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Car-sharing in Flanders

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Executive Summary

This report details the research conducted by researchers of the Steunpunt Circulaire Economie. The report covers the results of a consumer survey with over 2000 respondents, as well as four interviews with car-sharing companies and interest groups.

The main aims of this research are to get a better understanding of the position of car-sharing in Flanders, what people think of car-sharing, including the barriers people face, and what impact car-sharing is having on behaviour and the environment. The report concludes with a set of implications and recommendations for policy relating to car-sharing and its place in the circular economy. These conclusions are summarised below.

On the evidence of this report, car-sharing *could* help to reduce the environmental impacts associated with mobility, but only under certain conditions. There is a danger that car-sharing adds to environmental pressures if it is used as an additional form of mobility, rather than as a replacement for private car ownership. Thus, in order to maximise the environmental benefits of car-sharing, and to minimise the risk of increasing environmental burdens, car-sharing should only be encouraged at the expense of car ownership.

There is little evidence that reducing the cost of car-sharing for users will have environmental benefits. Evidence from those who already use car-sharing show that 91% do so because it is cheaper than owning and using a private car (figure 15). Moreover, of those who are not-sharing, cost was the least important barrier (figure 27). Reducing the cost of car-sharing to consumers will lead to a greater risk of increasing car-use, at the expense of public transport and cycling. Thus, policy should avoid subsidies, both for firms and consumers, whether in the form of direct cash transfers, refunds, or beneficial tax treatment.

Almost 40% of the respondents (figure 27) said that they might be more willing to share cars if the city would make it easier to park shared cars. However, the underlying principle expressed earlier means that any ease of parking restrictions or increase of spaces must be at the expense of private cars. That is, if parking for shared cars is to be eased, parking for private cars should be reduced and restricted concurrently.

Car-sharing has ambiguous effects on public transport. In our survey, 70% of car-sharing users joined car-sharing because it is faster than public transport (figure 15). This suggests that for some members, car-sharing could substitute for public transport, a negative outcome for the environment. To

avoid this substitution effect, public transport, as well as active modes such as cycling, must continue to be supported as much as possible by policies, even at the expense of car-sharing.

Results from the survey suggest that non-sharers are confused about aspects of car-sharing, such as costs and liability. More clarity about these issues from car-sharing firms could help. Regarding costs, there is substantial variation amongst car-sharing firms and their cost structures: a mix of membership fees, monthly fees, km costs, time costs, reservation costs etc. This makes it difficult for users to compare different car-sharing schemes, and crucially to compare it to car-ownership. Many firms already offer a cost calculator; however, a non-partisan price comparison website may ease decisions for potential users. Clear guidance regarding responsibilities, especially the procedure in the case of accidents, may also help ease concerns of potential users.

A common concern amongst non-sharers is the availability of cars, both geo-spatially (e.g. in their neighbourhood) and to meet demand (e.g. availability of a car when they need it), as highlighted in figures 26 and 27. These issues can be overcome by expanding the number of cars in the fleet; however, this will negatively affect the environmental impact and resource efficiency, as cars will be left unused for longer. This is a delicate balancing act for car-sharing firms to manage, as investing in the size of the fleet requires significant capital outlay, as discussed in section 3. However, p2p car-sharing can potentially take advantage of a large fleet if it can attract car-owners to the platform, while some local governments share their own fleet. Sharing an already existing fleet should reduce additional demand (and production) of cars, avoiding some environmental impact and material use.

Results from this research suggest that both existing car-sharers and potential car-sharers are willing to pay more for electric (shared) cars. Moreover, 94% of users joined car-sharing because they think it is better for the environment (figure 15). Thus, there appears to be an opportunity to use car-sharing to help the transition towards car electrification by improving infrastructure and breaking down the cultural norms that resist electrification. However, charging stations are expensive to install and a lack thereof may pose a significant barrier for electric car-sharing firms. Local governments, in conjunction with car-sharing firms, may expand charging stations in the area to increase the supply of electric shared vehicles. Having charging stations, however, is not enough: if parking spots in the city are scarce, it is a common problem that charging spots are taken just for parking space.

Local government could support car-sharing by greater enforcement of rules punishing this practice.

Our statistical analysis shows that company cars are one of the biggest hurdles for ones car-sharing intention. Talks are ongoing to change the system towards a mobility budget or to, at least, decrease the benefits that are currently on company cars.

The regulatory framework for shared cars is currently underdeveloped which means that there is no consistent set of rules across municipalities. However, it would be easier for car-sharing firms if the same rules would apply for the whole region or country. A unified view and regulatory framework would greatly reduce the costs that car-sharing firms incur for researching the local rules, negotiating with the cities, and implementing their business each time they want to expand to a different location.

This research has been conducted despite limited access to third-party data. To improve policy making in the domain of car-sharing, and mobility more generally, data collection and availability has to be improved. Greater collaboration between different levels of governments, car-sharing firms and universities/research institutes would enable a greater evidence base for policy making. One step towards this is the inclusion of open data clauses in the permits or contracts between (local) governments and CS firms.

Nederlandse Samenvatting

Dit rapport zet de details uiteen van het onderzoek van onderzoekers van het Steunpunt Circulaire Economie. Het rapport bevat de resultaten van een consumentenonderzoek met meer dan 2000 respondenten, evenals vier interviews met autodeelbedrijven en belangengroepen.

De belangrijkste doelstellingen van dit onderzoek zijn een beter inzicht te verkrijgen in de positie van autodelen in Vlaanderen, wat mensen denken over autodelen, inclusief de barrières waarmee mensen worden geconfronteerd, en welke impact autodelen heeft op gedrag en het milieu. Het rapport besluit met een reeks implicaties en aanbevelingen voor beleid met betrekking tot autodelen en de plaats daarvan in de circulaire economie. Deze conclusies zijn hieronder samengevat.

Op basis van dit rapport *zou* autodelen *kunnen* helpen om de milieueffecten gepaard gaand met mobiliteit te verminderen, maar alleen onder bepaalde omstandigheden. Het gevaar bestaat dat autodelen bijdraagt aan de milieudruk als het wordt gebruikt als een extra vorm van mobiliteit, in plaats van als vervanging voor particulier autobezit. Om de milieuvoordelen van autodelen te maximaliseren en het risico op toenemende milieulasten te minimaliseren, moet autodelen daarom alleen worden gestimuleerd ten koste van het autobezit.

Er zijn weinig aanwijzingen dat het verlagen van de kosten van autodelen voor gebruikers voordelen voor het milieu zal hebben. Uit gegevens van degenen die al autodelen gebruiken, blijkt dat 91% dit doet omdat het goedkoper is dan het bezit en het gebruik van een privé-auto (figuur 15). Van degenen die niet delen, was bovendien de kostprijs de minst belangrijke factor (figuur 27). Het verlagen van de kosten van autodelen voor consumenten leidt tot een groter risico op toenemend autogebruik, ten koste van het openbaar vervoer en fietsen. Het beleid moet dus subsidies, zowel voor bedrijven als voor consumenten, vermijden in de vorm van rechtstreekse overdrachten in contanten, terugbetalingen of een gunstige fiscale behandeling.

Bijna 40% van de respondenten (figuur 27) gaf aan misschien meer bereid te zijn om auto's te delen als de stad het gemakkelijker zou maken om gedeelde auto's te parkeren. Het eerder geformuleerde onderliggende principe betekent echter dat elk gemak van parkeerbeperkingen of toename van het aantal parkeerplaatsen ten koste moet gaan van privé-auto's. Dat wil zeggen, als parkeren voor deelauto's moet worden vereenvoudigd, moet parkeren voor privéauto's tegelijkertijd worden verminderd en moeilijker gemaakt.

Autodelen heeft ambigue effecten op het openbaar vervoer. In onze enquête heeft 70% van de autodeelgebruikers zich aangemeld voor autodelen omdat dit sneller is dan het openbaar vervoer (figuur 15). Dit suggereert dat voor sommige leden autodelen in de plaats zou komen van openbaar vervoer, een negatieve uitkomst voor het milieu. Om dit substitutie-effect te voorkomen, moeten het openbaar vervoer en actieve vervoerswijzen, zoals fietsen, zoveel mogelijk door beleid worden ondersteund, zelfs ten koste van autodelen.

Resultaten van de enquête suggereren dat niet-delers vragen hebben over aspecten van autodelen, zoals kosten en aansprakelijkheid. Meer duidelijkheid vanuit autoverzekeringsbedrijven over deze kwesties zou kunnen helpen. Wat de kosten betreft, is er een grote variatie tussen autodeelbedrijven en hun kostenstructuren: een combinatie van lidmaatschapskosten, maandelijkse kosten, km-kosten, tijdskosten, reserveringskosten, enz. Dit maakt het moeilijk voor gebruikers om verschillende autodeelsystemen te vergelijken, en nog meer om te vergelijken met autobezit. Veel bedrijven bieden al een kostencalculator aan; een onafhankelijke prijsvergelijkingswebsite kan beslissingen voor potentile gebruikers echter vergemakkelijken. Duidelijke richtlijnen met betrekking tot verantwoordelijkheden, vooral de procedure bij ongevallen, kunnen ook de bezorgdheden van potentile gebruikers helpen verlichten.

Een veel voorkomende zorg onder niet-delers is de beschikbaarheid van auto's, zowel geo-ruimtelijk (bv. in hun buurt) als om aan de vraag te voldoen (bv. beschikbaarheid van een auto wanneer ze deze nodig hebben), zoals aangegeven in figuren 26 en 27. Deze problemen kunnen worden opgelost door het aantal auto's in het wagenpark uit te breiden; dit heeft echter een negatieve invloed op de milieu-impact en de hulpbronnenefficintie, omdat auto's langer ongebruikt blijven. Dit is een delicate evenwichtsoefening voor autodeelbedrijven om te managen, omdat investeren in de omvang van de vloot aanzienlijke kapitaaluitgaven vereist, zoals besproken in hoofdstuk 3. P2p autodelen kan echter potentieel profiteren van een grote vloot als het auto-eigenaren naar het platform kan trekken, terwijl sommige lokale overheden hun eigen vloot delen. Het delen van een reeds bestaande vloot zou de extra vraag (en productie) van auto's moeten verminderen, waardoor enige milieu-impact en materiaalverbruik wordt vermeden.

Resultaten van dit onderzoek suggereren dat zowel bestaande als potentile autodelers bereid zijn meer te betalen voor elektrische (deel)auto's. Bovendien is 94 % van de gebruikers lid geworden van autodelen omdat ze denken dat dit beter is voor het milieu (figuur 15). Er lijkt dus een mogelijkheid te bestaan om autodelen te gebruiken om de overgang naar auto-elektrificatie te helpen door de infrastructuur te verbeteren en de culturele normen te doorbreken die weerstand bieden aan elektrificatie. Laadstations zijn echter duur om te installeren en een gebrek daaraan kan een belangrijke barrière vormen voor bedrijven die elektrische auto's delen. Lokale overheden, in samenwerking met autodeelbedrijven, kunnen laadstations in het gebied uitbreiden om het aanbod van elektrische gedeelde voertuigen te vergroten. Laadpalen hebben is echter niet voldoende: als parkeerplaatsen in de stad schaars zijn, is het een veel voorkomend probleem dat laadpunten louter als parkeerplaatsen worden ingenomen. De lokale overheid zou autodelen kunnen ondersteunen door een betere handhaving van regels die deze praktijk bestraffen.

