metropolitan areas. The percentages for Italy show a more dispersed distribution of the population: 19.3%, 21%, 15.9% and 44%, respectively. Colleoni (2016) breaks down the Italian figures distinguishing by municipality size. Based on Census data, he reports that in Italy 55.7% of the population lives in municipalities with less than 30,000 inhabitants, 29.5% in cities with between 30,000 and 250,000 inhabitants, and only 14.8% in cities with more than 250,000 inhabitants. We prefer Colleoni's statistics

[4] Nowadays, CS companies offer vehicles of various types, sizes and technologies such as: the very small and compact cars like the electric Renault Twizy (Bee in Naples); the electric and gasoline Daimler Smart; the gasoline Fiat 500; the Renault ZOE (Palermo); the Nissan Leaf (Bari); and the Bolloré Bluecar (Paris, Indianapolis, London, Turin, Rome), the Volkswagen Up!. Prices are increasingly more differentiated and customized (offering discounts to special groups like women or low-income persons) and even free service covered by advertising, as recently experimented (WaiveCar in Los Angeles, California).

[5] https://data.oecd.org/popregion/urban-population-by-city-size.htm#indicator-chart. Accessed February 2nd, 2016.

because CS is promoted and organized at municipality level. A large metropolitan area, estimated by OECD to comprise in Italy 44% of the population, consists, in reality, in an agglomeration of several municipalities. The CS services are offered only in the central municipalities. For instance, Milan is part of a metropolitan area of 7,528,000 people comprising 858 municipalities over an area of 8054 square kilometers. The area within which a CS vehicle can be parked in the free-floating service is restricted to the central municipalities, or with a surcharge in the semi-peripheral municipalities. Consequently, in Italy, considering the towns with less than 250,000 inhabitants and the peripheral municipalities of the large metropolitan areas, about 85% of population are not yet offered a CS service.

From a transportation point of view, the low-density areas have some specific characteristics which have both favorable and unfavorable implications for CS demand (Table 2).

Table 2
Characteristics of the low-density areas and their implication for CS use.

Characteristics	Implications for CS
Alternative to cars:	
• Public transport (PT, intercity bus or train): lower supply, lower frequency, distant intercity bus stops or train stations with the need to walk or to be offered a car ride from the point of departure\to the point of final destination, lower levels of service or no service on non-working days. As a result, low ridership and high cost per user	CS service needed, possible complementarity to PT
• Walking or biking: distances could be unfeasible	Favors CS demand
• Taxi: not available or very costly	Favors CS demand
• Dial-a ride services: sometimes available	Favors CS demand
Higher use of cars: high car ownership levels, high car modal share	Lowers CS demand
Parking is less of a problem	Lowers CS demand
Share of low-income families: higher or lower than in city centers?	CS demand needed?
Longer distances for working or school trips	Favors CS demand
Accessibility issues	CS needed

Let us first consider the modes of transport alternatives to the private car. Public transport, either in the form of intercity buses or trains, has a lower level of service. Trains or buses have lower frequency, the distance between bus stops (train stations) is longer than in more densely populated areas, the PT users need to walk to the bus stop (train stations) or to be offered a car ride from the point of departure (home, work) to the bus stop (train stations). Sometimes, no PT service is offered on non-working days. These factors contribute to generating low ridership, low occupancy rates and high costs per user. Growing residential and commercial dispersion levels make PT economically more unsustainable and less appealing to the users.

With regards to other modes of transport, walking or biking in low-density areas, because of longer distances and times, could be unfeasible. The taxi service could be unavailable or too costly, and the dial-a-ride service is only seldom organized, depending on PT budgets. As a consequence, CS might be a better solution to other-than-car alternatives. CS as a complement to the PT service might also be a viable solution.

However, the empirical evidence is that the families living in low-density areas have higher private car ownership levels and rely more on car use than the families located in the city center, since the housing choice is jointly made with the mode-of-transport choice, as the land use-transport literature has well documented. As a result, the vast majority of the people living in the low low-density areas might not be interested in using a CS service. Moreover, parking is less of a problem in these areas, as private garages or on- and off-street parking are more abundant. Two final features might, however, play a role in favor of CS in the low-density areas: the share of low-income families and the accessibility issues connected with the longer distances for working or school trips. Low-density areas very much differ in terms of income: some areas are the preferred location of the wealthy families, others host low-income families, for instance, in public housing. The latter might be in need of a CS service, as an alternative to the first, second or third car. It might make sense for the municipality to offer a CS service in order to lessen the accessibility issues of the low-income population in a more economical way. A social aim, together with the environmental, transport and economic motive, might motivate the municipality to organize a CS service.

A case in point, in Italy, is the organization of a CS service in the Trento area. Starting in 2009, the Cooperative Car Sharing Trentino offers a CS service in Trento (10 cars, 117,000 inhabitants), Rovereto (3 cars, 39,000 inhabitants), Riva del Garda and Levico (1 car each, 16,000 and 7800 inhabitants). The main members are a public transport operator for the entire Trento province, Trentino Trasporti spa, a company named Trentino Mobilità that manages parking lots and offers bike and CS services, and a grassroots association active on ecological issues, Trentino Arcobaleno. Supporting members are the University of Trento, the Museum of Science, and various municipalities, local banks and trade associations. The service is used by 100 private users and 30 firms (with potentially 400 users). The CS service is steadily growing, reaching 3000 trips in 2015. The tariffs are very affordable: between 2 to 7 Euros per hour (free or 1 euro at night) depending on the car, against a commercial rate which ranges between 15 and 17 Euros per hour in Milan. The cars are also available for the tourists visiting the areas.

