

Peer-to-peer carsharing in less-densely populated areas: An empirical analysis in Friuli-Venezia Giulia (Italy)

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ABSTRACT

Mobility plays a crucial role in wellbeing and quality of life. It enables access to services and resources necessary for economic and cultural development and is essential for social inclusion. Peer-to-peer carsharing (P2PCS) represents an effective solution with respect to the sustainability goals indicated by the European New Green Deal and in light of the accessibility objectives of the National Strategy for Internal Areas. For this reason, we estimated the potential supply and demand of P2PCS in Friuli-Venezia Giulia (FVG), an Italian region characterized by less-densely populated areas. We interviewed 200 individuals to test if they would rent a car and 249 car owners to test if they would rent out their car. We found that 10% of the sample would use a P2PCS service if the hourly rental rate was €7/h. The main reason preventing the service use is that the FVG residents are not aware of the platforms allowing the matching of car owners and renters. In the paper, we describe also the policies to be implemented to support both the demand and the supply side of the market and we estimate the contribution that P2PCS could make to the decarbonization of the regional transport system.

1. Introduction

Reducing transport environmental impact and enhancing accessibility and social inclusion are national transport policy priorities. Car-sharing (CS) reduces the number of cars on the road, relieving congestion and transportation costs (Baptista et al., 2014; Benjaafar et al., 2015). It provides convenient mobility solutions, while lowering energy consumption and greenhouse gas emissions (Correia and Viegas, 2011; Shaheen and Cohen, 2018; Shaheen et al., 2018). Several studies prove the effectiveness of CS in reducing car ownership and vehicle kilometers driven (Cervero et al., 2007; Martin et al., 2010; Nijland and van Meerkerk, 2017; Severis, 2019; Sioui et al., 2013; Zhou and Kockelman, 2011). According to the empirical evidence reported by Bondorová and Archer (2017), Kent (2014), Santos (2018) and Shaheen et al. (2019), CS encourages a behavioral shift towards multi-modal sustainable transport, complementing public and active forms of transport, such as cycling and walking. It is also demonstrated that CS helps meeting the mobility demand of urban residents in marginalized neighborhoods (Abraham, 1999; Dill et al., 2017; Kim, 2015) and improves social inclusion and accessibility (Clark and Curl, 2016). However, CS is difficult to scale geographically in less-densely populated areas because the utilization rate is not high enough to offset the operators' costs of purchasing, leasing and maintaining the vehicles,

representing 70% of the total costs (Ballús-Armet et al., 2014; Hampshire and Gaites, 2011). To be financially sustainable, CS requires a minimum utilization rate of 40%, meaning that a car has to be rented for more than 9 h a day, a goal achievable only in urban areas with high residential density and using reservation control policies (Hampshire and Srinath, 2011).

Peer-to-peer carsharing (P2PCS) differs from business-to-consumer carsharing (B2CCS) since fleets are made only of privately owned cars. Car owners and renters are peers and share the vehicles through a platform via which it is possible to book the car, post the characteristics of the car, of the car's owner and of the renter, and pay the rental rate. The platform has two main functions, i.e. matching the demand and the supply of the market and providing an all risks insurance that guarantees both car owners and renters in case of accidents. The insurance automatically starts from the moment the user starts driving the car to the moment s/he returns it to the owner (Münzel et al., 2020). The platform operator charges car owners and renters 30% and 5% of the rental rate, respectively, and uses the revenues to cover network operations and insurance costs. P2PCS is more scalable to less dense cities and suburban areas than B2CCS because start-up and operating costs are negligible and is less capital intensive. Indeed, observing the spatial differences in the growth of P2PCS in the United Kingdom, The Netherlands, France, Germany, and Belgium, van der Linden (2016) found that population

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density did not significantly influence the number of shared cars, supporting the hypothesis that P2PCS might be a more feasible alternative to B2CCS in less densely populated places.

In Italy, P2PCS is offered via two platforms, i.e. Auting, started in April 2017 with more than five thousand users and almost one thousand cars, and Genial Move, started in November 2018. Car owners need to be at least 21 years old and to possess their own car insurance, while renters are required to have held a full driving license for at least three years. Both platforms advise car owners on the rental rates to charge, but they are free to choose different values and to accept or reject the rental offers made by renters. In Italy, only daily rentals are currently available, although in other European countries platforms such as Getaround, the largest P2PCS operator serving five million members in the United States and in Europe, offer the service also by the hour. Although in Italy this form of car sharing is a relatively new business with 17,000 members, 1600 cars and 4150 rents,¹ it is growing rapidly, especially in metropolitan cities such as Milan, Turin, Bologna and Rome. Users are generally young, aged between 20 and 35 years, and are used to travelling using shared mobility services.

According to [Shaheen et al. \(2012\)](#) and [Shaheen and Cohen \(2013\)](#), many factors restrain the adoption of P2PCS including: insurance costs and availability, challenges about balancing revenues and pricing, expense of technological solutions aimed at opening and closing the vehicles, car availability, and assurance of vehicle reliability. However, little is known about the attitudes, perceptions, and decision process through which individuals decide to offer and rent a car and there is no research to date on the latent beliefs and psychological barriers preventing P2PCS adoption in less-densely populated areas. Moreover, no study exists on the potential of P2PCS in Italy, except for [Beria et al. \(2017\)](#) and [Mariotti et al. \(2013\)](#) who focused, however, on Milan, the second largest (1.4 million residents) and most densely populated Italian city (7.589 inhabitants/km²) analyzing only the supply side of the market.

Our research differs from these studies with respect to the area analyzed, since we interviewed the residents of Friuli-Venezia Giulia, a northeastern Italian region characterized by small and medium-sized towns and rural areas, and with respect to the type of persons we interview, not only potential suppliers (car owners) but also potential renters. Moreover, we analyzed how latent beliefs and psychological barriers, besides price, sociodemographic characteristics and travel habits, drive the intention to join a P2PCS system. In the literature, only few studies have analyzed both sides of the market, but none of them performed an econometric analysis of the role played by latent variables in engaging in the P2PCS market. Additionally, on the basis of the results we have obtained, we have estimated the contribution that P2PCS could make to the decarbonization of the regional transport system, an analysis that was never done before for any Italian context. Finally, we provide novel insights into the role of policy makers in supporting P2PCS initiatives.

2. Literature review on peer-to-peer carsharing

In the literature there are only few studies analyzing both the demand and the supply side of the P2PCS market and most of them were carried out in the USA ([Table 1](#)). [Dill et al. \(2017\)](#) interviewed 332 car owners and 249 car renters using Getaround, the largest P2PCS

¹ http://osservatoriosharingmobility.it/wp-content/uploads/2019/07/come-la-sharing-mobility-III-Rapporto-SM_13-e-FRONT.pdf.