Onze statistische analyse laat zien dat bedrijfswagens een van de grootste hindernissen zijn voor iemands intentie tot autodelen. Er zijn gesprekken gaande om het systeem te veranderen in de richting van een mobiliteitsbudget of om de voordelen van bedrijfsauto's te verminderen.

Het regelgevend kader voor deelauto's is momenteel onderontwikkeld, wat betekent dat er geen consistente set regels bestaat tussen gemeenten. Voor autodeelbedrijven zou het echter eenvoudiger zijn als dezelfde regels voor de hele regio of het hele land zouden gelden. Een uniforme visie en een regelgevend kader zouden de kosten die autodeelbedrijven met zich meebrengen voor het uitzoeken van de lokale regels, het onderhandelen met de steden en het uitvoeren van hun bedrijf elke keer dat ze naar een andere locatie willen uitbreiden aanzienlijk verminderen.

Dit onderzoek is uitgevoerd ondanks beperkte toegang tot gegevens van derden. Om de beleidsvorming op het gebied van autodelen en mobiliteit in het algemeen te verbeteren, moeten gegevensverzameling en -beschikbaarheid worden verbeterd. Meer samenwerking tussen verschillende niveaus van overheden, autodeelbedrijven en universiteiten/onderzoeksinstituten zou een grotere bewijsbasis voor beleidsvorming mogelijk maken. Een stap hiertoe is het opnemen van open data-clausules in de vergunningen of contracten tussen (lokale) overheden en CS-bedrijven.

Contents

1. Introduction

Flanders is the Dutch-speaking region in the North of Belgium. Flanders' traffic is problematic, especially around Belgium's capital, Brussels. Van Broeck (2018) summarizes a couple of striking numbers. Although Flanders is only 13.522 km^2 with about 6.5 million inhabitants, there are 4 million cars that need approximately 24000 hectares of parking space because, on average, the cars stand still for about 23 out of the 24 hours in a day. Van Broeck (2018) links the parking and mobility problems to bad spatial planning; many like to live in more rural areas but that means they rely on a car to get to work, shops, and other facilities. Making public transportation available close to everyone's home is also difficult if houses are spread everywhere. Changing the spatial planning takes a lot of time, and mobility as a service (MAAS) is viewed as a good temporary means to reduce car ownership, car usage, and ultimately resource use and CO2 emissions; car-sharing is part of MAAS.

1.1. Setting

This article describes the results of a online survey on car-sharing that was launched in Dutch in September, 2018. The survey was spread as a clickable link through several institutions' mailing lists, social media, and news letters to reach a broad and varied audience. The study's target audience were adults living in the Flanders region, in Belgium. Most of them already had a drivers' license but we were also interested in respondent who didn't have a license yet but were planning to get one soon (within 5 years). It has been said that younger people consider a car less of a status symbol and are thus less eager to get a drivers' license (the number of new drivers' licenses per year has dropped 18% since 2010, (Cardone 2019)). We wondered whether those who still need to get their drivers' license would be more willing to share cars once they start driving. Especially since experts believe the main reasons for postponing or forgoing obtaining a drivers' license is convenient public transportation and the high cost of getting a license (Hjorthol 2016, Le Vine and Polak 2014).

In line with neighboring countries, Belgium has seen a rise in the number of car-sharing businesses the last years. Table 1 gives and overview of all car-sharing providers that operate in the Flanders and Brussels region. All information was retrieved from the company websites. For the costs reported in Table 1, we distinguish three possible fixed costs that do not depend on car usage: a deposit (Dep), a one-off registration fee (Reg), and a periodical membership fee (M, mostly monthly or yearly). Additionally, what is paid for car usage may depend on the time (T) or distance (D) the car is used, and some also require fuel costs (F) or a fixed reservation fee (Res) to be paid.

Another important feature of a car-sharing system is the flexibility in the location where the car can be picked up or left after use (see Table 1). We distinguish four possibilities here, like Rodenbach et al. (2018) for instance. Free-floating systems allow the user to leave the car in a different place than where it was picked up. Sometimes, this can be in any location in the operational area (FF-OA) while some cars still have to be left at a station of the operator but it may be in a different location or even a different city (the free-floating, station based system, FF-SB). Round-trip systems require that the car is always returned to where it was picked-up; either in the same home base (RT-HB) or at exactly the same station (RT-SB).

Company	Costs							type		Location	Electric
Battmobiel			M		T	D	F	B2C	FF-OA	Ghent	Yes
Bolides				Res	T	D		B2C	RT-HB	Antwerp, Ghent, Leuven	No
Cambio	Dep	Reg	M		T	D		B2C	RT-SB	Belgium	Partly
Caramigo	Dep				T	D	F	P2P	RT-HB	Belgium	Partly
Cozycar	Dep		M			D		P2P	RT-HB	Belgium	Partly
Dégage!	Dep	Reg				D		P2P	RT-HB	Flanders	Partly
DriveNow	Dep	Reg			T			B2C	FF-OA	Brussels	Partly
Drivy					T	D	F	P2P	RT-SB	Brussels	No
Partago	Dep			Res	T		F	B2C	FF-OA	Flanders	Yes
Poppy					T	D		B2C	FF-OA	Antwerp	Partly
Stapp.in		Reg	M		T	D		B2C	RT-SB	Groot-Beveren	No
Tapazz					T	D		P2P	RT-SB	Belgium	No
Ubeeqo		Reg	M		T	D		B2C	RT-SB	Brussels	Partly
Wibee.be	Dep		M		T	D		P2P	RT-SB	Belgium	No
Zencar		Reg			T		F	B2C	RT-SB	Brussels	Yes
Zipcar		Reg			T	D		B2C	FF-OA	Brussels	Yes

Table 1: Overview of all car sharing systems operating in Flanders and Brussels

1.2. Literature review

This section is split into two sections; the first one reviews the stream of literature on the motivations and/or barriers for car-sharing while the second one reviews the literature on measuring the impact car-sharing has on society and/or the environment.

Company	Partnerships			Parking Benefits	For Profit
Battmobiel	Gov			✓	
Bolides	Gov		OEM	✓	✓
Cambio	Gov	PT	OEM	✓	✓
Caramigo	Gov		OEM		✓
Cozycar	Gov			✓	
Dégage!	Gov			✓	
DriveNow	Gov	PT	OEM	✓	✓
Drivy					✓
Partago	Gov	PT	OEM	✓	
Poppy					✓
Stapp.in			OEM		✓
Tapazz	Gov				✓
Ubeeqo	Gov	PT	OEM	✓	✓
Wibee.be					✓
Zencar	Gov		OEM	✓	
Zipcar	Gov			✓	✓

Table 2: Overview of partnerships, parking benefits, and profit focus

1.2.1. Car-sharing profiles, motivations and barriers

A first factor that may influence car-sharing membership, is *demographics*. Previous research has found that car-sharers are younger (Shaheen et al. 1998, Loose 2010, Prieto et al. 2017) and higher educated (Münzel et al. 2017, Adam et al. 2005) than the general population. However, there is no straightforward conclusion on how gender influences car sharing membership; Prieto et al. (2017) concluded males are more willing to share cars while Martin and Shaheen (2011) saw more willingness to share in women. Typically, though, a household decides to become a member of a car sharing system. Household with at least 2 adults and especially those with kids are more likely to have a car sharing membership as it might help them get by with only one in stead of two privately owned cars(Loose 2010, Münzel et al. 2017). For employment, Loose (2010) found that full-time employment increased the likelihood of sharing. While other access-base business models often claim to increase access to goods for people who are financially struggling (Bardhi and Eckhardt 2017), this does not really seem to be the case for car sharing. 6t-bureau de Recherche (2014) did find that one particular one-way car sharing scheme attracted a lot of students (with low incomes) who used it as a more practical alternative to public transportation.

Car-sharing in Flanders is most present in *larger cities*. There are several reasons for this. Firstly the higher population density means that shared cars are used more intensely in urban areas and less cars are needed to get a shared car close to many sharers. This makes for a more profitable and easier business for car-sharing firms (Münzel et al. 2017). Secondly, research has shown that people in urban areas are more open to car sharing and sharing in general (Loose 2010). Lastly, an urban environment often has better public transportation and expensive parking space which makes car-sharing more interesting than owning a car (Münzel et al. 2017, Huwer 2004, Adam et al. 2005).

When asked about the reason for sharing cars, many car sharers state that it is cheaper than owning a car (provided the car is used very little). One can save on maintenance costs, purchasing costs, but also parking costs (in Flanders, several communities provide parking benefits for shared cars). It is calculated that a shared car would be cheaper for people who drive less than 10,000 to 12,000 kilometers per year (Loose 2010). However, the benefit will depend on the car that would have been chosen as a private car; if one would choose a small, fuel efficient car, the turning point beyond which sharing is no longer financially beneficial is 6500 kilometers (van Driel and Hafkamp 2015).

Most of the articles that are reviewed in this section use *consumer studies* to come to their conclusions. However, very few include a choice experiment in their study. Liao et al. (2018) is very similar to our survey considering that they designed a choice experiment where the attributes include many similar car-sharing system characteristics such as the fuel type of the vehicles, one-off and recurring operating costs, return location and availability and access time. Liao et al. (2018) one-off, monthly, and operating costs for both private cars and car-sharing systems. We limit the cost parameters to just two. Intermediate trials with a test audience reveled that this type of cost structure was too difficult to comprehend and compare. While they also include both car sharers and non-carsharers, all respondents are required to make a choice between buying (or not scrapping) a car and car-sharing. In contrast, in our DCE, car sharers choose between two car-sharing systems to get a better estimate of the WTP for car-sharing system attributes from those who have used it before.

1.2.2. Car-sharing impacts

Measuring the impact of the sharing economy on the environment is crucial to establish the extent to which it can help the transition to a more sustainable economy. To meet global environmental goals to reduce greenhouse gas emissions and to reduce material throughput, technological change is unlikely to be sufficient: there will also need to be a change in behaviour.

The purported benefits of car-sharing include a reduction in car production and car use amongst existing car drivers as a result of behavioural changes Cohen and Kietzmann (2014). On the technological side, benefits may be stimulated at other stages of the value chain, such as the development of cars with higher fuel efficiencies and much longer lifetimes (in terms of distance travelled) Material Economics (2018). These effects are all interrelated, and the ultimate effect on the environment is a result of a complex interaction between these effects.