To conclude, setting up a CS service in low-density areas poses many challenges. Given the high private car dependence of the population and the characteristics of these areas, the demand for CS is most likely to be low. At the same time, and somewhat conflicting with the previous statement, some segments of the population (low-income families, infrequent car users) would probably benefit from such a service on economic and accessibility grounds, given the scarce and costly possibilities of offering a satisfactory

PT service. In other terms, there is an unsatisfied demand which the regular market forces would not serve since the profit-oriented CS providers would not enter such a market. Municipalities and cooperatives might, consequently, be interested in stepping in mainly for economic and social reasons, providing a CS service for such most likely "thin" demand.

As a consequence, we expect that in low-density areas, the only viable business model could be station-based, run by municipalities or public companies on social grounds, subsidizing CS tariffs (but saving on PT supply), and complementary to the PT service.

As for the users, we expect them to belong to low income families, having mostly economic motivations, making longer trips, most likely for non-commuting purposes (when the PT service is less frequent and the destinations are more dispersed). The empirical analysis will help us test our expectations.

The issue of offering a CS service in small and medium towns and in low-density areas has insufficiently been researched. Interestingly exceptions are Steininger and Bachner (2014) who explore the possibility that a rail company offers (electric) cars to commuters in order to allow them access from their home to the nearest train station, and, at the same time, organizes the day use of the car by businesses such as postal services or mobile health care. They evaluate the costs, market potential, and environmental merits of this concept for Austria and find that the potential market is likely to be of sufficient interest for a national rail company to offer such a service. Perschl and Posch, 2016, specifically discuss the challenges of introducing a CS service in rural areas. They conducted interviews with experts, analyzed some successful case studies and concluded that the development of the right business model for the region under consideration is crucial.

In the following sections we present the results of a field research performed in Friuli Venezia Giulia, a region located in the northeast of Italy with a quite disperse population distribution where the carsharing service is not offered yet. The aim of the research was: a) to estimate the potential demand for CS and its distribution relative to the size of the municipality; and b) to analyze who would be the users who would take advantage of the CS service, if it were offered.

4. The Friuli Venezia Giulia case study

The Friuli Venezia Giulia (FVG) region is located in the northeast of Italy, bordering with Austria and Slovenia. The FVG region has 1.229 million inhabitants, living mostly in small to medium-sized towns. There are 4 provincial towns: Trieste (the capital), Udine, Pordenone and Gorizia. Trieste is the largest town in the region. Although it is the 15th largest Italian city (Rome and Milan being the only ones having more than one million people, and Naples, Turin, Palermo and Genoa being the ones with more than 500,000 inhabitants), Trieste is quite densely populated, with 2485 inhabitants per square-km (the 12th most densely populated Italian city). Compared with the remaining provincial towns, Trieste enjoys a much larger PT supply and a lower of car density. Because of these characteristics Trieste has a much larger share of people commuting to work or to school using PT.

The population distribution of the FVG region by city size is the following: Trieste has 17% of the population, Udine 8.1%, Pordenone 8.1%, the towns with a population between 25,000 and 50,000 inhabitants host 5.1% of the population (Gorizia being one of them). The remaining 65.5% of the population live in towns or villages having less than 25,000 people. It is, hence, fair to conclude that the population of the region is quite dispersed over the territory, with only Trieste having the features which could be favorable to a CS service. CS is, however, not offered in any of the towns of the FVG region.

In a previous paper (Danielis and Rotaris, submitted) we reported the details of a research project devoted to estimating the potential demand for CS in the FVG region, since actually the service is not provided. Building on the literature (particularly, Schuster et al., 2005, and Duncan, 2011), we developed a methodology that estimates the probability that a person would use CS accounting for the fact that: a) each person uses many modes of transport to satisfy his\her mobility needs; b) a person may sometime travel with friends and family; and 3) there are many nonmonetary and time cost\benefits affecting the decision to use CS.

We assume that the mobility pattern of each person is determined by the individual specific mobility needs and has a generalized cost (GC) that depends on the mix of transport modes used. It is also assumed that a person will use CS (and would give up or not buy a private car) if the GC of the mobility pattern including CS, but without the private car, is smaller than the GC of the mobility pattern in which CS is not available, which is the current scenario in FVG region. Since the value of some components of the GC are unknown, a Monte Carlo simulation technique is used to estimate the GC of the two scenarios at the individual level. 10,000 simulation runs are performed for each individual. The percentage of times that the GC of the scenario including CS is higher than the GC of the current scenario is assumed to represent the probability that such a person would use CS.

In order to collect the needed information to implement the methodology, three distinct surveys were carried out.

- Survey 1: a detailed computer-assisted interview, administered to 50 persons.
- Survey 2: a contingent valuation interview focused only on the Willingness To Pay\Willingness To Accept evaluation of the intangible components of each transport mode. We collected about 223 interviews.
- Survey 3: a paper-and-pencil questionnaire focused on the mobility patterns. We collected about 1276 interviews.

The latter were collected during 2014. The sample comprised individuals aged between 18 and 25 years (49%), between 26 and 65 years (43%), and over 65 years (8%), almost equally distributed between women (54%) and men (46%).

The description of the models used to study the socio-economic characteristics of the potential CS users and of the main results obtained is reported in the next Section. The detailed description of the content of the interview and of the econometric results is reported in the Appendix.

4.1. The potential demand for carsharing in FVG

As reported and discussed in detail in Danielis and Rotaris (submitted), it is estimated that, in absolute terms, only slightly fewer than 40 thousand people (30,481 + 8311) have a probability higher than 50% to become CS users in FVG (Table 3).