² Although in Italy the existing P2PCS platforms provide only daily rentals, in other European countries where this form of CS is already widespread it is possible to rent the vehicles also by the hour. Since this form of P2PCS has higher potentialities both in more- and in less-densely populated areas, we decided to investigate this innovative version of the P2PCS instead of the existing one.

operator, in Portland (Oregon). They found that most rentals were for shopping or leisure, although 20% were for work-related purposes. Half of the trips had one or more secondary purposes. One-third of the trips would not been taken without the P2PCS service, while 20% would been by public transportation and 19% via another CS or rental service. Some renters (13%) also reported that P2PCS had kept them from needing to buy a car. In the renters' view the service increased planning trips flexibility and helped them saving money. Additional reported driving factors in choosing P2PCS were the fact that the rental cars are at close spatial distance compared to other car rental services. Supporting the local and sharing economy, reducing the overall number of cars on the road, creating an opportunity to meet others in the community, and having access to a car without owning one, were also cited as relevant factors. Negative reported elements were lack of owner accountability to responding to reservations/requests from renters, lack of availability and unclear scheduling processes. With respect to the supply side of the market, the authors found that owners were more likely to decrease their peak-period driving and that about 30% increased walking, bicycling and using public transit. Those who rented their vehicles out frequently were inclined to plan their schedules, were not concerned about potential damage to their vehicle or about not knowing who renters were. The main reason for renting their car was earning money, followed by using existing resources more efficiently, reducing the number of cars on the roads, adopting a more environmentally sustainable behavior, but also helping other people in the community, meeting like-minded people, creating community, and supporting the local economy. On the negative side, participants cited the risk of having their vehicle damaged and of renters disrespecting owner's rules, besides the extra attention needed to keep the car ready for rentals, including keeping it fueled up and clean. [Ballús-Armet et al. \(2014\)](#) interviewed three hundred respondents living in San Francisco and Oakland, California. They found that the key reasons for willing to use P2PCS by renters were the possibility to select from a wide variety of vehicle locations and flexible plan schedules, the monetary savings compared to owing a car or to other rental services, and the expanded mobility options in settings with less comprehensive and frequent transit options. Only 25% of surveyed vehicle owners, however, were willing to share their personal vehicle through P2PCS due to liability and trust concerns. The authors also found that those who drove almost every day were less open to renting their car and that the main driver for sharing the car was the possibility of getting extra earnings. [Shaheen et al. \(2018\)](#) performed an online survey in 2014 with 1.151 P2PCS members of the most popular P2PCS platforms in the United States (RelayRides/Turo, Getaround and eGo carsharing). They studied which socioeconomic characteristics increased the willingness to use P2PCS services. According to their results, the most important factors were income level, educational level and being white, young and male. They also found that using P2PCS services increased the overall number of trips made. However, they also found that using P2PCS shifted users' mobility patterns toward more sustainable options, indeed taxi use decreased, while carpooling, walking and riding a bicycle increased. The authors reported as co-benefits of P2PCS also higher accessibility and reduced car ownership. The authors found that car renters were motivated by the vehicles variety, the service flexibility, cost effectiveness and convenience, and by the fact that it removes the concerns and burden of personal vehicle ownership. They were most concerned about coordinating vehicle access with vehicle hosts. Car owners, instead, were motivated by the possibility of earning extra income, while contributing to the sharing economy and the environmental sustainability. Their main concerns were the occasional lack of access to their own car and the risk that the car was damaged.

With reference to the European context, [Wilhelms et al. \(2017a, 2017b\)](#) analyzed what factors favor P2PCS provision by car owners in Germany. They performed in-depth interviews with 20 car owners recruited in collaboration with a German P2PCS organization. They found that the most important factor for the respondents was the

reduction of fixed costs of car ownership such as maintenance, taxes and insurance. Another important factor was the possibility of earning extra income. They also found the car owners were sensitive to the possibility of allowing some users to live a car-free life, of reducing the number of unused vehicles on the street and of increasing the environmental sustainability. They also interviewed 21 car renters and they found that their main motives for using P2PCS was the possibility of saving money limiting their mobility budget. Another important factor taken into account by renters was the possibility of saving time reducing the hassle of renting a car since they perceived P2PCS as being more flexible than B2BCS. A third important factor was the fact that, according to the renters interviewed, it was easier to find exactly the car they wanted to rent via P2PCS compared to B2CCS. Münzel et al. (2019) analyzed whether the socioeconomic characteristics and the motives for willing to use the carsharing services differ between users of business-to-consumer services and peer-to-peer services. They interviewed 1835 individuals representative of the Dutch population over the age of 18. The survey was conducted in 2014. According to their results, P2PCS renters were more cost-sensitive but less public-transport-oriented than B2CCS users. They also found that P2PCS car owners were more used to providing their car to friends and family than B2CCS users and that trusting others was a more important factor than gaining extra income in order to accept to rent out their car. Finally, Valor (2020) analyzed which were the psychological barriers preventing the adoption and use of a P2PCS services in Spain. They conducted 20 in-depth interviews with

respondents aged between 18 and 50, with a higher education level and living in Madrid. The respondents were not P2PCS users at the time of the interview. On the basis of the data collected during the interviews, the author concluded that the service was perceived as a stressful activity. Potential adopters, especially car owners, anticipated emotions of worry, fear and anxiety that might occur while renting or renting out a car. According to the author, this phenomenon represents a significant barrier for the uptake of P2PCS services.

There are only two studies analyzing the potentialities of P2PCS in Italy, i.e. Beria et al. (2017) and Mariotti et al. (2013), however both of them focused exclusively on the supply side of the market. The authors studied the socio-demographic characteristics of car owners willing to rent out their cars in Milan. They performed a CAWI survey in 2012 interviewing 1211 individuals. Half of the sample stated that they would be willing to share their car. The potential sharers were most frequently male, young, educated, cost-sensitive and more used to travelling by bike or by bus. Cars would be preferably shared during nighttime. On the basis of the minimum monthly revenue stated by the car owners, the authors estimated that 2 €/h was the rate above which the large majority of owners would rent out their cars. Besides Beria et al. (2017) and Mariotti et al. (2013) no other study exists on the P2PCS market in Italy and nothing is known on the demand side of the market. Our study fills this gap, analyzing the potentialities of P2PCS in a less-densely populated region such as FVG.

Table 1
Data, methodology, aims and results reported in the literature focused on the demand and supply side of the P2PCS market.