Existing car-sharing studies tend to focus on the effects of car-sharing on car-ownership, often neglecting effects on car-use altogether. In general, car-sharing is associated with a reduction in the number of cars owned, either through the sale or scrappage of a car, or through cancelling the planned purchase of a car. However, in a number of these studies, there are not adequate methods to eliminate reverse causality, i.e. cases where a lack of car-ownership *causes* someone to join car-sharing, rather than vice versa. By ignoring this, results will be positively biased, showing a greater effect of car-sharing than is the case in reality.

Moreover, focusing exclusively on car-ownership alone will not reveal whether car-sharing results in a net environmental benefit. Private cars are likely to be replaced less often than shared cars because of their lower use-intensity. An elementary calculation can thus show that, unless car-sharing reduces car-use or increases car longevity (i.e. the total distance travelled in the car during its lifetime), then the number of cars produced will not be affected at the aggregate.

It is thus vital to look at the impacts of car-sharing on car-use, which some studies have done. In general, car-use appears to fall amongst some users (e.g. those who get rid of a car), but increases for others (e.g. those who did not own a car). Martin and Shaheen (2011) found that the number of car-sharing users that increased their km travelled by car was greater than those that reduced their in car km. However, at the aggregate, car-sharing resulted in fewer km driven by car (and less emissions) due to the size of the effect: the decrease in km travelled by car per person because of car-sharing was much larger than the increase in km travelled for the other group without a car. Reductions in car-usage have also have been found by, inter alia, Martin and Shaheen (2016), Cervero et al. (2006), Nijland and van Meerkerk (2017). However, the methods use to estimate changes in car use rely on car-sharing users' estimate of their own change in behaviour. This can introduce a number of issues, such as self-assessment bias and recall bias, both of which can lead to inaccurate estimates of the effect of car-use.

In sum, while there seems evidence of a benefit of car-sharing for the environment and resource use, there are a number of methodological shortcomings that could lead to question this broad conclusions. Moreover, few studies examine how or what is responsible for this benefit in car-sharing, or which characteristics of users or car-sharing schemes may lead to a benefit of car-sharing. This research aims to fill these gaps by conducting a robust impact evaluation car-sharing.

2. Methodology

We started with interviewing car-sharing users, car-sharing experts, and three Belgian car-sharing companies (see Section 3). Based on information from the interviews and a review of the academic literature, a first version of the survey was designed. This initial survey was then reviewed by a test group with a balanced mix of experienced car-sharers on the one hand and people who were completely unfamiliar with car-sharing on the other hand. After several iterations of review and adjustments, the final survey was put online September 2018. The survey was made with Qualtrics and stayed online until the end of October, 2018. The survey consists of several parts. Respondents were asked about their socio-demographic information (Section 2.1) and their current and historic mobility choices and options (Section 2.1). Respondents who are shared cars got some extra questions (Section 2.3). Next, all respondents are asked to make 8 choices between fictitious cars to buy or share in a discrete choice experiment (Section 2.5). Lastly, the survey concludes with some closing questions and room for the respondent to leave feedback to the survey (Section 2.6).

2.1. Demographics

Since previous research indicates that many socio-demographics matter in making mobility choices, people are first questioned about the following:

- Age: Shaheen et al. (1998), Loose (2010), Prieto et al. (2017) show that younger people are more likely to share cars.
- Gender: Prieto et al. (2017) found men to be more likely to share cars.
- Occupation (and income): Prieto et al. (2017) found that car-sharers are often in the lower income category and a French car-sharing study

found most car-sharers had executive jobs although one of the car-sharing system (Autolib') attracted quite some students (6t-bureau de Recherche 2014).

- education: car-sharing attracts more highly-educated people according to (Becker et al. 2017, Prieto et al. 2017, 6t-bureau de Recherche 2014)
- Location (postal code and rural vs urban environment): Loose (2010) found that car-sharers mostly lived in urban environment. This is to be expected since this is where offer of shared car well developed and diverse.

2.2. Mobility data

Whether or not someone has a car, bike, or public transport subscription will certainly influence the interest in sharing cars. For many, nothing beats the convenience of having a private car in the driveway and it is hard to imagine having to reserve a shared car in advance or walking a couple of minutes to get to the car. Therefor, we asked respondents whether they have a drivers' license, private or company cars, public transport subscriptions, bikes, motorcycles, and scooters. For private cars, we obtained the type/model of the car, age, fuel type, estimated weekly kilometers, and the number of passengers that are usually in the car.

6t-bureau de Recherche (2014) noted a decrease in the number of private cars and the vehicle kilometers travelled for their sample of car-sharers. To test this, we asked respondent how many kilometers they travel with all transportation modes (private car, company car, as a passenger in someone else's car, shared car, public transportation, by foot, (electric) bike, motorcycle, taxi). We also asked about how they commute to work or school and how far this commute is. To be able to compare car ownership between car-sharers and non-car-sharers, we ask all respondents how many cars they bought (new or 2^{nd} hand), least, sold, and scrapped in the last 5 years. For the next five years, we ask respondents how likely it is that the obtain another private car.

2.3. Car-sharing

To realistically estimate the environmental impact of car-sharing, a lot of data is needed. Some data can be retrieved from industry-level data such as the number of cars that a car-sharing firm has, the longevity, and the fuel efficiency of these shared cars compared to the average private car. But it is expected that people who start sharing cars will likely alter their mobility habits when they start sharing.

We firstly ask car-sharer whether they sold or scrapped a car because they started sharing, or whether they did not buy a car because of car-sharing. This allows each car-sharing user to be sub-categorised into different user types, each of which is expected to change their behaviour differently. We also ask sharer how they think they changed their mobility habits since they started sharing; whether they drive a car, bike, or walk more or less. We also ask how often they drive the shared car, for which trips they use it, and which other modes of transport they use in combination with a shared car. Looking forward, we ask them how likely it is that, in the next five years, they will buy, sell, scrap or do not replace their current car *because of* car-sharing.

Many of these questions are hypothetical or require people to make an estimate (partly based on possibly subjective feelings). To control for this uncertainty, responses to these questions were on a scale to represent how confident respondents' were in their answers.

2.3.1. Motivations and inhibiting factors for car-sharing

Non-sharers were asked why they are not sharing cars and what would have to change for them to start sharing cars.

Sharers, on the other hand, were asked about their motivations to start sharing and whether they would consider to stop sharing (and, if so, why).

There were also some respondents that used to share cars but were not sharing cars anymore. This is an interesting group of people because they have real experience with car-sharing and appeared to be not satisfied.

A recent survey with one-way car-sharing users in France revealed that only 6% of the respondents mentions ecological concerns and most use shared cars because it is more practical than PT (6t-bureau de Recherche 2014). Those who found shared cars more practical than the private car, usually attributed this to the parking benefits they had. Some car-sharing businesses also expect environmental concern to be a motivational factor to few and thus look for other ways to make car-sharing more appealing (see Section 3).

2.4. Attitude/scale questions

Attitude or scale questions are typically added to surveys to better understand the underlying motivations, attitudes and values that drive people's choices. Respondents are commonly asked to rate several statements on a five- or seven-point scale from ‘strongly disagree’ to ‘strongly agree’. However, previous experience with online surveys showed that respondent are not always too eager to fill in these question as they require a lot of careful reading and may appear quite boring. Therefor, we limited the set of attitude questions and spread them over the survey in smaller batches so as not to exhaust the respondent too much with long lists of scale questions.

The statements were mainly based on previous literature on the motivation for car use and sharing. In particular, Steg (2005) investigated instrumental, symbolic, and affective motives for car use through scale questions. Hawlitschek et al. (2016), on the other hand, examined drivers for sharing and many of their questions were adapted to fit the car-sharing setting. In total, there were 46 statements which were used in a factor analysis, as described in section 5.1.

2.5. Discrete choice experiment

A discrete choice experiment (DCE) is a stated preference technique that asks respondents to state their preference over different alternatives. It is especially suitable for multidimensional problems such as the choice between buying or sharing a car. A baseline alternative, corresponding to the status quo or opt-out situation is included in each choice set in order to be able to interpret the results in standard welfare economic terms.

The survey has two DCEs - one for non-carsharers (DCE-NCS) and one for ca-sharers (DCE-CS). The first lets us explore why non car-sharers prefer to buy a car over sharing one and which attributes or specific features of car-sharing systems might entice them to start sharing. The second gives more insight into which attributes are most important for people who have actual practical experience with car-sharing. The attributes were chosen after an exploratory literature review, extensive talks with (non) car-sharers, field experts, and car-sharing companies. We describe each in detail in Section 2.5.1 and Section 2.5.1 respectively.

2.5.1. DCE-NCS

In this experiment, respondents are faced with 8 choices between (A) buying a car, (B) sharing a car or (C) an opt-out option (’neither’) in the following scenario (translated from Dutch).

$$\left\{\begin{array}{l}\text{Imagine that you (and your family) are in need of a new car.}\\[1em]\text{Imagine you just got your driver's license and you decide you}\\\quad\text{want to start driving more often}\end{array}\right.$$

We will ask you to choose between two options to expand your mobility options eight times. If neither of the options seem attractive to you, you can also indicate this. There are no right or wrong answers, we are only interested in your opinion

If you choose to **purchase a car**, **omnium** insurance is included. The **cost per kilometer** must be interpreted as the expected cost for fuel, insurance, taxes, and all maintenance costs.

A **shared car** also always includes an **omnium** insurance. The cars you use can be owned by other individuals who share their personal car on a **sharing platform** or owned by a **car-sharing company**. To be a member, you need to pay a monthly **subscription fee**. Next to that fee, you pay for each **kilometer** that you drive with the car. There are no costs other than those that are specified. Some cars need to be left behind in a dedicated parking spot after you used them while other systems are more **flexible** and the cars can be left behind anywhere. Reserving can be done online, through phone or a smartphone app.

The attributes that are involved in buying or sharing a car differ, as shown in Table 3. When people buy a car, there are many technical attributes to a car that play a key role (brand, model, price class, maximum speed, number of seats,...). As we are not interested in the willingness to pay for many of these car attributes, we first question the respondent about their preferred car model (mini; family car (max 5 passengers); family car (more than 5 passengers); sports car; SUV; or a self-specified other model), preferred fuel type (diesel; petrol; electric; hybrid; LPG; or other), price class, and whether they would buy a new, nearly new, or second hand car. The price class categories go from less than 5000 until more than 50000 euros, in steps of 5000 euros. In the experiment, the mid-point of the indicated price class is used as the ***budget*** in the attribute levels of the purchasing cost (see Table 3).

Most attributes in Table 3 are self-explanatory but the flexibility and availability might require some additional explanations.

The flexibility refers to the options the car-sharer has in the location where he can pick up and drop of a car. The least flexible option is a station-based system with fixed parking spots where the shared car can be picked up and needs to be returned after use. Free floating systems are the most flexible as the car can be left wherever after use. Free-floating systems usually also allows users to locate the shared cars through gps-tracking. An intermediate system was also included where the car can be left anywhere within a 2 kilometer radius around the pick-up location.

The availability captures the time it typically takes to get from the user's home to the shared car. If the closest car is not available at the time one needs a car, we reasoned that there must be another car further away.