Table 3
Probability of being a CS user for the FVG population (above 18 years old).
Source: Danielis and Rotaris (submitted).

	Number of persons	%
Zero probability	621,428	59.9
Probability less than 25%	195,523	18.9
Probability between 25% and 50%	181,425	17.5
Probability between 50% and 75%	30,481	2.9
Probability between 75% and 100%	8311	0.8
Total	1,037,168	100

They correspond to 3.7% of the population holding a driving license, an estimate that we consider realistic and that is much lower than the ones reported in the literature for the metropolitan areas. In fact, in a pioneering paper Schuster et al. (2005) estimate that in Baltimore, Maryland, the percentage of cars that would be cheaper to share rather than to own range from 4.2%, for the traditional neighborhood CS model, to 14.8%, for a commuter-based CS model. In a city of a million people, assuming a 50% car ownership ratio, it would range between 21 and 74 thousand shared cars. Duncan (2011) estimates the market potential of CS, defined as its ability to provide cost savings to those who adopt it in favor of car ownership, in the San Francisco Bay Area. He estimates that a third of Bay Area households, that is more than 800,000 households, have at least one car with a usage pattern that is economically compatible with CS.

Grouping the estimates by town size (Table 4), Danielis and Rotaris (submitted) find that Trieste, as expected, is more prone to use CS. The number of people having a higher than 50% probability of benefitting from giving up the car and becoming a CS user is equal to 5.6% of the town's population, higher than the 3.7% regional average, corresponding to 7961 people. Quite surprisingly, however, also some residents living in the towns with less than 20 or 50 thousand inhabitants have also a higher than 50% probability of becoming CS users. They represent 3.8% and 4.9% of the population, respectively. In absolute terms, they are 29,000 people. The towns of Udine and Pordenone, on the contrary, have very few or no people which are very likely CS users.[6] In summary, these findings suggest us that there is a potential demand for CS: 1) in Trieste, as expected, estimated at 5.6% of the driving population; 2) but also in the municipalities with less than 50,000 inhabitants, estimated to be between 3.9 and 4.9%.

Table 4
Probability of being a CS user town size – values in %.
Source: Danielis and Rotaris (submitted).

	Town size[a]					Total
	< 20 th.	20–50 th.	Pordenone	Udine	Trieste	
Zero probability	61.2	69.1	66.5	59.1	49.1	59.9
Probability less than 25%	17.3	11.2	21.0	22.8	25.4	18.9
Probability between 25% and 50%	17.7	14.8	12.5	16.1	20.0	17.5
Probability between 50% and 75%	3.1	2.4	0.0	2.0	4.2	2.9
Probability between 75% and 100%	0.7	2.5	0.0	0.0	1.4	0.8

[a] The cities of residence of the respondents are subdivided into 5 groups: less than 20 thousand inhabitants, between 20 and 50 thousand inhabitants, Pordenone (51 thousand inhabitants), Udine (100 thousand inhabitants) and Trieste (the largest town, with 209 thousand inhabitants).

The next section will report the results of an econometric analysis of the socio-economic and transport-related characteristics of the potential CS users in the FVG region.

4.2. The potential users in the FVG region

The literature describing the socio-economic characteristics of the carsharing users is now abundant,[7] as described by Jorge and Correia (2013) and Ferrero et al. (2015). It is frequently found that users are typically self-employed, with an income level below

[6] In the case of Udine and Pordenone there appears to be a significant difference between the stated willingness to use CS and the one estimated by our model based on the estimated generalized cost of their mobility choices.

[7] Recent contributions are: Cervero et al. (2007), Transit Cooperative Research Program (2005), Douma and Andrew (2006), Burkhardt and Millard-Ball (2006), Loose (2010), Sioui et al. (2010), Martin and Shaheen (2011), Costain et al. (2012), Habib et al. (2012), Coll et al. (2014), Kim et al. (2015), Lang (2015).

average, aged between 25 and 44, and have a graduate education and a higher environmental awareness (Schaefers, 2013). The household size is generally less than the average and the number of cars available per household is typically below average.

The collected sample allows us to identify who the potential users of a CS service would be in the FVG region. Four models have been estimated identifying: (1) the willingness to use CS if available; (2) the potential use of CS for commuting; (3) the potential use of CS for non-commuting trips if the private car were unavailable; (4) the probability of using CS.

4.2.1. *Willingness to use the carsharing service*

Using as the dependent variable a discrete variable with values between 1 and 5, according to the willingness to use the CS service ($WUCS_j$) stated by each individual, and as explanatory variables the socio-economic characteristics collected during the interview, an ordinal logit model was estimated. The cumulative probability C_{ij} that each individual *i* states each of the *j* discrete values $WUCS_i$ that is

$$C_{ij} = Pr(WUCS_i \leqslant j) = \sum_{k=1}^{j} Pr(WUCS_i = k)$$

can be modelled as a cumulative logit that is as a linear function of γ independent variables:

$$\text{logit } C_{ij} = \log(C_{ij}/(1-C_{ij})) = \alpha + \Sigma b^{*} x_{\gamma}$$

The specification of the estimated ordered model follows:

$WUCS_j$ = one + b_{AGE}*AGE + $b_{RETIRED}$*RETIRED + $b_{UNEMPLOYED}$*UNEMPLOYED + b_{TS}*TRIESTE + $b_{N.COM}$*N.COMMUTING + b_{TRIPS}*TRIPS + $b_{N.NON\_COM}$*N. NON-COMMUTING TRIPS + b_{ENV}*ENV.SENSITIVITY b_{CS_KNW}*CS_KNOWLEDGE.