	Country - year	Sample	Data type	Research question	Adopters' socioeconomics	Renters' motives/ concerns	Owners' motives/ concerns
Ballús-Armet (2014)	USA - 2013	residents of San Francisco and Oakland	RP & SP, intercept survey	differences between B2C and P2PCS adopters and barriers against P2PCS	aged under 40, not frequent car user	convenience, vehicle variety, economic benefits/liability, car reliability	extra income, car used more efficiently/ liability, distrust
Beria et al. (2017); Mariotti et al. (2013)	Italy - 2012	residents of Milan	SP, computer assisted web interviews	analyzing sociodemographic characteristics of potential adopters renting out their personal vehicle	male, young, educated, cost-sensitive, bike or bus riding	n.a.	n.a.
Dill et al. (2017)	USA - 2012	members of P2PCS living in Portland	RP, survey, vehicle use data, in-depth interviews	impact of P2PCS on distance travelled and accessibility	young, higher income and education, not single, living in urban areas	flexibility, cost savings, accessibility/ owner accountability, car availability	extra income, car used more efficiently, environmental sustainability, social inclusion/potential damages, distrust
Münzel et al. (2019)	The Netherlands - 2014	Dutch population over the age of 18-	RP & SP, survey	differences between B2C and P2PCS adopters	higher education, living in urban areas, environment sensitive	cost and time savings, convenience/n.a.	extra income/n.a.
Shaheen et al. (2018)	USA - 2014	Members of RelayRides/ Turo, Getaround and eGo carsharing	focus groups, expert interviews, online survey	effects of P2P members travel and vehicle ownership	white, male, younger, higher income and education	flexibility, convenience, cost savings, vehicle variety/liability, car reliability, coordinating key transfer	extra income, contributing to sharing economy and environmental sustainability/ organizational burden, potential damages
Valor (2020)	Spain - n.a.	residents of Madrid region	in-depth interviews	factors hampering P2PCS adoption	young, higher education, living in urban areas	cost savings/car reliability and availability, responsibility among owners and renters	extra income, environmental sustainability, facilitating others' projects/organizational burden, potential damage, distrust, liability
Wilhelms et al. (2017a, 2017b)	Germany - n. a.	German P2P car sharers	in-depth interviews	factors favoring P2PCS adoption	n.a.	cost and time savings, flexibility/n.a.	cost savings, extra income, car used more efficiently/n.a.

3. Stated preferences of car owners and renters in FVG

3.1. The sample

We interviewed a representative sample with respect to age and gender of the FVG population aged 21 or older. The sample comprises only individuals having a driving license and being 21 years old or older, since this is the minimum age required to join a P2PCS platform in Italy.

The car owners' sample includes 249 individuals, equally divided between female and male. Most of them are 25–44 years old (41%) or 45–64 years old (39%). Half of the sample has a high school diploma, while 13% and 36% has a bachelor and a master degree, respectively. Employees and the self-employed represent 78% of the sample. Half of the sample has a family income in the €30,000–€70,000 range (Table 2). Trieste, the largest town of region with 203,000 inhabitants, and its province is the place of residence of 35% of the sample, 44% of the sample lives in Pordenone, the third largest town of the region with 51,000 inhabitants, or in its province, while 21% of the sample lives in other towns or rural areas of the region.

Table 2

Socio-demographic characteristics of the sample of car owners and of the FVG population.

	Sample of car owners	FVG population*
Gender		
male; female	52%; 48%	49%; 51%
Age		
21-24; 25-44; 45-64; >64	6%; 41%; 39%; 14%	7%; 34%; 41%; 17%
Education		
middle school; high school; bachelor; master	2%; 49%; 13%; 36%	
middle school or high school; bachelor or master		79%; 21%
Occupational status		
employee; self-employed; student; retired/ housewife; unemployed	55%; 23%; 5%; 15%; 2%	
employee; self-employed; not working; unemployed		38%; 26%; 29%; 7%
Income		
<€30,000; €30,000-€70,000; >€70,000	29%; 45%; 26%	
<€15,000; €15,000–26,000; €26,000–55,000; >€55,000		37%; 34%; 24%; 5%

Sources (*): https://www.regione.fvg.it/rafv/export/sites/default/RAFGV/GEN/statistica/FOGLIA56/allegati/Regione_in_cifre_2019.pdf; https://rendire.s.iresfvg.org/documenti/rassegna/2019/RICERCA/DICHIARAZIONI_IRPEF_2018_Infoclick.pdf.

Most of the respondents own both city and family cars, only 16% possess executive cars. Cars are mainly used for leisure, commuting to work/study or shopping and, less frequently, for family care. The large majority of the sample (70%) uses the car on a daily basis (Fig. 1).

The renters' sample includes 200 individuals, equally divided between females and males. The majority is 25–44 years old (35%) or 45–64 years old (39%). Half of the sample has a middle or a high school diploma, while 30% and 18% has a bachelor and a master degree, respectively. Employees and the self-employed represent 57% of the sample. Almost 70% of the sample has a family income in the €30,000–€70,000 range (Table 3). Trieste and its province is the place of residence of 38% of the sample, 30% of the sample lives in Udine, the second largest town of the region with 99,000 inhabitants, or its province and 36% of the sample lives in other towns or rural areas of the region.

Most of the respondents have two (50%) or more cars (23%) and use the car on a daily basis both during weekdays (49%) and weekends (70%), as depicted in Fig. 2.

Table 3

Socio-demographic characteristics of the sample of renters and of the FVG population.

	Sample of renters	FVG population*
Gender		
male; female	52%; 49%	49%; 51%
Age		
21-24; 25-44; 45-64; >64	9%; 35%; 39%; 17%	7%; 34%; 41%; 17%
Education		
middle school; high school; bachelor; master	18%; 35%; 30%; 18%	
middle school or high school; bachelor or master		79%; 21%
Occupational status		
employee; self-employed; student; retired/ housewife; unemployed	48%; 9%; 19%; 18%; 7%	
employee; self-employed; not working; unemployed		38%; 26%; 29%; 7%
Income		
<€30,000; €30,000-€70,000; >€70,000	22%; 68%; 10%	
<€15,000; €15,000–26,000; €26,000–55,000; >€55,000		37%; 34%; 24%; 5%

Sources (*): https://www.regione.fvg.it/rafv/export/sites/default/RAFGV/GEN/statistica/FOGLIA56/allegati/Regione_in_cifre_2019.pdf; https://rendire.s.iresfvg.org/documenti/rassegna/2019/RICERCA/DICHIARAZIONI_IRPEF_2018_Infoclick.pdf.

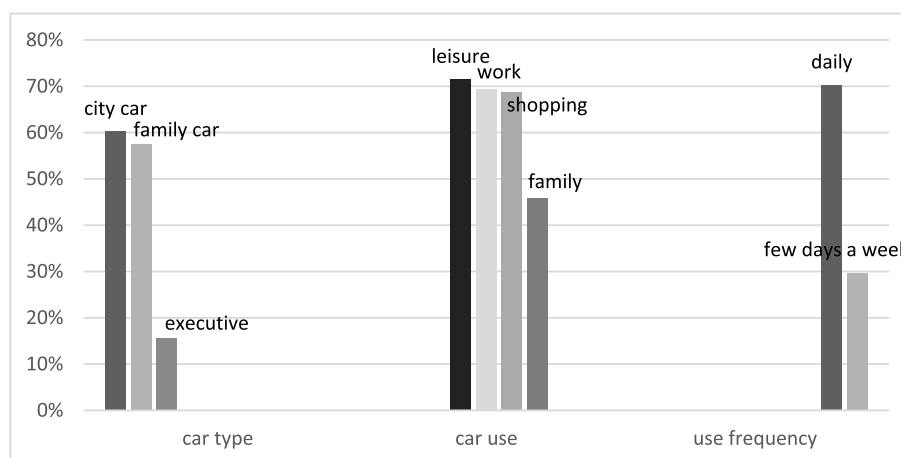


Fig. 1. Car type and car use of car owners.