2.5.2. DCE-CS

car-sharers choose between two car-sharing systems (A and B) or staying with their own car-sharing system. For later analysis, it is thus necessary to know what their current car-sharing system is. We ask respondents for the following information:

- Their primary (i.e. most often used) car-sharing system of which they are a member. This also gives us information about whether the fleet includes electric cars or not and whether it's a B2C or P2P system (Table 1). Some respondents were left out because they indicated a ride-sharing system in stead of a car-sharing system or an informal sharing system with friends or family.

- The costs for using the shared cars. Table 1 showed that the cost structure may be quite complicated. Respondents were asked for registration fees, yearly or monthly fixed costs, costs per kilometer, and costs per hour of driving/usage/parking. If people indicated they did not know some of these costs, we used the average costs that peers who did fill in all costs or tried to find the standard pricing scheme of their primary car-sharing system (for instance, if there were too few peers to get a reliable average cost). If that did not work, the respondent was excluded

Buying a car		Sharing a car	
Attribute	Attribute levels	Attribute	Attribute levels
Purchasing cost	***budget*** -2000 ***budget*** -1000 ***budget*** ***budget***+1000 ***budget***+2000 ***budget***+3000 ***budget***+4000 ***budget***+5000	Monthly cost	0 5 10 15 20 25
Kilometer cost	0.15 0.3 0.5 0.7	Kilometer cost	0.2 0.4 0.6 0.8 1
Fuel type	petrol diesel electric	Fuel types in the fleet	Diesel and petrol all kinds, including electric
		Type of system	B2B P2P
		Flexibility	Free floating 2km radius exact same spot
		Availability	2 minutes 5 minutes 15 minutes
		Reservation time	10 minutes in advance 1-3 hours in advance 2 days in advance

Table 3: Attributes and attribute levels (costs in euros)

for further analysis. All of these costs were recalculated to one monthly cost and one kilometer cost to be able to compare it to the chosen attributes in the other options. $M_{month} = Reg/24 + M_{month} + M_{year}$ and $D_{km} = D_{km} + 0.6 * (T_{hour})$. If only one of the three hourly costs are filled in, T_{hour} is equal to this costs. If multiple are filled in, costs for using or parking get a weight of 20% (if they are filled in) while driving costs get a weight of 80 or 60% if one or both of the other hourly costs are filled in respectively. The hourly costs (T_{hour}) are multiplied by 0.6 to obtain a kilometer cost as data studies showed that an average car-sharing trip took about half an hour while the travel distance was about 3km (Habibi et al. 2017).

- The number of minutes, hours, or days it takes to reserve a car.

- The time it take to get from their home to the shared car in minutes

2.6. Closing questions

To end the survey, respondents get some text boxes where they can leave any message they still want to send to the researchers. They are asked to mention any aspect of car-sharing that was overlooked in the survey but highly influences their decision (not to) share cars. Links were provided to the website of autodelen.net and the portal of the research unit. Lastly, they were referred to a separate form where they could leave some contact details if they were interested in winning cinema, Fnac, or Win-for-life tickets (with a value of 20).

3. Company interviews

To investigate which levers and/or obstacles Flemish CS firms experience to expand their business, four interviews of 1.5 to 2 hours were taken with representatives of three CS companies (Van Ootegem 2017d,a,c) and with Jeffrey Matthijs of autodelen.net (Van Ootegem 2017b). Autodelen.net is an umbrella organization for CS firms in Flanders which also informs consumers with regards to all practicalities that come with becoming a car-sharer. The three CS firms were selected based on their size, the type of organization and the type of CS system they offer. *Dégage* is a P2P CS firm that operates mainly in the city of Ghent. They recently also launched bike sharing and are spreading their CS services to other cities in Flanders. Dégage is mostly led by volunteers. Partago is a B2C initiative with a fully electric fleet. The cars can be located and unlocked with an app. The system is essentially free-floating but the cars do need to be left at a charging station at the end of the use. At the time of the survey, they were mainly based in Ghent but, like Dégage, they are quickly spreading to other cities. Cambio is the player with the most experience and the most members on the Belgian market. They have a station-based, round-trip CS model. This section will summarize the most important conclusions from all four interviews.

The main goal that is achieved by promoting CS is that *sustainable mobility is facilitated*, i.e.:

- reducing the number of cars
- reducing the number of kilometers that are driven with cars

- increasing the number of kilometers that are driven with cars
- increasing public transportation use
- increasing biking, walking, and other alternatives
- stimulating alternative fuel cars (eg. electic)

If all of the above benefits are realized, this will firstly lead to more sustainable mobility, but also to many other positive side effects, each a laudable objective with clear social added value:

- Positive *environmental effects* by reducing the number of cars and the number of kilometers that are driven with a car. It is expected that people are less likely to take the car if it is not available in their garage at all times.
- *Social cohesion* is promoted, especially in P2P CS systems with more social interaction. CS may also support and aid in the development of alternative cohabitation forms and (behavioral) practices
- Cooperative, sustainable, *social entrepreneurship* with a social purpose.

The interviewees thus agree that there are significant benefits in sharing cars for the environment, sustainable mobility, and from a social viewpoint. What is more, the benefits in each of those areas will likely even reinforce each other. The only issue on which there was some disagreement between interviewees was whether or not electric vehicles are shared more or less. Cambio stated that "sharing is more important than a forced electrification because sharing, in itself has many environmental advantages". They fear that having an only electric fleet might hinder some to start sharing if they do not feel comfortable with, for instance, the limited driving distance of the electric car or the limited number of charging stations.

To structure the information, the first three sections describe conclusions that are relevant for the local (Section 3.1), regional (Flemish) (Section 3.2), or federal level (Section 3.3). The following section discusses how CS (does not) fit into the current Flemish culture from a broader, systems-thinking view (Section 3.4). Lastly, Section 3.5 describes some determinants of CS systems that determine customer choices.

We would like to emphasize that Section 3 contains the views of the interviewees and not necessarily those of the authors. During the interviews, we took the same standpoint as the interviewee; that CS should be promoted as an alternative to car ownership because it could limit the number of cars and kilometers driven with cars (this proposition is investigated further in Section 6). The main focus for the interviews was defining the most important levers and obstacles for Flemish CS firms to establish or expand their business.

3.1. Local level

CS is and remains a mostly local (or urban / city-specific) phenomenon. Therefor, local (city) governments are the first and foremost potential partners for CS companies. There are *many alternatives for car ownership* in cities so CS is typically more successful. In a city with trains, trams and buses, there are plenty alternative for a car and, thus, a car is needed only sporadically. Owning a car becomes less attractive and sharing is more appealing; it is "no longer sensible to be a car owner" (Van Ootegem 2017a).

Local governments can play an important role by creating levers to make CS more successful. CS organizations are often looking for *partner cities* to help them establish themselves in the city. Cities are the engine for future developments in many areas, including mobility, and thus, CS. Several ways in which local governments may stimulate CS were mentioned: they can help out with communication, logistics, creating mobihubs (Mobihubs 2019), purchase or cooperation guarantees, and bringing in capital.

Communication is best set up in both a permanent way (e.g. an information sheet) and a specific/ short term way (e.g. promoting an activity). Local governments and cities have the best communication channels to reach local inhabitants, for example, the city's or village's newspaper, info sheet, website, or local activities. They can also organize specific event after which word-of-mouth will follow. Such a bottom-up approach has often proven to be most successful so starting up a new CS initiative is best done locally.

Local governments are the ideal *logistic partners*. They can offer *parking benefits* to shared cars. Similarly, they can provide reserved parking spaces for shared cars or add proper signals with the reserved parking spots. Proper *signalization* and/ or patrolling around the reserved parking spots is required to prevent them from being (mis)used by other drivers. All of this is seen as a huge motivation to start sharing, especially if parking space is currently scarce or expensive in the city.

Local governments can also install CS hubs or, better yet, mobihubs (Mobihubs 2019). Mobihubs are physical centers where (shared) bikes, public transport, shared cars, electric charging stations, taxis, or even shops with pick-up point for package deliveries all come together. There hubs are expected to be very important in rural areas as well where they would represent an offline version of Mobility as a Service (MaaS). Accomplishing such a mobihub will require a very well-coordinated policy vision and spacial planning.

Local organizations and governments can also establish *purchase guarantees* i.e., a minimum amount that the communal service will use the shared cars. This may significantly reduce the risk a starting CS business experiences. CS organizations may also choose to co-own cars with the local governments. Sharing the existing city's car fleet in a P2P CS system, although conceptually attractive, is not straightforward. It is unclear who will clean the cars (Cambio has a norm for cleanliness), maintain the car, and coordinate the availability of the cars. "CS is more than just making cars available. It is a service that does not 'happen' by itself. Cities have too little experience with it and take it too lightly" (Van Ootegem 2017a).

Capital needs are high for B2C CS companies because they have to prefinance an entire fleet of cars. What is more, the sharing system will only flourish if the service and car availability is high, meaning that plenty cars are needed to be able to attract plenty customers. Whether the cities can (or should) help by incorporating guarantees, buying cooperative shares, or supporting financial models to gather citizen capital is still an open question.

We close this section with some (good) examples or experiences in the city of Ghent (the cradle of both Partago and Dégage):

- Ghent offers parking licenses to all CS organizations such that shared cars can be parked in any parking spot in the city for free.

- Ghent repays the registration fee that is required to become a member of the CS organization.

- Ghent supports CS communication and promotion through, for instance, posters in the streets.

- Ghent has taken measures against driving cars in the city (expensive parking spots, many one-way streets, slow traffic,...). These measures have had a positive effect on the public opinion about mobility; the awareness had certainly increased.

- Thanks to Ghent, CS companies such as Partago an Dégage are firmly embedded into the daily city life. This is important for the future; if the CS companies are part of daily life, they will be taken into account in future projects.

3.2. Regional (Flemish) level

The most important obstacles that would need to be addressed at the Flemish level are:

- All cities and communities currently have a different way of recognizing or deciding to accept a CS firm. A standardized *Flemish regulatory framework* would help because this would make it much easier to move to different cities if the CS company has been recognized in one. currently, there is a Flemish resolution for CS (De Ridder et al. 2016).

- Widespread promotion and *awareness* is lacking and the Flemish government could promote the CS idea, sector, and good examples.

- As local governments do not always have the manpower to work out a whole policy for a CS firm, Flemish government could *support and incentivize* them, possibly financially. Examples would be to outline how to arrange purchase guarantees, or incentives to share the city's car fleet.

- Flanders can implement and support *'testing grounds'* to try out new initiative such as sharing vehicles for people with physical disabilities, sharing school buses, or other vehicles for special need groups. These testing grounds may also allow to test new business models.

3.3. Federal level

The biggest obstacles and how they at the federal level may be solved are the following:

- The *VAT-rate* for CS is currently 21% because it falls in the rental sector. However, the goals in sharing cars are very different from the goals in renting cars. Interviewees stated that the VAT-rate should be lowered to 6%.