4.2.2. *Hypothetical change of modal split of commuting trips*

A conditional logit model is estimated using as the dependent variable a binary variable (CS_COMMUTING) that is equal to 1 if the respondent states that, if the private car were unavailable for commuting trips, the CS service would be used at least once. To estimate the model the outliers and the observations collected from non-commuting individuals (retired, housewife, unemployed) have been excluded, that is why the sampled observations used are 1125.

The following specification of the utility function of using CS (U(*USING CS FOR COMMUTING*)), rather than alternative transport mode (U(*NOT USING CS FOR COMMUTING*)) has been used:

U(NOT USING CS FOR COMMUTING) = α*one

U(*USING CS FOR COMMUTING*) = b_{STU}*STUDENT + b_{DRL}*DRIVER_LICENSE + b_{NCH}*N.CHILDREN + b_{TS}*TRIESTE + b_{CTR}*N.COMMUTING TRIPS + b_{CD}*COMMUTING_DIST + b_{CSK}*CS_KNOWLEDGE.

4.2.3. *Hypothetical change of modal split of non-commuting trips*

A conditional logit model is estimated using as the dependent variable a binary variable (CS_NON_COMMUTING) that is equal to 1 if the respondent states that, if the private car were unavailable for non-commuting trips, he would use the CS service at least once. All the observations collected have been used to estimate the model, except 5 observations for which the status of the individual is missing.

The following specification of the utility function of using CS (U(*USING CS FOR NON-COMMUTING*)), rather than alternative transport mode (U(*NOT USING CS FOR NON-COMMUTING*)) has been used:

U(NOT USING CS FOR NON-COMMUTING) = one

U(*USING CS FOR NON-COMMUTING*) = b_{AGE30_60}*AGE_{30_60} + $b_{AGE>60}$*$AGE_{>60}$ + b_{STU}*STUDENT + b_{EMP}*EMPLOYED + b_{TS}* TRIESTE + b_{ENV_SENS}* ENV.SENSITIVITY + b_{CS_KNW}* CS_KNOWLEDGE + $b_{N.COM\_TRP}$* N.COMMUTING $TRIPS_{<6}$ + b_{DST26_50}*DISTANCE_26_50 + b_{DST51_100}*DISTANCE_51_100 + b_{DST101_200}*DISTANCE_101_200 + $b_{DST>200}$*DISTANCE_ > 200.

4.3.3. *Socio-economic determinants of hypothetical change of modal split of non-commuting trips*

An ordinal logit model has been specified using as the dependent variable the estimated probability of choosing a CS ($PROB\_CS_j$) service expressed via five classes: "Class 0" if the individual stated that he would never use the CS, "Class 1″ if the estimated probability of using the car sharing is between 0 and 25%," Class 2″ if the estimated probability is between 26% and 50%," class 3″ if the estimated probability is between 51% and 75%, "Class 4″ if the estimated probability is greater than 75%. The model has been estimated on the basis of 1175 observations due to missing data or outliers that have been excluded from the original database.

The specification of the estimated ordered model follows:

$PROB\_CS_j$ = one + b_{AGE30_60}*AGE_{30_60} + $b_{AGE>60}$*$AGE_{>60}$ + $b_{N.CH}$*N.CHILDREN + b_{DR_LC}*DRIVER_LICENSE + b_{TS}*TS + b_{ENV}*ENV.SENSITIVITY b_{CS_KNW}*CS_KNOWLEDGE

The detailed discussion of the results obtained for each model can be found in the Appendix. A summary of the results is reported in Table 5.

Table 5
Socio-economic determinants of potential demand of CS: summary.

	Willingness to use CS	Use of CS for commuting	Use of CS for non-commuting	Probability of using CS
CS knowledge	Positive sign	Positive sign	Positive sign	Positive sign
Environmental awareness	Positive sign		Positive sign	Positive sign
Age	Negative sign		Negative sign	Negative sign
Status	Retired (−) Unemployed (+)	Student (+)	Student (+) Unemployed (+)	
N. children		Positive sign		Positive sign
N. driver license		Positive sign		
N. car/N. driver license				Positive sign
Trieste	Large (+)	Large (+)	Large (+)	Large (+)
N. trips	Positive sign	10–20 (+)	Positive sign	
Distance travelled		> 25 km (+)		

One of the factors that seems to most affect the potential for CS in the FVG region is the degree of knowledge of CS. Regardless of the potential demand indicator and of the model specification used, the willingness to opt for CS as an alternative to a private car increases, the higher is the level of knowledge of what CS is. This result is in line with most of the studies analyzing the factors influencing the CS demand with respect to both the actual services (Loose, 2010; Kim et al., 2015; Lang, 2015) and those not yet in place (Zheng et al., 2009; Efthymiou and Antoniou, 2013).

Environmental awareness is also an important determinant, confirming the results obtained both studying the actual demand (Burkhardt and Millard-Ball, 2006; Loose, 2010; Costain et al., 2012; Kim et al., 2015; Lang, 2015) and on the potential demand (Zheng et al., 2009; Efthymiou and Antoniou, 2014). On these bases it is possible to foresee that initiatives aimed at promoting and describing the lower environmental impact of CS in the FVG region (fairs, conferences, info-point with central nodes of the transport network such as train stations or airports), including real test via fleets temporarily available at urban traffic generators and attractors (universities, hospitals, shopping centers, stations, airports), would increase the willingness to use this mode of transport as an alternative or as a complement to a private car.