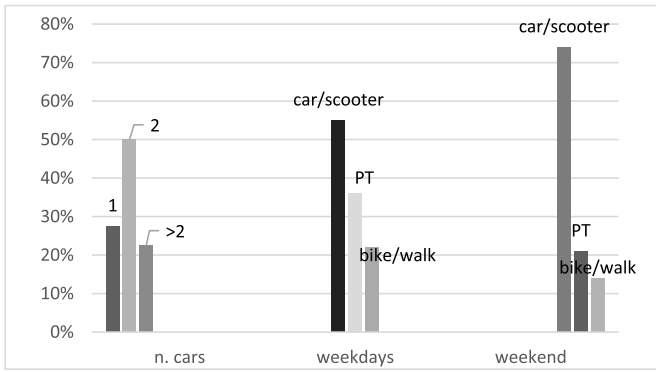


Fig. 2. Renters' travel habits.

3.2. The sampling strategy and the questionnaire

Our research is based on face-to-face interviews that we conducted in November–December 2019. We opted for this methodology to collect the data since it allowed us to more accurately screen the answers given by the respondents and to keep the respondents focused on the questions we proposed. However, the quality of the data collected might have been influenced by the interviewer's ability and the answers to sensitive questions could have been biased toward more socially desirable outcomes due to the presence of the interviewer. To overcome these sources of potential bias we trained the interviewer on how to carry out the interviews in order to guarantee the homogeneity and neutrality of the procedure used to collect the data. We also standardized the clarifications to be given during the interviews, if requested. We randomly selected and indiscriminately approached individuals at gathering places such as squares, malls, supermarkets, bus stops and train stations. We did not provide incentives for participating in our research. Each interview lasted 10- to 15 min.

We structured the questionnaire into four parts. The first part focused on the respondents' travel habits and mobility patterns. We only interviewed individuals who had a driving licence. Additionally, but only for the car owners' sample, we selected only respondents whose household owned at least one car. We aimed the second part of the questionnaire at detecting whether the respondent knew what a P2PCS is and whether s/he would use it. Afterwards, we provided each

respondent with a standardized description of what a P2PCS is and how it works in Italy. The P2PCS description we provided was identical across all the interviews. Subsequently, we asked the minimum hourly rental rate that car owners would be willing to accept to rent out their car and the maximum hourly rental rate that car renters would be willing to pay to rent a car.² We proposed the following values €5/h; €10/h; €15/h; €20/h; €30/h; €40/h; €50/h and "other". The range of values proposed was large enough to ensure that none of the respondents stated that s/he would be willing to accept or pay a value higher than €50/h. We chose these values on the basis of the rates currently charged in the Italian platforms, ranging from €28 to €107 per day, and on the basis of the values proposed by Beria et al. (2017) and Mariotti et al. (2013).

In Fig. 3 we report the percentage of individuals willing to rent and to rent out a car by the hourly rental rate. As expected, as the hourly rental rate increases the percentage of renters decreases, while the percentage of car owners willing to rent out their car increases. The percentage of individuals willing to rent out their car is at maximum 42%, but increases up to 62% if details on car renters' reliability are published in the P2PCS platform. The average WTA is €13.5/h while the median WTA is €10/h. These values are significantly higher than the WTA reported by Beria et al. (2017) and by Mariotti et al. (2013) which was equal to €2/h. However, Beria et al. (2017) and Mariotti et al. (2013) asked the minimum monthly rate that the respondents were willing to accept and derived the hourly rental rate dividing the value stated by the respondents by the number of renting hours per month.³ The percentage of car renters is at maximum 25%, but increases up to 64% if no refueling is needed at the end of the car rental. The average WTP is €5.5/h while the median WTP is €5/h.

It is interesting to notice that about 10% of both samples would be willing to engage in this market for an hourly rental rate of €7/h, which is smaller than the current rates of a standard CS service (about €12/h). This result is in line with the evidence reported in the literature according to which P2PCS rates are lower than B2CCS ones (e.g., Ballús-Armet et al., 2014). The percentage value we found is quite promising considering that in 2017 only 1.5% of the Italian population used a CS service (ISTAT, 2017).

In the third part of the questionnaire, we asked the respondents what they would be worried about if using a P2PCS service. The respondents could select more than one item. We proposed the items listed in Table 4 and Table 5 allowing the respondents to add additional items if not

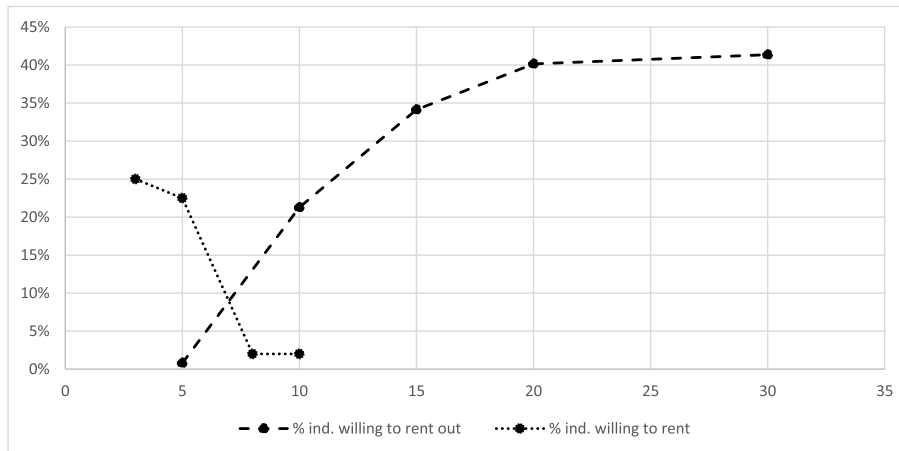


Fig. 3. Percentage of individuals willing to rent out and to rent a car by hourly rental rate.

³ Estimated as the product of the number of days and the number of hours per day that the respondents stated they would rent out their car.

Table 4

Factors conditioning the willingness to rent out a car (percentage of the 249 car owners we interviewed who answered to the question selecting the items proposed).

Which of the following factors would mostly worry you if you were to rent out your car?	
I could not use my car any time I want	63%
Not knowing the renter	43%
I should remove my personal belongings	37%
The car could be damaged	26%
The car could be left dirty	17%
I would face time constraints to give and get back the keys	16%
The unlocking system might not work properly	9%
I would have to refuel my car	2%
The car could be stolen	0%

Table 5

Factors conditioning the willingness to rent a car (percentage of the 200 potential renters we interviewed who answered to the question selecting the items proposed).

Which of the following factors would most worry you if you were to rent a car?	
I would face time constraints to get and give back the keys	95%
I would face distance constraints	61%
I would have to book the car in advance	61%
Not knowing the car owner	56%
I might damage the car	52%
I would have to refuel the car	42%
I would have to clean the car	30%
I would be responsible for the owner's personal belongings	25%
The car might be dirty	12%
The car might be stolen	7%

included in the list. We selected the items to be proposed on the basis of the evidence reported in the literature (Ballús-Armet et al., 2014; Beria et al., 2017; Dill et al., 2017; Mariotti et al. 2013) and on the basis of a focus group we conducted involving colleagues and researchers in the transport economics field. In the last part of the questionnaire, we collected data on the socio-demographic characteristics of the respondents. We tested the questionnaire with a sample of 30 individuals, 15 car owners' and 15 car renters. After the pilot test, we added a more detailed description of P2PCS and we fine-tuned the description of the list of factors that could potentially prevent the adoption of P2PCS.