- In Belgium, *company cars* are very beneficial from a fiscal point-of-view. Shared cars currently simply cannot compete with company cars. Recently, there have been some suggestions for introducing a *mobility budget* for employees that can be used for any mode of transport to get to work. This new system could make public transportation or shared cars better competitors against the company car.

- A license plate that clearly distinguishes shared cars from regular cars can make patrolling for parking violations easier.

- Some busy streets have a priority lane, reserved for buses. The interviewees suggest that these might also be used by shared cars or creating a special lane for shared cars only.

3.4. Culture of (car) ownership and a systems thinking view

A general obstacle for CS is *materialism*; the fact that people like to own things. For cars, people value the convenience of having a car close by at all times and owning a nice car is considered a status symbol. For many, their car is almost like an extra private room where they talk, have meetings, or even eat. And cars are more and more customizable or fitted to the individual. This car culture would have to change for CS to flourish since this requires that the car they used is also used by others.

Altering the current car culture will require some reflection about the current *way of life*; it should evolve into a more socially sensitive and environmentally conscious system. Our anthropocentrism is very large (and disastrous). We must distance ourselves from the idea that everything must always be immediately available. We should make more conscious choices to determine how we want to spend out time.

This change of attitude or way of life will also require more drastic changes in *the whole system* of mobility and spatial planning. We all have to make better choices about where we live, work, shop, relax, and also how we all live together. The urban sprawl is costing Flanders a fortune (Vermeiren et al. 2019).

3.5. Determinants of shared car use

Although there is consensus that CS is cheaper than owning a car for those who drive less than 10.000km per year, few actually make the shift to shared cars. In general, the limited success may be explained by the following determinants; ease of use, availability and proximity of the shared car, and price.

For the *price*, it is difficult for users to make a *fair* comparison between the price of a shared or privately owned car. The actual price of a private car consists of the purchase price, maintenance, vehicle inspection, insurance, fuel costs, etc... . Car owners rarely take into account all of these and tend to consider only fuel costs while indirect costs are overlooked. This means that shared system may seem overpriced. It should also be noted that external costs (pollution, congestion,...) are significant for the society but neglected in any price calculation. It is expected that these costs are lower for shared cars than privately owned cars.

A second important benefit of CS is *ease of use* but this is often underrated. One does not have to take care of maintenance of the car (big or small), there's no car insurance, you do not have to look for a replacement when it breaks down... One is really carefree if he shares cars.

Thirdly, the *availability and proximity* of the car is important. Three criteria play a role: where you want a car, which car you want, and when you want it. Starting from those criteria, Cambio offers alternatives to choose from when a customer makes a request to come as close to what they want as possible. As such, 90% of the car requests are fulfilled. Only 10% cannot be fulfilled, for instance if a large moving truck is needed at a very specific time and it has been reserved by someone else in advance.

If the perception of people can be shifted toward the idea "that shared cars should be chosen for convenience", the group of customers that can be convinced may be a lot larger since this would not only attract people with environmental motives.

4. Exploratory data analysis

In total, 3433 individuals opened the survey online. They were told that the survey would take approximately 20 minutes and that they would have a chance for a prize (cinema tickets, lottery tickets, or a 20 gift voucher for a multimedia store.

For further analysis, we only focus on people who filled in, at least the full DCE experiment. As such, we are left with 2106 respondents (i.e. a response rate of 61.35%). The violin and box-plots in Figure 1 shows the distribution of the time it took respondents to fill in the whole survey. Since car-sharer received some additional questions, it took these respondents slightly longer to fill in the survey. It should be noted that the Qualtrics survey platform allows respondent to close their browser and continue their answers later on (up until a week later). Completion times of more than 2 hours are not shown in the Figure to exclude outliers such as those who stopped and continued at a later point in time (140 respondents took more than 2 hours to complete the survey).

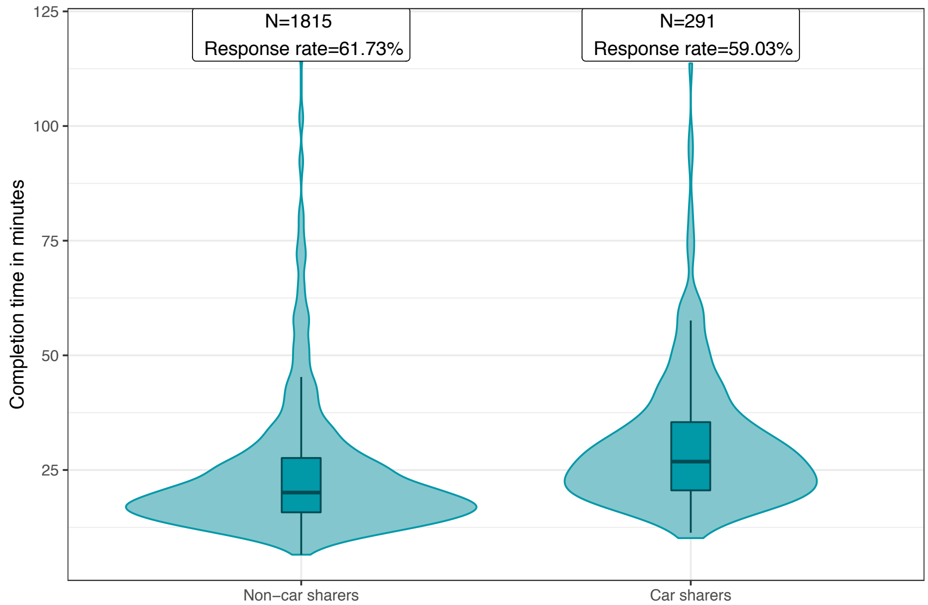


Figure 1: Distribution of the time it took respondents to fill in the survey.

The Qualtrics software also allows to track the progress of the respondents. Figure 2 shows how far respondents got into the survey. As indicated on the figure, many stopped when we asked them to describe all the privately owned cars in their family. This question was quite detailed; we asked for the model of car, the year it was produced, the fuel type, the average number of kilometers they drive per week, and how sure they are about their estimated average mileage per week. There is another drop in respondents when we get to the DCE. This requires respondents to really think and compare different options. Some respondents might have underestimated the mental effort that the survey required and were not willing to put in the effort. Finally, 60.08% of the non car-sharers and 59.46% of the car-sharers filled in the complete survey. The P-value of 0.47 for the Logrank test indicates that there's no statistical difference between how much the car-sharers and non-car-sharers completed the survey.

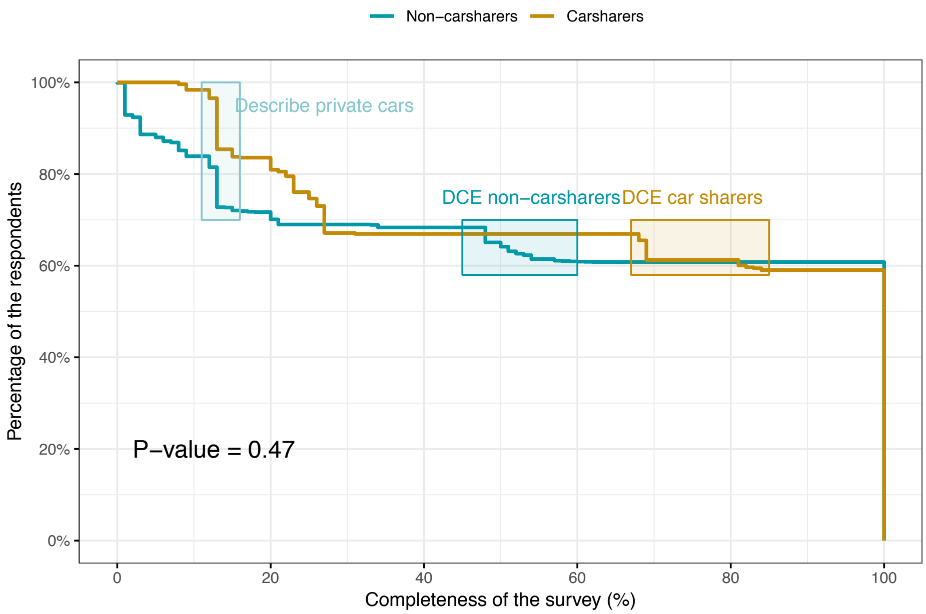


Figure 2: Distribution of the time it took respondents to fill in the survey.

4.1. Demographics

Figure 3 shows the distribution of the age and gender of the respondents. Overall, the survey attracted a nice range of ages and gender. There's a slight peak in respondent in their mid-twenties. This is likely due to the fact that two Masters' students were asked to spread the survey; they mainly spread it in their own group of friends through social media.

The mean age of car-sharers appeared to be significantly lower than the mean age of the non-car-sharers (mean age of 37.8 vs 41.1 years old, One-Way ANOVA p-value < 0.001) but there was no significant difference in gender (Chi-Squared test, p-value of 0.97).

Figure 3: Distribution of the age and gender of the respondents.

When it comes to education, car-sharers are relatively higher educated with more people having a Master degree or higher (Figure 4). Among the non-sharers, there are far more people whose highest degree was secondary school. This difference in education is statistically significant (Chi-Squared test, p-value < 0.001).

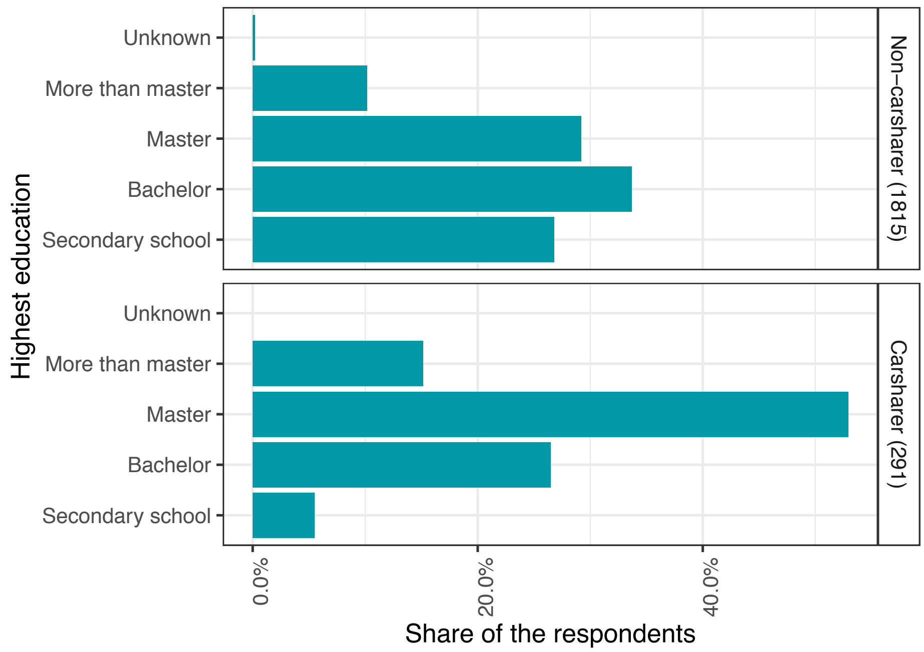


Figure 4: Highest obtained education

In Figure 5, it is clear that there are less unemployed and more full-time and part-time employed people among the sharers. This could be due to precarity; if people do not have a steady job and income, taking part in access-based business models is risky if this requires fixed monthly payments. As many CS systems require people to have a drivers' license for at least a number of years, students are naturally also underrepresented in the sharers' group. With a p-value < 0.001 for a Chi-Squared test, the differences in employment are statistically significant.