The socio-economic characteristics of the potential users also play an important role. Age is an important determinant: older people have a lower propensity to using CS, as documented in almost all of the literature. On the contrary, with regard to the status and the type of activity carried out by the individuals, our results are only partially consistent with those generally reported in the literature. From our analysis, in fact, it emerges that the students would be the most likely users of CS, while most of the studies conclude that the self-employed or the employees as the most probable users. The difference, however, could be explained by the higher discounts of the public transport rates guaranteed to students in the geographical contexts (especially in the US and Canada, see Zheng et al. (2009) relative to the FVG situation. Unemployed people is a further segment of the population which shows an interest in using CS. This is consistent with our expectation that CS could also have social and economic motivations.

According to our analysis the household composition, in particular the presence of children and a family mobility pattern with heavy reliance on private vehicles are also associated to a greater CS propensity. This result is not completely in line with those reported in literature, with the exception of Mariotti et al. (2013) and Kim et al. (2015).[8]

A specific goal of our research was to test the effect of city size and population density on the potential CS use. The econometric analysis has also demonstrated that, as expected, the respondents living in Trieste, the largest city in the region and the one with highest density, have a higher propensity to use CS.

Finally, the characteristics of the individual mobility pattern seem to play a significant role in determining the potential demand for CS: it is higher for non-commuting trips. This expected result, given the characteristics of our sample, has been already highlighted in the literature (Cervero et al., 2007; Zhou et al., 2008; Costain et al. 2012; Kim et al., 2015).

5. Conclusions

The recent strong growth of CS has taken place worldwide mainly in the large cities. However, CS might generate the much praised benefits of providing an alternative to buying and owning private cars, of reducing the need for parking places while at the same time increasing accessibility and PT use also in the small-to-medium size cities and in the lower density areas.

As discussed in the previous section, in the large cities CS is provided by large profit-oriented firms, capable of offering efficient and flexible services, using the most advanced technologies with highly differentiated and customized prices. In the lower density areas and small-to-medium size cities the challenges are much greater. The lower demand resulting from a complex of unfavorable factors (higher car ownership level, larger parking availability, low PT service, fewer or absent taxi service and so on) requires a different business model for the provision of CS: more socially oriented, with a greater involvement of the local municipalities and public transport operators to offer a service, most likely at favorable prices.

[8] They justify this unusual result, on the one hand, by the fact that car users are more prone to use a transport mode that implies driving a motor vehicle, and, on the other hand, with the advantage enjoyed by carsharing users in terms of parking fees and free access to restricted traffic zones if compared to the higher costs and constraints imposed on car drivers.

FVG is a case in point, given its low-density towns and scattered conurbations. In order to understand, in such a region, what the potential demand could be and who the potential users would be, we have performed a field survey. The results have shown that:

- Overall, the potential demand is estimated to be equal to 3.7% of the population holding a driving license: it is a percentage that is lower than in most large cities but still not negligible. As expected, the share is higher in Trieste (5.6%), where more favorable conditions exist, but it is relevant also in the municipalities with less than 50,000 inhabitants (between 3.9 and 4.9%).
- The potential users are the ones that are better informed about CS, the environmentally conscious and the young. They are more common among students or unemployed people, rather than among professionals, as in the more urban environments. They would improve their accessibility and, possibly, jointly use CS and PT. Being part of a larger family with various cars and licenses makes also CS use more likely. We also find that CS is mostly likely to be used for non-commuting and longer trips.

The biggest caveat concerning our research and our data is linked to the hypothetical bias. As in the FVG region no CS service does exist, for the reasons explained above, asking a person whether or not s\he would use CS and under which conditions can be only speculative. Nevertheless, we hope we have provided some new evidence on a very important topic for the promotion of a sharing economy and for the sustainability of the communities located in small-to-medium size towns and lower density areas.

Appendix A. The interview and the descriptive and econometric results

The first part of the interview dealt with the socio-economic characteristics of the respondents such as gender, age, occupation, income, availability of a driving license, number of family members with a driving license, and number of cars in the family. Then, the respondents were asked: to rate on a Likert scale (1 = definitely not, to 5 = definitely yes) their knowledge of what CS is, the likelihood that they would use CS if available, and the importance attributed to the concept of sustainable mobility. In the following sections we report some descriptive results and some econometric analysis on these results.

A.1. Willingness to use the carsharing service

When asked whether they would be willing to use a CS service if available, 66% of the sample stated that they would not use CS (rate equal to 1 or 2), 18% were uncertain (rate 3), while 16% responded they would use it (rate 4 or 5). On the bases of the data collected the ordinal logit model described in Section 4.2.1 has been estimated (see Table 6). Only 1207 observations were used since some outliers were excluded. The statistical significance of the model is acceptable: adjusted Rho^2 of 0.10.[9]

Table 6
Ordinal Logit of the willingness to use the CS service.

	Coeff.	Std.Err.	t-ratio	P-value
ONE	−1.32	0.29	−4.50	0.00
Age: 1 “18 − 25″; 2 ”25 − 65″; 3 “ > 65“ (ordinal)	−0.96	0.11	−8.62	0.00
Retired (dummy)	−1.07	0.42	−2.54	0.01
Unemployed (dummy)	2.21	0.56	3.96	0.00
City size: Trieste (dummy)	0.47	0.12	3.93	0.00
N. Commuting trips: 0 “0″; 1 ”1 − 10″; 2 “11 − 20″; 3 ” > 20“(ordinal)	0.38	0.09	4.19	0.00
N. Non-commuting trips “11 − 20″	0.31	0.13	2.42	0.02
Environmental awareness (ordinal, 1 to 5)	0.49	0.06	8.71	0.00
CS knowledge (ordinal, 1–5)	0.38	0.05	8.41	0.00
Mu(1)	1.45	0.06	24.10	0.00
Mu(2)	2.59	0.08	33.39	0.00
Mu(3)	3.63	0.11	32.38	0.00
McFadden Pseudo R-squared	0.10			
N. Obs.	1207			

All the parameters are statistically significant and have the expected sign. The model predicts the effect that each variable produces on the probability of the willingness to use the CS service (expressed on a Likert scale from 1 to 5).