The majority of car owners would be worried about not being able to use their car according to their needs, although car owners are not constrained on the number of days or hours during which the car should be rented (Table 4). They are free to plan the days and time windows during which to rent out their car according to their travel habits, and they can change the timetable chosen any time before the car is rented. The second most important factor bothering the car owners is distrust about unknown renters. However, P2PCS platforms such as Getaround enable both renters and car owners to post comments and ratings on their counterpart, thus reducing the knowledge gap on their reliability. Moreover, in less-densely populated areas the service would most probably be used by individuals belonging to the same community and knowing each other at least by sight, so reducing even further this potential psychological barrier. The need of removing personal belongings before renting the car is the third most important factor perceived by car owners. Installing the car with a locked interior drawer where to temporarily store the items could reduce this source of concern. The possibility that the car could be damaged is also conditioning the car owners; however, any damage caused to the vehicle or to third parties during the rent is fully covered by an all risks insurance issued by the platform guaranteeing both the car owner and the car renter. As for the burden caused by the need of meeting the renter to give and get back the keys, it could be avoided by installing a device allowing the renter to open and close the car using her/his cellular phone instead of the keys.

The platform's owner generally provides for installing the device, for its purchase and maintenance costs and guarantees for its proper functioning. This system also enhances the flexibility of the service, since car owners and renters do not need to meet before and after the car is used. It also avoids the need to come into contact with strangers. Moreover, the all risks insurance guarantees the car owner if the unlocking system does not work and in the event that the car is stolen. Finally, a surcharge could be agreed between the parties to cover the cost of cleaning the car if needed. Although the car owners mentioned several sources of concern, most of them seem to be due to misconceptions as to how the system works rather than on features of the services that are incompatible with their needs and preferences.

Analyzing the evidence reported in Table 5, it is interesting to notice that four out of ten factors conditioning the willingness to rent a car are also important for car owners. They are the time constraint faced due to the need of getting and giving back the keys, not knowing the car owner, being responsible for the car and for the personal belongings of the car owner. As already pointed out, however, properly describing how the service works and how both parties are warranted against car damage would certainly reduce these sources of concern. As for the others factors, the majority of the renters are bothered about the possibility of facing a constraint on the maximum distance that can be travelled and about the need of booking the car in advance. With respect to the first factor, however, it is up to the parties to define any distance constraint and whether to apply a surcharge to extend it. As for the second factor, as long as the car is provided with an unlocking system, there is no need to book it in advance. The need of refueling and cleaning the car is again up to the agreement reached by the parties. Car owners, for example, could exempt renters from refueling and cleaning the car upon payment of a predefined surcharge. A minority of renters would be worried about the possibility that the car could be dirty, but the ratings and comments available in the platforms about the car characteristics and the cleaning conditions could reduce this source of concern. Finally, only few renters would be concerned about the fact that the car could be stolen while they are using it.

3.3. Econometric analysis

We used the data collected to estimate two binomial logit models (BNL) and two mixed logit models (MXL) one for each sample type (Table 6). Equation (1) describes the utility of renting out the car (vs. the utility of not renting out the car) for car owners or the utility of renting the car (vs. the utility of not renting the car) for car renters. The utility function is assumed to be a linear function of the r socio-economic characteristics SE_{rq} , of the k mobility habits MH_{kq} and of the m psychological barriers and misconceptions about how the service works PBM_{mq} of respondent q , of the hourly rental rate RR_i of alternative i and of an i.i.d. error term ε_{iq} with extreme value type 1 distribution.

$$U_{iq} = ASC_i + \sum_r \phi_r SE_{rq} + \sum_k \beta_{ki} MH_{kq} + \sum_m \gamma_{mi} PBM_{mq} + \delta_i RR_i + \varepsilon_{iq} \quad (1)$$

Subsequently, we relaxed the assumptions of no taste variation among respondents, of fixed substitution patterns, and of no correlation in unobserved factors over time or individuals and we estimated the mixed logit model (MXL) described in Equation (2).

$$U_{iq} = ASC_i + \sum_r \phi_r SE_{rq} + \sum_k \beta_{kiq} MH_{kq} + \sum_m \gamma_{miq} PBM_{mq} + \delta_i RR_i + \varepsilon_{iq} \quad (2)$$

where β_{kiq} is the coefficient of the mobility habit of alternative k for individual i and q is the coefficient of the misconception or psychological barrier γ_{miq} with reference to alternative m for individual i . The value of each parameter q , β_{kiq} and γ_{miq} varies over the respondents according to density function $f(\beta|\Delta)$ and $f(\gamma|\Delta)$, respectively, where Δ describes the parameter distribution (mean and covariance).

Since for both samples the mixed logit model is the best fitting one,

Table 6

Estimates of the models of the willingness to rent out (car owners' subsample) or to rent (car renters' subsample) a car.

Willingness to rent out a car					Willingness to rent a car				
Car owners	BNL		MXL		Car renters	BNL		MXL	
	Estimate	p-val	Estimate	p-val		Estimate	p-val	Estimate	p-val
constant	-6.75	0.00	-17.86	0.00	constant	-2.91	0.03	-7.08	0.07
younger than 45	1.74	0.00	0.80	0.52	younger than 45	1.04	0.01	2.68	0.07
employed (vs retired)	1.54	0.00	3.83	0.01	employed (vs retired)	1.41	0.00	3.98	0.05
unemployed (vs retired)	1.96	0.00	6.31	0.05					
student (vs retired)	1.62	0.00	8.84	0.02					
female (vs male)	0.88		4.30	0.00	female (vs male)			6.37	0.01
low income (<€30k)	1.73	0.00	3.42	0.00	living in urban areas	-0.94	0.02	-10.30	0.00
environmentally conscious	0.64	0.00	2.16	0.02	high freq. car user	-1.76	0.00	-9.97	0.00
car used each weekday	-0.78	0.00	-4.20	0.00	range of high freq. car user			4.39	0.02
					high freq. car user_urban			7.82	0.02
car used <6 h/d	0.53	0.02	2.31	0.04	city car	4.30	0.00	11.76	0.00
city car	1.19	0.00	3.08	0.01	rental rate €/h	-0.93	0.00	-2.54	0.00
rental rate €/h	0.18	0.00	0.61	0.00	damage concerns	-1.50	0.00	-9.36	0.00
damage concerns	0.89	0.00	2.19	0.04	range of damage			2.38	0.08
standard deviation of damage			2.48	0.03	damage_living urban area			7.24	0.04
time constraints concerns	1.03	0.00	2.06	0.03	km constraints	4.16	0.00	11.0	0.00
standard deviation of time constraints			3.43	0.00	mandatory car cleaning	0.90	0.02	2.08	0.20
time constraints_student			-7.89	0.06	range car cleaning			5.84	0.01
					concern about car stolen	3.91	0.00	12.07	0.00
imp. of car availability	-1.19	0.00	-9.75	0.00	need booking in advance	2.05	0.08	8.13	0.12
standard deviation of imp. of car availability			4.61	0.00	refueling need	-3.32	0.00	-9.53	0.00
imp. of car availability_younger than 45			8.05	0.01	distrust about owner	1.87	0.01	3.36	0.15
distrust about renters	-1.95	0.00	-13.56	0.00	No. individuals	200		200	
standard deviation of distrust on renters			5.68	0.00	No. observations	800		800	
distrust about renters_younger than 45			8.93	0.00	LL (0)	-554.52		-554.52	
No. individuals	249		249		LL (final)	-320.66		-246.52	
No. observations	1245		1245						
LL (0)	-862.97		-862.97						
LL (final)	-320.66		-246.52						