Those who are not working are either simply unemployed or retired as shown in Figure 6. Most students are in the 'other' group except for a few who work while studying. The non-sharer include relatively more retired and blue collar workers and less self-employed and white collar workers. Just like employment, the differences between job types in sharers and non-sharers are statistically significant (Chi-Squared test, p-value < 0.001)

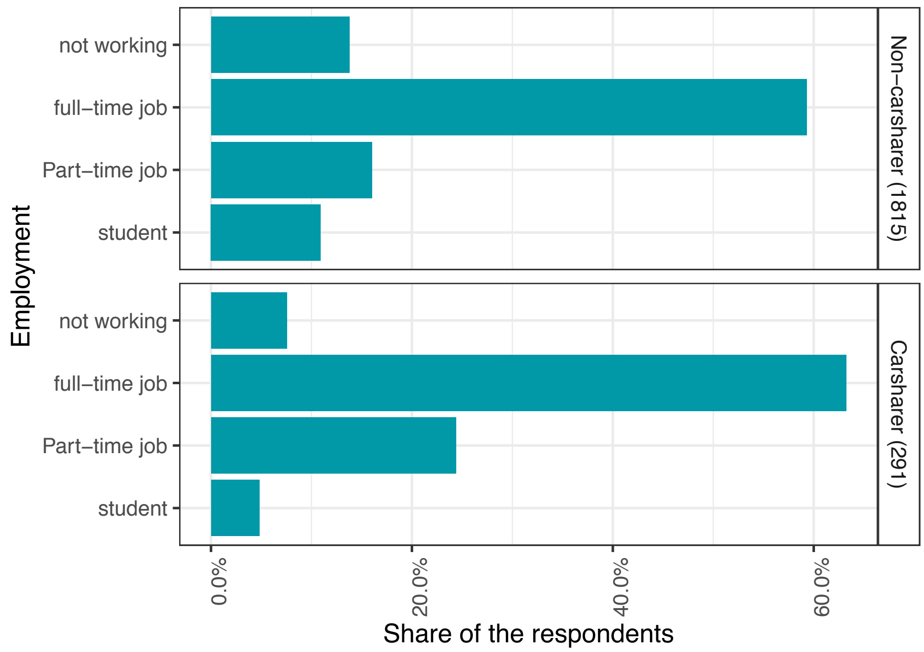


Figure 5: Professional status of the respondent

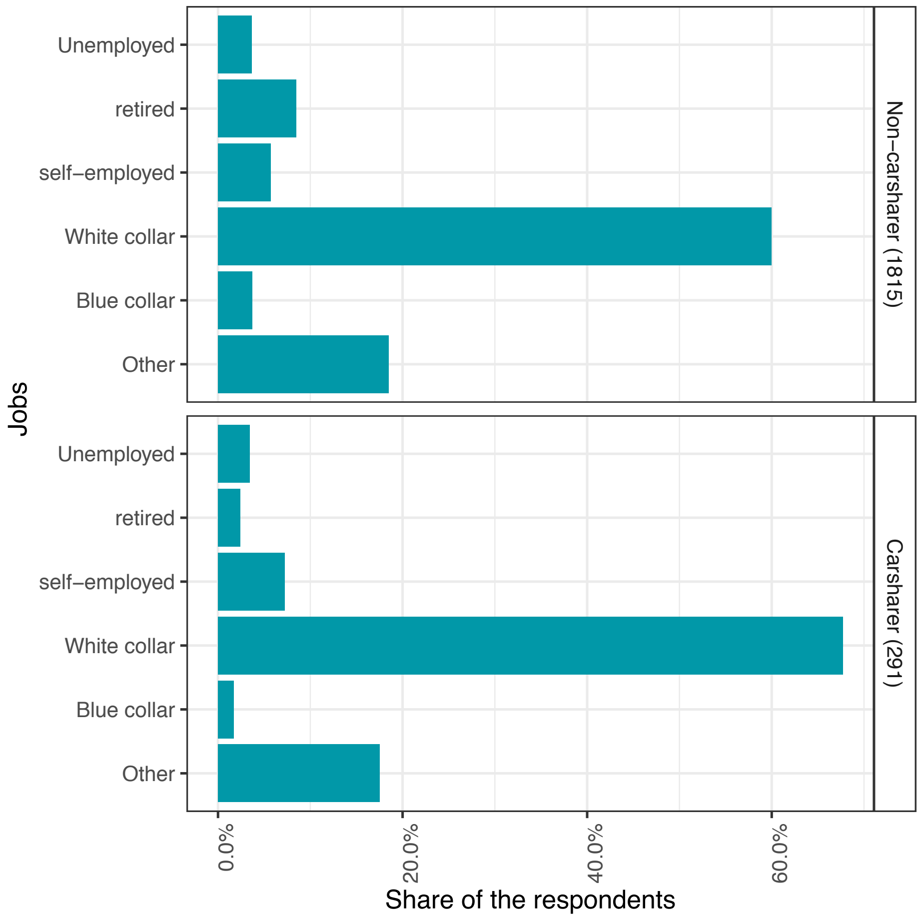


Figure 6: Job or occupation of the respondent

In the questionnaire, we defined a family as the people one usually lives with under the same roof. We asked respondent how many people are in their family and how many of them are minors (under 18 years old). Since the legal age to get a drivers' license in Belgium is 18, minor will never have a drivers' license but we still asked how many people in the family have a drivers' license because this will likely influence the number of cars that are necessary in the family. Figure 7 shows that there seems to be little difference between the sharers and non-sharers. Couples without kids are the biggest group, followed by couples with kids. Having minors in the family does not seem to be an inhibiting factor for joining a car-sharing system.

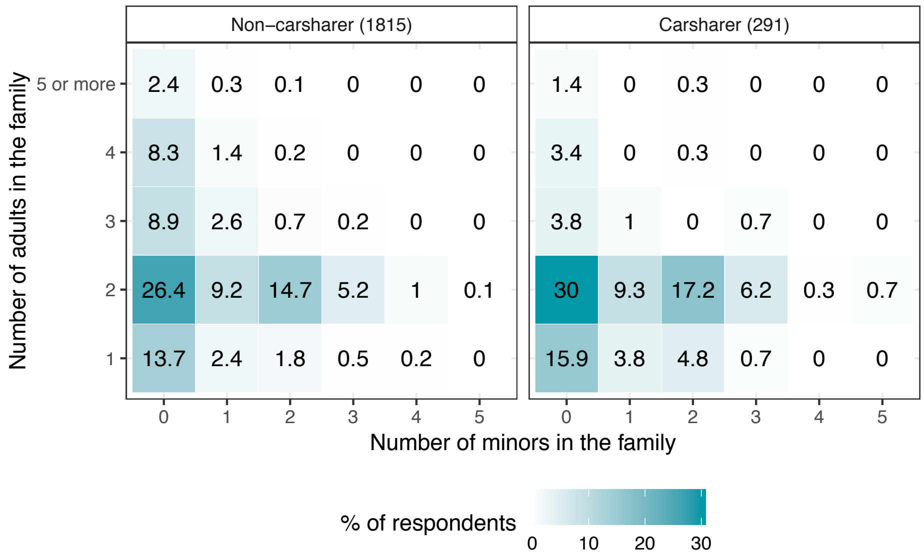


Figure 7: Family composition. Numbers in the graph show the percentage of (non) sharers' families with a certain family composition.

We also asked respondents about their monthly net income for the whole family. Many respondents choose not to answer this question. The results are shown in Figure 8. At first glance, it seems like there are more sharers in the income scale between 1500 and 2500. We also split up the results for the number of adults in the family since this will likely influence the net family income (see Figure 9). Overall, we can conclude that the sharers have relatively less people in the highest and more people in the lower income groups (especially in single-adult families).

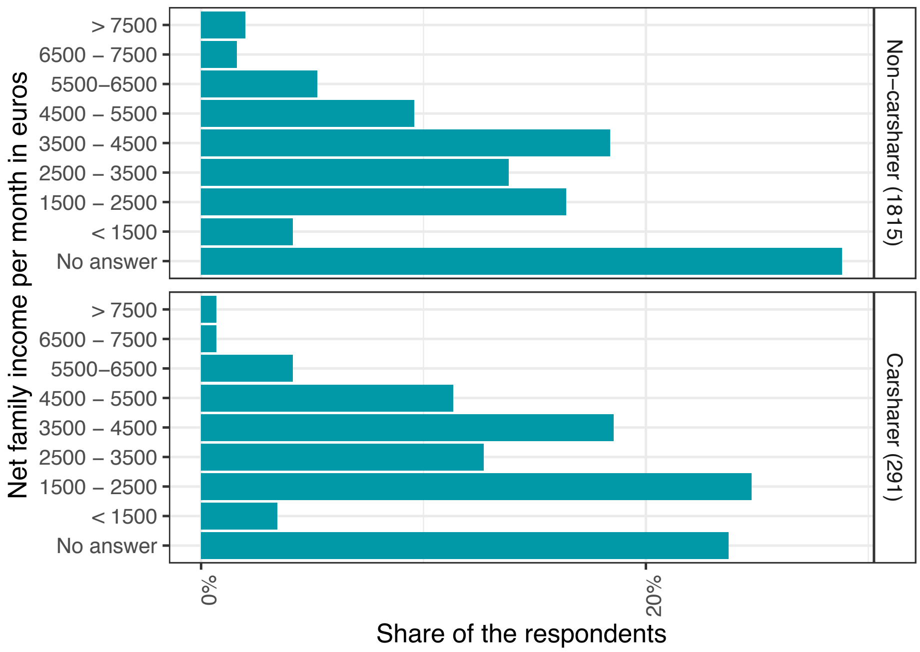


Figure 8: Net family income for sharers and non-sharers.