If, in Table 7, the sign of the marginal effect of one socio-economic variable with respect to a specific level of willingness to use the CS service is negative, it means that the variable reduces the probability that the sample states that level of willingness to use the CS service, and vice versa. If along a row of Table 7 the sign changes from negative to positive, it means that the variable increases the likelihood that the sample is willing to use the CS service and vice versa.

[9] All the models have been estimated using Nlogit 4.0.

Table 7
Socio-economic determinants of the willingness to use the CS service.

	Willingness to use CS from 1 to 5				
	1(no)	2	3	4	5 (yes)
Age: 1 "18–25"; 2 "25–65"; 3 " > 65" (ordinal)	0.21	0.00	−0.10	−0.06	−0.05
Retired (dummy)	0.26	−0.07	−0.10	−0.05	−0.03
Unemployed (dummy)	−0.28	−0.21	0.05	0.17	0.27
City size: Trieste (dummy)	−0.10	0.00	0.05	0.03	0.02
N. Commuting trips: 0 "0"; 1 "1 − 10"; 2 "11 − 20"; 3 " > 20" (ordinal)	−0.08	0.00	0.04	0.03	0.02
N. Non-commuting trips "11 − 20"	−0.07	0.00	0.03	0.02	0.02
Environmental awareness (ordinal, 1–5)	−0.11	0.00	0.05	0.03	0.02
CS knowledge (ordinal, 1–5)	−0.09	0.00	0.04	0.03	0.02

According to our estimates the willingness to use the CS service decreases as the respondent's age increases (discrete variable AGE with 1 representative of the age class "18–25"; 2 of the age class "26–65"; 3 of the age class " > 65") and for those who are retired (dummy RETIRED).

Instead, a positive impact on the propensity to use a CS service is estimated if the individual lives in Trieste (dummy TRIESTE), if the individual is unemployed (dummy UNEMPLOYED) and as the level of sensitivity to environmental issues (discrete variable ENV.SENSITIVITY from 1 to 5) and the level of knowledge of CS (discrete variable CS_KNOWLEDGE from 1 to 5) increase. In addition, the propensity to use CS increases the more frequent the commuting is (discrete variable N.COMMUTING TRIPS having the value 0 for a number of trips equal to 0; 1 for a number of trips in the range 1–10; 2 for a number of trips in the range 11–20; and 3 for a number of trips greater than 20) or non-commuting trips (dummy variable N. NON-COMMUTING TRIPS equal to 1 for a number of trips of between 11 and 20).

A.2. Hypothetical change of modal split of commuting trips

In the second part of the interview, the respondent was asked to fill in information regarding the mobility patterns for daily home-university commuting and non-commuting purposes (recreational, shopping, etc.) reported in Tables 8 and 9.

Table 8
Current mobility patterns (Scenario A_SQ).
Source: Danielis and Rotaris (submitted).

Mode of transport	N° of round trip journeys	Average distance per journey	N° of journeys made with other people	n° of accompanying persons
Current mobility patterns for home-work\college trips during a week				
Car				
Motor bike			Do not fill in	Do not fill in
Bus			Do not fill in	Do not fill in
Train			Do not fill in	Do not fill in
Taxi				
On foot			Do not fill in	Do not fill in
Bicycle			Do not fill in	Do not fill in
TOTAL		Do not fill in	Do not fill in	Do not fill in
Current mobility patterns for other-than-home-work\college trips during a week				
Car				
Motor bike			do not fill in	do not fill in
Bus			do not fill in	do not fill in
Train			do not fill in	do not fill in
Taxi				
On foot			do not fill in	do not fill in
Bicycle			do not fill in	do not fill in
TOTAL		do not fill in	do not fill in	do not fill in

Table 9
Most likely mobility patterns if the CS but not the car were available (Scenario B).
Source: Danielis and Rotaris (submitted).

Mode of transport	N° of round trip journeys	Average distance per journey	N° of journeys made with other people	n° of accompanying persons
Current mobility patterns for home-work\college trips during a week				
Motor bike			Do not fill in	Do not fill in
Bus			Do not fill in	Do not fill in
Train			Do not fill in	Do not fill in
Taxi				
On foot			Do not fill in	Do not fill in
Bicycle			Do not fill in	Do not fill in
Carsharing				
TOTAL		Do not fill in	Do not fill in	Do not fill in
Current mobility patterns for other-than-home-work\college trips during a week				
Motor bike			Do not fill in	Do not fill in
Bus			Do not fill in	Do not fill in
Train			Do not fill in	Do not fill in
Taxi				
On foot			Do not fill in	Do not fill in
Bicycle			Do not fill in	Do not fill in
Carsharing				
TOTAL		Do not fill in	Do not fill in	Do not fill in

As can be seen, the respondents were requested to describe their mobility patterns under two scenarios. Describing the current weekly mobility patterns was not particularly difficult. Filling in Table 9 proved more difficult because the respondents were asked to allocate their current mobility under the hypothetical assumption that they do not have a car and that CS is available. Since CS is not available yet in the FVG region, the respondents asked about the costs, the rules and the availability of the shared cars. The interviewers provided the information available regarding the existing CS service offered in Italy and clarified some doubts, although some uncertainties remained.