we will comment only on the estimates of the parameters of the MXL.⁴

The willingness of car owners to rent out their vehicle is higher for females, contrary to the results obtained by Barbour et al., 2020, by Beria et al., 2017 and by Mariotti et al. (2013). It is also higher for individuals being younger than 45 years (in line with Barbour et al., 2020; Beria et al., 2017; Dill et al., 2017; Mariotti et al., 2013). Having a family income lower than €30,000 (similarly to Barbour et al., 2020) and being environmental conscious (as in Costain et al. 2012; Dill et al. 2017; Efthymiou et al., 2013) are also factors positively influencing the willingness of car owners to rent out their vehicle. Unemployed, students, or employed individuals are more willing to rent out their car than the retired or homemakers. Owning a city car which is not used each weekday or which is not used for more than 6 h a day is also a factor increasing the willingness to rent out the car, similarly to Ballús-Armet et al. (2014). In addition, the value of the hourly rental rate significantly influences the willingness to rent out the car, in line with the results found by Ballús-Armet et al. (2014), Beria et al. (2017), Dill et al. (2017) and Mariotti et al. (2013).

As for the misconceptions about the service characteristics and the psychological barriers influencing the supply side of the market, they are highly heterogeneous as proven by the fact that the standard deviation

of the distribution of the parameters is statistically significant. More specifically, the probability of being willing to rent out the car is related to the concern that the car could be damaged, as found by Dill et al. (2017), and that giving and getting back the keys of the car would be a source of time constraint, although this last factor is deemed as less important by students. This is most probably due to the fact that students' have less stringent time constraints than other segments of the population. The probability of not being willing to rent out the car, instead, is linked to the concern that the car would not be available if needed, although this source of concern is less important for individuals younger than 45 years. Many other studies such as Ballús-Armet et al. (2014), Barbour et al. (2020), Mariotti et al. (2013) and Shaheen et al. (2018) have found that the willingness to engage in the P2PCS is higher for younger adults. The fact that younger people are less affected by the concern that the car is not available is in line with this evidence. Finally, the probability of not being willing to rent out the car is related to the fact that renters are strangers and their reliability is unknown.

The willingness to rent a car is higher for females, for individuals living in small towns or rural areas, for people younger than 45 years and for individuals being employed. Also travelling by car only a few days per week increases the willingness to rent a car, although the

⁴ We tried different specifications of both the MNL and the MXL. In Table 2 we report the best fitting ones. The best fitting distribution of the random parameters is the normal one.

preferences with respect to this factor are heterogenous and its importance is smaller for individuals living in densely inhabited urban areas, in our case study the city of Trieste. City cars are the preferred type of vehicles for renting. The value of the hourly rental rate significantly negatively influences the willingness to rent a car, in line with our expectations.

With respect to car renters, several misconceptions and psychological barriers influence the willingness to engage in the P2PCS market. The concern that the car could be stolen and of facing a constraint on the maximum distance that can be travelled influences the probability of being willing to rent a car, similarly to the results of [Ballús-Armet et al. \(2014\)](#). The need to clean the car after its use also significantly affects the willingness to rent a car, although with respect to this factor the preferences of the sample are highly heterogeneous. For some individuals, it is perceived only as an additional burden, for some others, instead, it is a guarantee that the vehicle will be cleaned before they use it. The probability of not being willing to rent a car, instead, is characterized by the concern of damaging the car during its use, although there is high heterogeneity with respect to the importance of this factor and its relevance is smaller for people living in densely inhabited urban areas, most probably because they are used to travelling on congested roads. A second factor related to the probability of not being willing to rent a car is the need to refuel the vehicle before giving it back to the owner. Finally, there is a significant psychological barrier influencing the willingness to rent a car, that is the need of interacting with a stranger, whose reliability is unknown.

3.4. Segmentation analysis

On the basis of the parameters of the mixed logit models reported in [Table 6](#), we estimated the WTA and the WTP of different segments of the car owners' sample and of the car renters' sample, respectively. With respect to the potential suppliers of the service, we deemed it interesting to study the WTA of the prevailing segments. They are characterized by employees (51% of the sample), being environmental conscious (45%), with a yearly income smaller than €30,000 (29%) and having a city car (47%) which is used daily (70%) but less than 6 h per day (54%). We estimated the WTA of these segments distinguishing the values obtained by gender and age. We also took into account the most widespread misconceptions about the P2PCS service as perceived by the majority of the car owners' sample. They are the possibility that the car could be damaged (29% of the sample), the concern that the car is not always available (30%) and the additional uncertainty about the renter's reliability (20%). The results we obtained range from €1.7/h to €50.5/h ([Table 7](#)).

Similarly, we studied the WTP of the prevailing segments of the car renters' sample comprising employees (47% of the sample), living in rural areas (62%), occasionally using a small car (51%) and being willing to rent a city car (88%). We also took into account their main sources of concern, i.e. the possibility of facing a distance constraint (21%), the risk of damaging the car (12.5%), and the need to refuel the vehicle (15%). We obtained estimates ranging from €0.4/h to €11.3/h ([Table 8](#)).

Table 7

Estimated minimum WTA (€/h) to rent out the car by gender, age and source of concern.

	Car damage	Car availability	Car availability and distrust about renters
Woman younger than 45	€1.7/h	€8/h	€15.6/h
Man younger than 45	€8.7/h	€15/h	€22.7/h
Woman older than 45	€1.7/h	€21.3/h	€43.5/h
Man older than 45	€8.7/h	€28.3/h	€50.5/h

Table 8

Estimated maximum WTP (€/h) to rent a car by gender, age and source of concern.

	Distance constraint	Distance constraint and car damage	Distance constraint, car damage and refueling
Young woman	€11.3/h	€7.6/h	€3.9/h
Young man	€8.8/h	€5.1/h	€1.4/h
Old woman	€10.3/h	€6.5/h	€2.8/h
Old man	€7.8/h	€4.0/h	€0.4/h

According to our analysis, only some segments of the potential suppliers and renters have compatible WTA and WTP. It is indeed the case for those car owners whose main concern deals with the possibility that the car is damaged and for those car renters whose main concern deals with the distance constraint. However, the sample's limited awareness about the characteristics of the service significantly influences these values. Properly communicating how the service actually works, how the parties can freely agree on the setting of the service and how both parties are guaranteed against any damage that might be caused to or by the car could significantly reduce the existing gap between the estimated WTA and WTP.