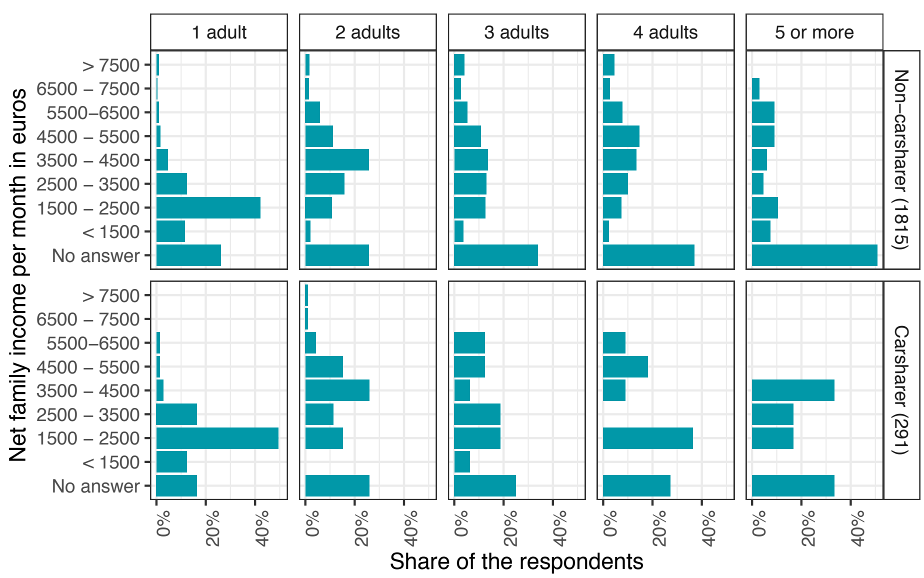


Figure 9: Net family income for sharers and non-sharers, separated by the number of adults in the family.

A last demographic that we would like to discuss is the place where people live. We asked people for their postal code and whether they live in an urban, suburban, or rural area. As the survey was available only in Dutch, there are few respondents from the French-speaking Walloon region and only a few from the Brussels-Capital region. Table 4 shows the province or region of the respondents and the type of environment they live in. One thing that stands out is that many of the car-sharers live in East Flanders. This is because Dégage actively spread the survey among their members and they operate mainly in Ghent (in East Flanders). Another important thing to notice is that non-sharers live mostly in rural areas while less than 10 percent of the sharers live in a rural environment.

Variable	**Levels**	$\mathbf{n}_{\text{NCS}}$	$\%_{\text{NCS}}$	$\mathbf{n}_{\text{CS}}$	$\%_{\text{CS}}$	$\mathbf{n}_{\text{all}}$	$\%_{\text{all}}$
Location	Brussels	28	1.5	14	4.8	42	2.0
	Walloon Brabant	0	0.0	0	0.0	0	0.0
	Flemish Brabant	410	22.6	43	14.8	453	21.5
	Antwerp	405	22.3	57	19.6	462	21.9
	Limburg	297	16.4	3	1.0	300	14.2
	Liège	2	0.1	0	0.0	2	0.1
	Namur	0	0.0	0	0.0	0	0.0
	Hainaut	2	0.1	0	0.0	2	0.1
	Luxembourg	0	0.0	0	0.0	0	0.0
	West Flanders	196	10.8	11	3.8	207	9.8
	East Flanders	474	26.1	163	56.0	637	30.3
$p = 0.0005$	all	1814	100.0	291	100.0	2105	100.0
Environment	Rural	756	41.8	27	9.3	783	37.3
	Suburban	598	33.1	75	25.8	673	32.1
	Urban	454	25.1	189	65.0	643	30.6
$p = 0.0005$	all	1808	100.0	291	100.0	2099	100.0

Table 4: Living location and environment of not car sharers (NCS) and car sharers (CS). P-values of Fisher's exact test added. Missing data is left out.

4.2. Mobility data

To be able to compare the impact of car-sharing on the environment, we have to know how vehicle ownership, travelled kilometers, and travel modes differ between sharers and non-sharers. Table A.39 in the appendix shows the number of cars, bikes and public transportation subscriptions (non) sharers have in their family. It appears that car-sharing families have significantly less private, company cars, and motorcycles but more public transport subscriptions and bikes. There is also a substantial different in the kilometers that are driven with each of the transportation modes; Figure 10 shows this graphically while Table A.38 in the appendix summarizes the raw data for sharers and non-sharers. It can be seen that sharers walk, bike, and use public transportation more. 95% and 75% of sharers never drive a company or private car respectively and if they do, they tend to drive it for shorter distances.

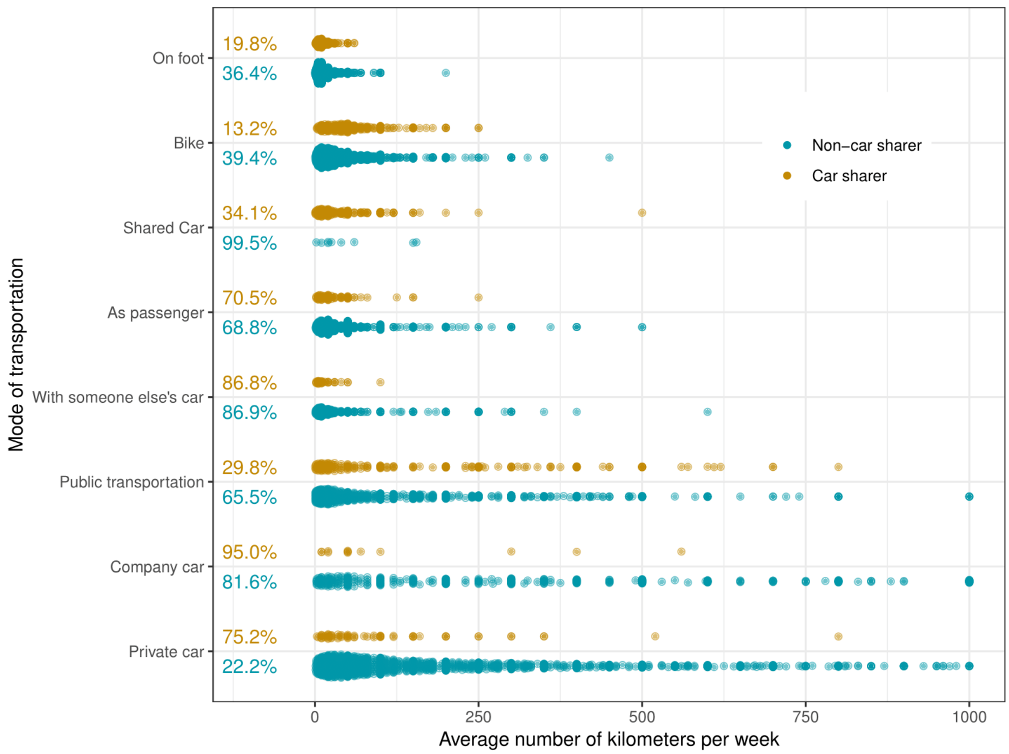
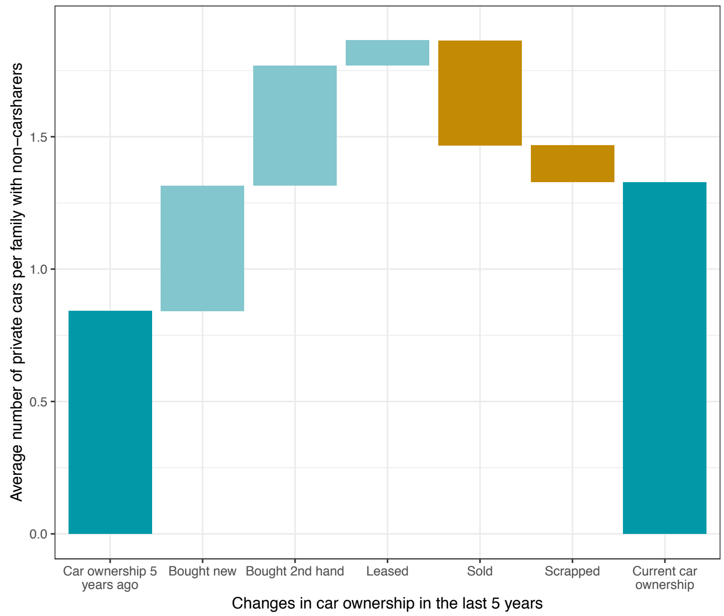
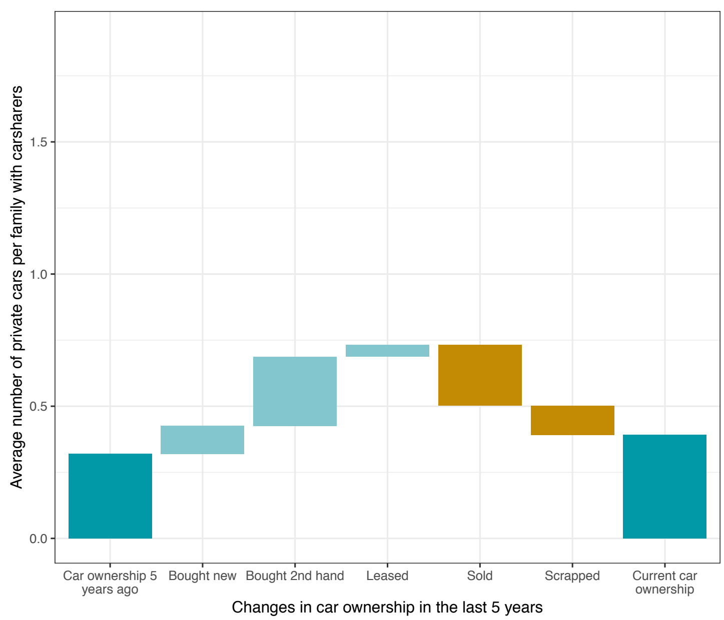


Figure 10: Weekly kilometers travelled by (non) sharers using different transportation modes. Percentages on the left indicate the percentage of respondents that never use the transportation mode.

Apart from current private car ownership, we also asked respondents how many cars they acquired and have gotten rid of in the last 5 years. Figure 11 shows waterfall charts for the changes in car ownership of the average non sharing and sharing family respectively. Firstly, it is clear that the average sharing family has less private cars than non-sharers. Secondly, non-sharers bought approximately an equal amount of new and second hand car while sharers seem to opt for second hand a lot more often.



(a) Non sharers



(b) car-sharers

Figure 11: Changes in car ownership over the last five years

Looking at the future, Figure 12 shows that there are relatively less people in the sharing group that consider it to be (highly) likely that they will buy a new private car in the next 5 years. There is also a minority (52 respondents) that stated they will never buy a new private car. Most of them want to avoid buying a private car because of environmental reasons, because they prefer to walk or bike, or because they have access to shared cars (Figure 13, multiple reasons could be selected).