The main results are the following. If the private car were no longer available for commuting, but a CS service were offered, it would be used by 17% of the sample. The unavailability of the private vehicle would, in fact, be partially substituted also by the use of public transport (bus, +11%, and train, +4%), motorbike (+5%) and bicycle (+5%) (see Fig. 1).

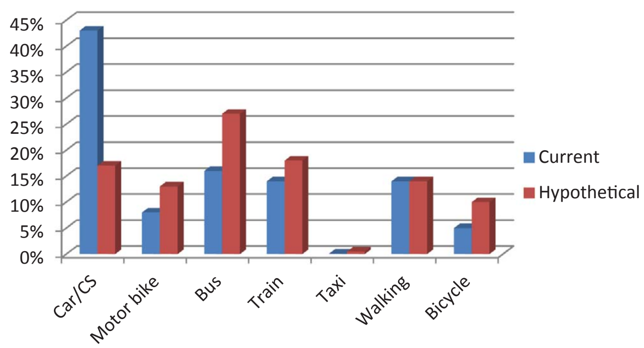

Fig. 1. Current and hypothetical modal split of commuting trips.

The impact of the provision of a CS service would be even larger for non-commuting trips (see Fig. 2). In this case, indeed, if the private car were no longer available, but a CS service were offered, this would be used by 28% of the sample. Also in this case the unavailability of the private vehicle would, in fact, be partially substituted also by the use of public transport (buses +16% and +4% train), motorbike (+7%) and bicycle (+3%).

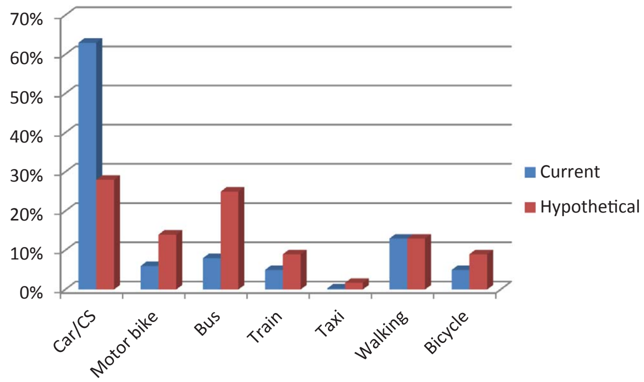

Fig. 2. Current and hypothetical modal split of non-commuting trips.

The relationship between each indicator of the potential demand and the socio-economic characteristics of the individuals has been analyzed in order to identify the determinants of the demand for CS. We split the analysis between commuting and non-commuting trips.

A.3. Socio-economic determinants of hypothetical change of modal split of commuting trips

On the bases of the data collected the logit model described in Section 4.2.2 has been estimated. Since the utility function of not using the CS service contains only a constant, the parameters are to be interpreted as follows: the constant indicates the propensity of not using the CS service, while the other parameters indicate the effect that each socio-economic variable specified in the model produces on the propensity to use the CS service for commuting trips (everything else being equal). The statistical significance of the model is modest: adjusted Rho^2 equal to 0.06, but it is acceptable considering that the explanatory variables used describe only the characteristics of the individuals and not the characteristics of the transport modes among which the individual chooses (see Table 10).

Table 10
Socio-economic determinants of CS use for commuting trips.

	Coeff.	Std.Err.	*t*-ratio	P-value
ONE	2.08	0.30	6.97	0.00
Student (dummy)	0.62	0.15	3.97	0.00
N. Driver license	0.14	0.08	1.79	0.07
N. children < 18 age	0.23	0.10	2.33	0.02
City size: Trieste (dummy)	0.41	0.15	2.77	0.01
N. Commuting trips: 10–20 (dummy)	0.38	0.17	2.24	0.03
Commuting distance travelled: 1–25 (dummy)	−0.93	0.19	−4.88	0.00
CS knowledge (ordinal, 1–5)	0.10	0.06	1.84	0.07
McFadden Pseudo R-squared	0.06			
N. Obs.	1125			

All parameters are statistically significant and have the expected sign. There is a negative effect on the propensity of using the CS service for commuting trips if the trips are short (dummy COMMUTING_DIST equal to 1 if the trip is shorter than 25 km). A positive impact on the propensity to use the CS service is estimated, as the level of knowledge of CS increases (discrete variable CS_KNOWLEDGE from 1 to 5), as the frequency of commuting trips per week increases (dummy variable N.COMMUTING TRIPS equal to 1 for a number of trips between 11 and 20), the larger is the number of household members having a driving license (cardinal variable DRIVER_LICENSE), if there are children younger than 18 years old (cardinal variable N.CHILDREN), if the individual is a student (dummy STUDENT) and if he lives in the city of Trieste (dummy TRIESTE).

A.4. Socio-economic determinants of hypothetical change of modal split of non-commuting trips

On the bases of the data collected the logit model described in Section 4.2.3 has been estimated. The utility function of not using the CS service for non-commuting trips contains only a constant, while the utility function of using the service contains all the other variables. Also in this case, therefore, the parameters are to be interpreted as follows: the constant indicates the propensity of not using the CS, while the other parameters indicate the effect that each socio-economic variable s pecified in the model produces on the propensity to use the CS, everything else being equal. The statistical significance of the model is acceptable: adjusted Rho^2 equal to 0.12 (see Table 11).

Table 11
Socio-economic determinants of CS use for non-commuting trips.