4. Contribution of P2PCS to the decarbonization of the transport sector in FVG

We also estimated the potential contribution of the P2PCS system to the decarbonization of the transport system of FVG using the methodology illustrated in [Fig. 4](#). More specifically, we estimated how many individuals living in the region and aged between 21 and 65 years old would use the service. Since, according to the data we collected, 10% of the sample would rent a car if the average hourly rate were €7/h, we estimated that, with such an hourly rate, 68,355 individuals would use the service. In Italy, the average distance travelled by car per person per day is km 19, that is km 5720 per person on a yearly basis ([ISFORT, 2019](#), p. 16).⁵ The most recent estimates of the reduction of the distance travelled by CS users in Europe are between 18% ([Nijland and Meerkerk, 2017](#)) and 20% ([Schreier et al., 2015](#)), implying that in FVG the reduction of the distance travelled on a yearly basis by the P2PCS users would range from 70.4 Million Vehicle Kilometers (MVKM) to 78.2 MVKM. Since the life cycle GHG emissions of an internal combustion car is 165 gCO₂eq/km ([Danielis, 2017](#)), the estimated use of P2PCS would reduce the GHG emissions by a quantity ranging between 11.6 Kt and 12.9 Kt per year. The current price of the European emission allowances in the European Trading System is €25.15/t⁶ and the European commission forecasts that it will rise up to €65/t in order to cut by 55% the GHG emissions by 2030 ([EU, 2020](#)). This implies that the monetary value of the decarbonization allowed by the P2PCS on a yearly basis in FVG would range between 292 K€ and 839 K€.

We also tested how different policies aimed at favoring the use of P2PCS would improve the decarbonization impact of the transport system in FVG. If a discount of €2 on the parking fees were granted and the renters' WTP would increase by the same amount, the percentage of users would rise up to 13%. In this scenario the reduction of the life cycle GHG emissions would range between 15.1 Kt and 16.7 Kt per year, corresponding to a monetary value of the decarbonization process ranging between 380 K€ and 1090 K€. If the car owners renting out their cars were exempted from the car tax, which is about €240 per year for a

⁵ Assuming that the car would be used during the working days (304 per year).

⁶ <https://markets.businessinsider.com/commodities/co2-european-emission-allowances>.

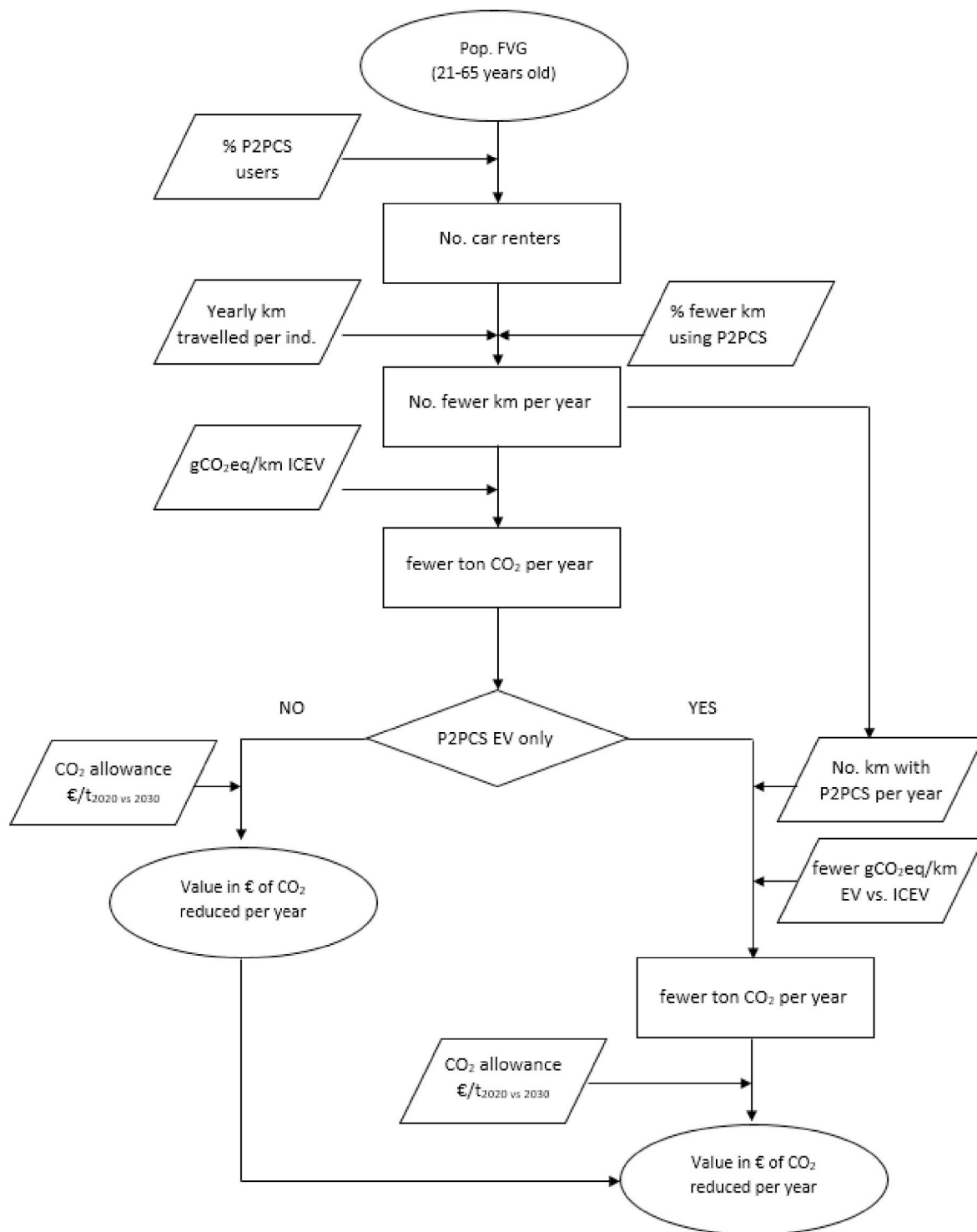


Fig. 4. Flow chart of the methodology used to estimate the decarbonization of the transport sector in FVG.

city car, and their WTA would reduce by €3, the percentage of users would rise up to 17%. In this scenario the reduction of GHG emissions would range between 19.7 Kt and 21.9 Kt per year, corresponding to a monetary value ranging between 496 K€ and 1426 K€. Finally, if the government subsidized the purchase of battery electric vehicles⁷ to be shared via the P2PCS system and all the vehicles shared were electric,

the additional yearly reduction of GHG emissions would range between 9.3 Kt (without parking discounts or tax exemptions) and 16.4 Kt (with car tax exemptions). This additional emission reduction would correspond to a monetary value ranging between 236 K€ and 1063 K€.

Overall, the GHG emissions would reduce by a quantity ranging between 11.6 Kt and 37.9 Kt with a corresponding monetary value ranging between 292 K€ and 2463 K€, according to the policies used to promote the P2PCS service, the price of the European emission allowances and the type of shared vehicles used (electric vs. petrol/diesel). These estimates are based on several critical assumptions dealing with

⁷ The estimated life cycle GHG emissions of a battery electric vehicle give the Italian energy mix are 135 gCO₂eq/km (Danielis, 2017).

the yearly average distance travelled per person, the reduction in the number of trips made by renters and the reduction in the distance travelled due to the P2PCS use. Further research should be carried out to test the robustness of our assumptions.