	Coeff.	Std.Err.	*t*-ratio	P-value
ONE	2.7	0.47	5.7	0
Age 30–60 (dummy)	−0.59	0.2	−2.94	0
Age > 60 (dummy)	−1.46	0.4	−3.62	0
Student (dummy)	0.6	0.37	1.63	0.1
Employed (dummy)	0.53	0.33	1.62	0.1
City: TS (dummy)	0.1	0.07	1.54	0.12
Environmental awareness (ordinal, 1 to 5)	0.21	0.06	3.33	0
CS knowledge (ordinal, 1 to 5)	0.23	0.05	4.48	0
N. non-commuting trips < 6 (dummy)	−0.29	0.15	−1.9	0.06
Distance travelled: 26–50 km (dummy)	0.67	0.2	3.29	0
Distance travelled: 51–100 km (dummy)	1.15	0.2	5.86	0
Distance travelled: 101–200 km (dummy)	1.19	0.21	5.62	0
Distance travelled > 200 km (dummy)	1.29	0.23	5.72	0
McFadden Pseudo R-squared	0.12			
N. Obs.	1271			

All parameters are statistically significant and have the expected sign. Most notably there is a negative effect on the propensity to use the CS service for non-commuting trips for older individuals (dummy variables AGE_{30_60} and $AGE_{>60}$ equal to 1 if the individual is aged, respectively, between 30 and 60 years, and if the individual is older than 60 years), and for those who make less than 6 trips per week (dummy $N.COMMUTING\ TRIPS_{<6}$). A positive impact on the propensity to use CS, instead, is estimated for those who live in Trieste (dummy TS), for those who study or work (dummy STUDENT and EMPLOYED), as the level of sensitivity for environmental problems (discrete variable ENV.SENSITIVITY from 1 to 5) and as the level of knowledge of the CS service (discrete variable CS_KNOWLEDGE from 1 to 5) increases. The propensity to use CS increases also the longer the non-commuting trips (dummy variables for each distance class: 26–50 km, 51–100 km, 101–200 km; > 200 km) are.

A.5. Socio-economic determinants of probability of replacing the private car with a carsharing service

On the basis of the data describing the individual mobility pattern it has been possible to calculate both the current and the hypothetical generalized cost of transport, assuming, in this second case, that the car is unavailable, while a CS service is available. Comparing the value of the cost in these two alternative scenarios the probability of using the CS service at least once, whether for commuting or non-commuting trips, has been estimated. The results of the model described in Section 4.2.4 are reported in Table 12.

Table 12
Ordinal Logit of the probability of using the carsharing service.

	Coeff.	Std.Err.	*t*-ratio	P-value
ONE	−1.55	0.28	−5.52	0.00
Age 30–60 (dummy)	−0.60	0.13	−4.76	0.00
Age > 60 (dummy)	−2.02	0.32	−6.36	0.00
n. children	0.13	0.08	1.58	0.11
n. cars/driver license	0.74	0.21	3.52	0.00
City: TS (dummy)	0.26	0.12	2.20	0.03
Environmental awareness (ordinal, 1–5)	0.18	0.06	3.21	0.00
CS knowledge (ordinal, 1–5)	0.24	0.05	5.37	0.00
Mu(1)	1.19	0.06	20.03	0.00
Mu(2)	2.97	0.12	25.14	0.00
Mu(3)	4.20	0.21	20.03	0.00
McFadden Pseudo R-squared	0.04			
N. Obs.	1175			

The statistical significance of the model is not particularly good: adjusted Rho^2 equal to 0.04, but it is acceptable on the ground that the explanatory variables that have been used describe the characteristics of the individuals and not the characteristics of the transport modes among which the individuals can choose and considering that the dependent variable is itself an estimated value. Moreover, some socio-economic variables that are relevant to the modal choice, including the number of trips made and the distance traveled, could not be included because they were already used to estimate the probability of using a CS service. All parameters studied, however, are statistically significant and have the expected sign. The model predicts the effect that each socio-economic variable produces on the probability of using the CS (see Table 13).

Table 13
Socio-economic determinants of the probability of using the carsharing service.

	Probability of using the carsharing				
	0 (none)	0%–25%	26%–50%	51%–75%	76%–100%
Age 30–60 (dummy)	0.15	−0.04	−0.08	−0.02	−0.01
Age > 60 (dummy)	0.42	−0.19	−0.18	−0.04	−0.02
n. children	−0.03	0.01	0.02	0.00	0.00
n. cars/driver license	−0.18	0.05	0.10	0.03	0.01
City: TS (dummy)	−0.06	0.01	0.04	0.01	0.00
Environmental awareness (ordinal, 1–5)	−0.04	0.01	0.02	0.01	0.00
CS knowledge (ordinal, 1–5)	−0.06	0.01	0.03	0.01	0.00

According to the model described in Table 13 there is a negative relationship between the probability of using the CS ($PROB\_CS_j$) and the age of the respondent (expressed with two dummy variables AGE_{30_60} and $AGE_{>60}$ equal to 1 if the individual is aged, respectively, between 30 and 60 years, and if the individual is older than 60 years). The probability, instead, increases if there are children in the household (N.CHILDREN), the higher the ratio of the number of cars owned over the number of driving licenses (DRIVER_LICENSE, indicative of the dependence of the family mobility on the private car) and if individuals live in a large city (dummy TS with a value equal to 1 in the case of residents in the city of Trieste). Also the environmental sensitivity (dummy ENV.SENSITIVITY) and the degree of knowledge of the service (dummy CS_KNOWLEDGE) have a positive impact on the probability of using this transport mode.

The econometric results just described are summaried and discussed in Section 4.2 “The potential users in the FVG region”.

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