5. Conclusions

In this research, an *ad hoc* data set has been collected and analyzed to measure the potentialities of P2PCS, a new form of two-sided market that is still unknown and underused in Italy. With the exception of [Beria et al. \(2017\)](#) and [Mariotti et al. \(2013\)](#), who studied, however, only the supply side of this market and analyzed a unique territorial context such as Milan, the second largest and densest Italian city, this is the first research on the P2PCS carried out in Italy specifically designed for less densely populated areas. We found that the potential supply and demand of P2PCS in FVG is significantly influenced not only by socio-demographic characteristics such as gender, age and occupational status, but also by travel habits and by latent beliefs about the service flexibility. An important factor influencing both the supply and the demand is the value of the rental rate. According to our analysis, only some segments of the potential car owners and renters have compatible WTA and WTP. However, about 10% of both samples would be willing to engage in this market if the hourly rental rate were €7/h, a value that is in line with the rental rate currently charged by B2CCS providers.

Despite our results, P2PCS is actually underused in FVG. This might be because many Italians consider their car as a good rather than as a service, as reported by [Laurino and Grimaldi \(2012\)](#) who studied the potentialities and the barriers preventing the uptake of B2CCS in Italy. However, according to our research, it is also because very few people are aware that the P2PCS services are actually available. None of the individuals we interviewed knew that there are currently two platforms serving the Italian market, Auting and Genial Move, and that there are car owners renting out their vehicle in FVG at rates that are in line with the WTP stated by our sample. Since the main feature of a two-sided market such as P2PCS is the existence of cross-group network externalities, its success strictly depends on reaching the critical mass on both sides of the market and FVG is far from having reached the minimum mass needed. [De Lorimier and El-Geneidy \(2012\)](#) and [Habib et al. \(2012\)](#), who studied the most important factors influencing the willingness to use a B2CCS service, already proved that the number of vehicles available at the carsharing stations has a major impact on how frequently the service is used. Although in the literature there are no indications on how large the critical mass should be, it is clear that in FVG the market is only at its very early stage of development and that it will take more effort by all the stakeholders involved in its growth before it represents a viable alternative to owning a car. As already found by [Awasthi et al. \(2009\)](#) with respect to B2CCS, appropriate marketing strategies and awareness campaigns are essential for the success of this new form of carsharing.

On the one side, the operators managing the existing platforms should invest in promoting the service better and in clarifying how the system works, especially with respect to liability and insurance issues. Fear of damaging the car and of having the car damaged are among the mostly cited reasons why individuals would not engage in the system. Flexibility is another important source of concern of both sides of the market. Car owners should be reassured about the fact that they are free to choose when and for how long to rent out their vehicles and that they can change the timing chosen according to their needs. Similarly, renters should be informed that they do not need to book the car in advance and that they can rent and use it as long as it is available and is equipped with an unlocking system enabling them to open and close the vehicle with their cellular phone. Moreover, since renters are concerned about the maximum distance that they can travel, they should be advised that the system allows parties to freely change the max distance constraint

(generally km 150) and that they can agree on the surcharge to be paid for any additional km travelled. Refueling is also a matter of concern since generally renters are in charge of it; to overcome such a potential barrier it should be clearly communicated that the system allows different arrangements, including paying the refueling cost directly to the owner. Trust is also a critical issue in a collaborative consumption markets such as P2PCS as recently proven also by [Valor \(2020\)](#). To reduce this psychological barrier, platform operators should publish not only the description of the car but also the renters' comments on their previous experiences using the car and their opinion on the car owner's reliability. Currently in the Italian platforms, ratings on renters are not available, but it is a feature that can be easily implemented and that, according to our results, would positively influence the number of car owners willing to rent out their car. Moreover, if the service were used in less densely populated areas as a community service, car owners and the car renters would most probably know each other, minimizing the psychological discomfort of dealing with a stranger.

Local administrators could provide parking discounts and reserved parking areas to the P2PCS users. As suggested by ([Bocken et al. \(2020\)](#)), [Cohen and Shaheen \(2016\)](#), [Hampshire and Gaites \(2011\)](#), and [van der Linden \(2016\)](#), exemption from parking limits and of parking fees, provision of on-street and off-street parking, and universal parking permits would lower the generalized cost of using the car fostering the willingness to engage in the system. Alternatively or additionally, Local administrators could grant tax ownership discounts to car owners willing to rent out their cars reducing the gap between their WTA and renters' WTP. These different forms of subsidies could also be designed in order to take into account the frequency with which the car is rented or/and the environmental sustainability of the vehicle rented (electric or hybrid vehicles vs. internal combustion ones). Finally, local administrators could finance the provision of a regional platform on which to promote and book not only public transport services but also P2PCS services (Mobility as a Service, MaaS) enhancing the visibility of this new form of shared mobility as suggested also by [Shaheen et al. \(2020\)](#).

At the national level, the government should regulate how earnings from P2PCS are taxed, preventing unfair competition with professional rentals. Italy has proposed a bill regulating the emerging sharing economy sectors, requiring platforms to sign up to a sharing economy registry and to provide documents for the AGCM's (competition authority) approval. According to the bill, personal income from sharing economy platforms below €3000 would not be taxed, income under €10,000 would be taxed at a 10% rate, while revenues over €10,000 would be subject to the standard marginal tax rate. [Vaughan and Daverio \(2016\)](#) estimated that taxes paid would be reduced by 56.5% for people earning less than €10,000.

Finally, the social and environmental benefits of this new form of mobility should be taken into account when deciding how to regulate and subsidize the market. Subsidies such as parking discounts or car tax exemptions are justified as long as the net social benefits of these policies are positive. According to our estimates, P2PCS could reduce the GHG emissions in FVG by a quantity ranging from 11.6 Kt to 37.9 Kt per year, corresponding to a monetary value ranging between 292 K€ and 2463 K€. Specific studies, however, should be carried out to estimate how the mobility habits of renters and car owners would change (fewer trips and shorter distances travelled) and how this additional mobility service would increase social inclusion and would address the transition toward a more sustainable transport system (less energy consumption and mitigation of climate change impact).

Generalizing our findings requires caution since we collected the data in November–December 2019 before the corona virus pandemic started. The health emergency has most probably altered the safety perception of sharing a car with strangers and a specific research should be carried out on this matter. In addition, the number of commuting trips has significantly reduced due to the high percentage of people

working and studying from home, possibly negatively affecting also the demand for P2PCS services. Indeed, according to the annual report of the sharing mobility trends, in Italy the percentage of carsharing trips per day decreased by 20% in October 2019 compared to February 2019.⁸ Future research lines should also include the collection of both revealed and stated preference data in both less and more densely populated Italian regions. With these additional data, it would be possible to control for the hypothetical bias characterizing the stated preference approach and to account for the different cultural characteristics and mobility habits between the northern and the central-southern Italian regions. Additional effort would also be devoted to estimate hybrid choice models, since they are better able to control for the latent variables influencing the choice process under study.

CRedit authorship contribution statement

Lucia Rotaris: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing.

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