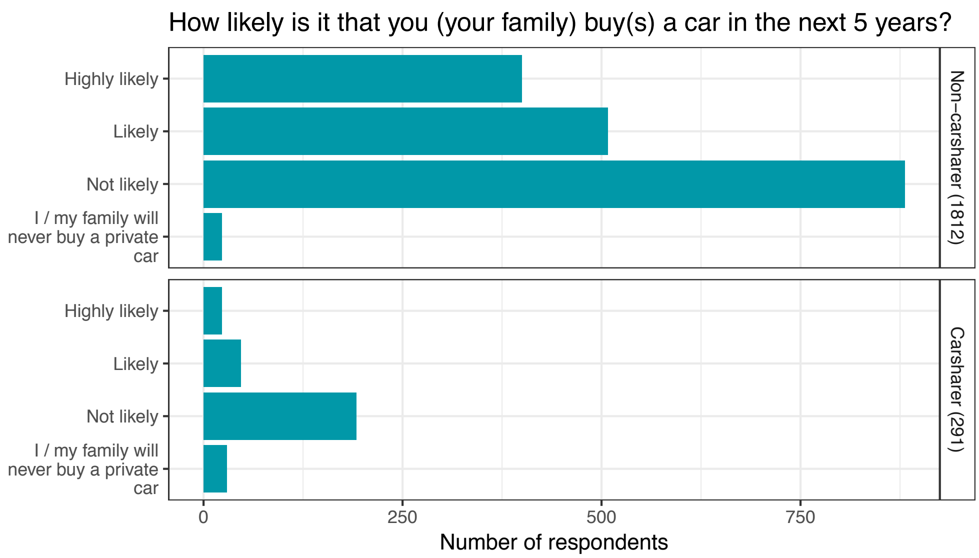


Figure 12: Likelihood of buying a new private car in the next five year. Missing values are left out.

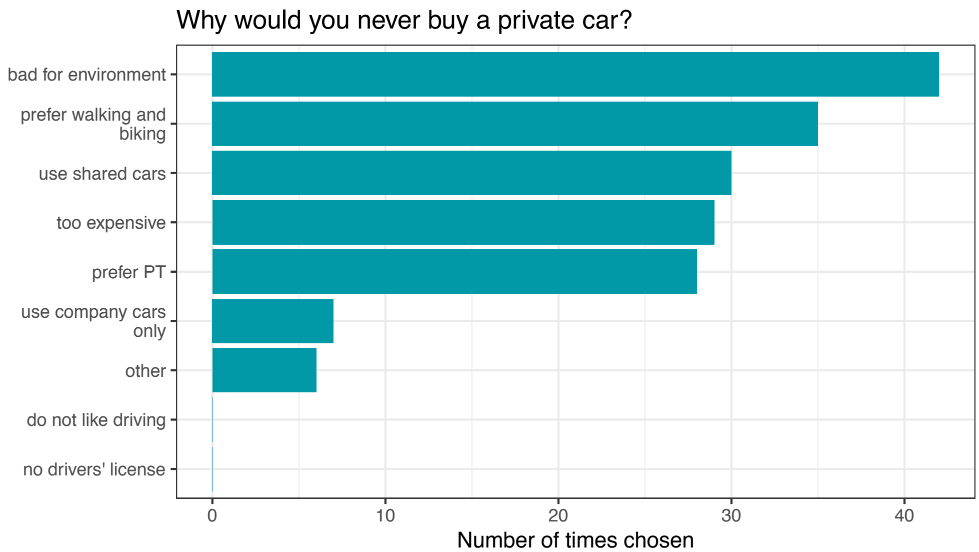
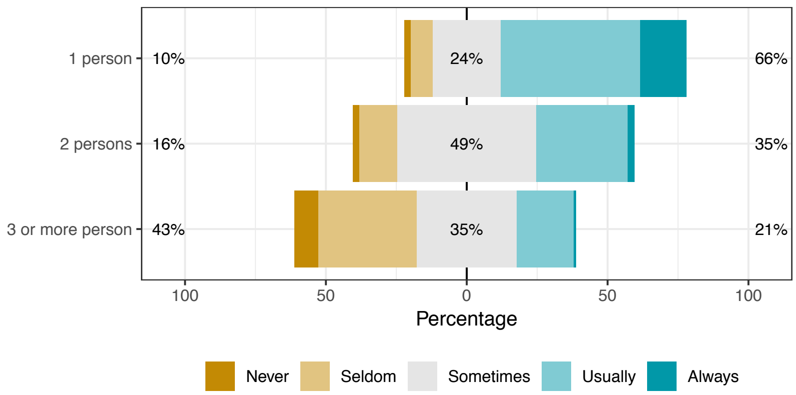
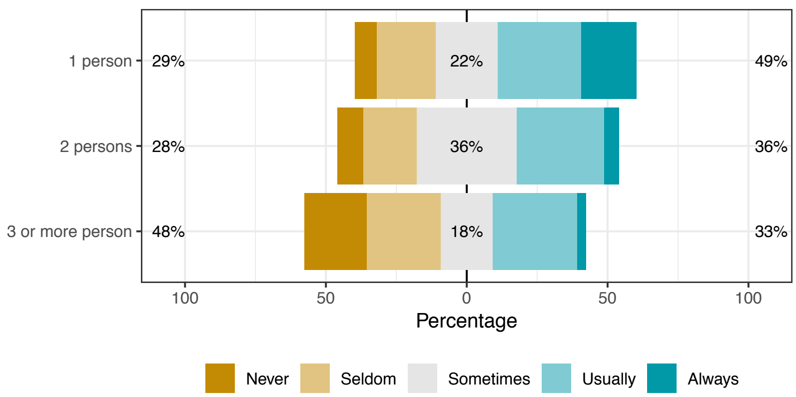


Figure 13: Reasons for never wanting to buy a car.

When the respondents use the car, they are often alone in the car, as shown in Figure 14. However, it appears that shared cars are used a bit more efficiently because they are less likely to be driven without any passengers. 33% of respondents claim to usually or always have three or more people in the shared car while this is only 21% for private cars. A possible cause for this difference, is that shared cars are rarely used for the commute to work; a ride that is often performed solo.



(a) Private cars



(b) Shared cars

Figure 14: Number of passengers in a car, including the driver for personal and shared cars.

To finish this section, we would like to mention that section Appendix A.1 in the appendix briefly touches upon the debate on how much the living environment influences the the choice of transportation mode and the distance that people travel.

4.3. Car-sharing

This section describes which car-sharing firms are represented in our sample, how often CS is used, and the motivations for using it. Table 5 shows that 40% of respondents have been sharing cars for over 3 years. Cambio is the most common car-sharing system, followed closely by Dégage. One respondent indicated that he uses the cars that local government makes available for their inhabitant outside office hours. 7 respondents informally share cars with friend or families. 25 respondents were classified as 'not active' since they (almost) never used the shared cars but they did have a membership with a car-sharing system. Table 5 only shows the primary car-sharing system of the respondent, 26 respondents were a member with two providers and 4 respondents even had three memberships. The car-sharers are quite evenly divided between P2P and B2C systems. Respondents that are not active or shared cars of the local government are classified as 'Other' systems. It is also encouraging to see that most car-sharing systems include electric cars in their fleet.

Variable	**Levels**	**n**	%
Membership	less than 1 year	73	25.2
	1-3 years	100	34.5
	over 3 years	117	40.3
	all	290	100.0
CS system	Bolides	1	0.3
	Cambio	118	40.5
	Caramigo	2	0.7
	Company	3	1.0
	Cozycar	26	8.9
	Dégage	81	27.8
	Drivenow	1	0.3
	Drivy	2	0.7
	EcoMobiliteitGent	2	0.7
	Local government	1	0.3
	Informal	7	2.4
	Not active	25	8.6
	Partago	13	4.5
	Poppy	6	2.1
	Ubeeqo	2	0.7
	Zipcar	1	0.3
	all	291	100.0
CS system type	B2C	147	50.5
	P2P	118	40.5
	Other	26	8.9
	all	291	100.0
Electric cars	No	39	13.4
	Yes	252	86.6
	all	291	100.0

Table 5: Car sharing descriptives

Most people joined a car-sharing system because they want to have access to the car every now and then, because they believe it is better for the environment, or because is it cheaper than a personal car (Figure 15). Other important motivations were that it liberates them from all the practicalities that come with owning a cars, because it is faster than PT, and because of parking benefits. Only 22% of the respondents share because shared cars are offered by their employer.

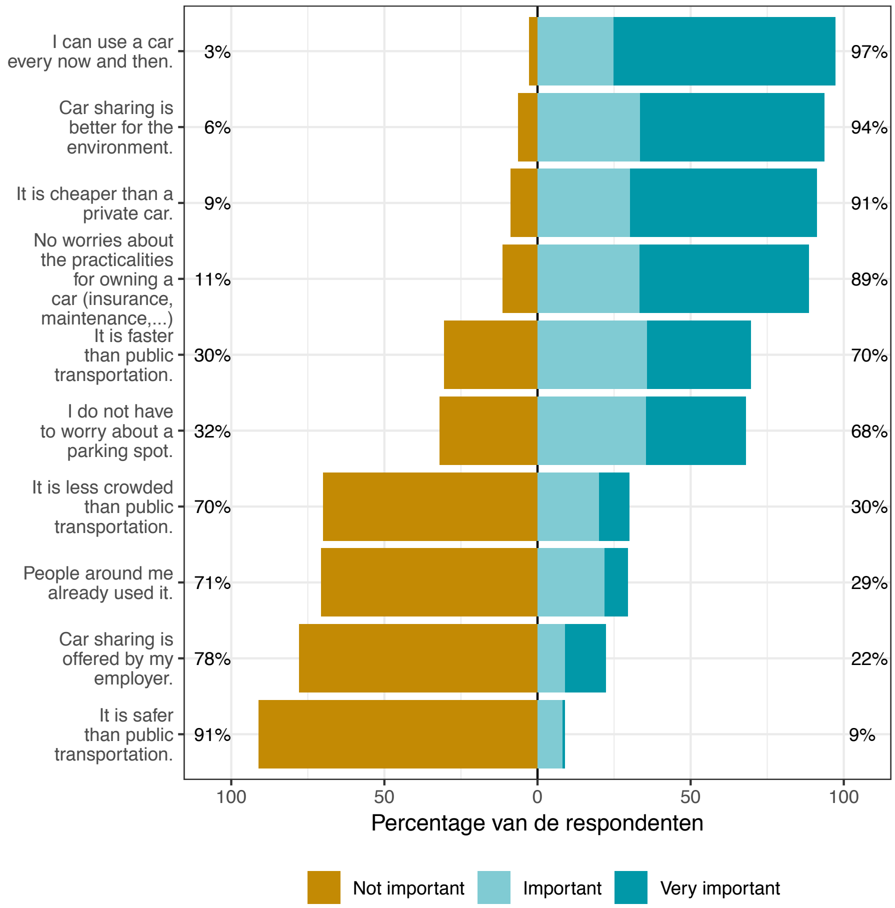


Figure 15: Reasons for joining a car-sharing system (multiple could be chosen).

Figure 16 and 17 show that very few people use the shared car daily and that it is most often used for visiting family and friends, leisure activities, and shopping. It makes sense that the shared car is only used occasionally since previous research showed that car-sharing only makes economic sense for users if the car is used less than 10,000 kilometers per year (see, for example Litman (2000)). Respondents also had the opportunity to fill in any other reason to use the shared car. Here, they mentioned some trips for which a larger car is needed (moving house, buying large furniture, bringing stuff to recycling center or junk yard) ; this shows that some people really do value the flexibility of choosing a car that fits their needs. Some use it to learn how to drive, going to school, and doctor visits.

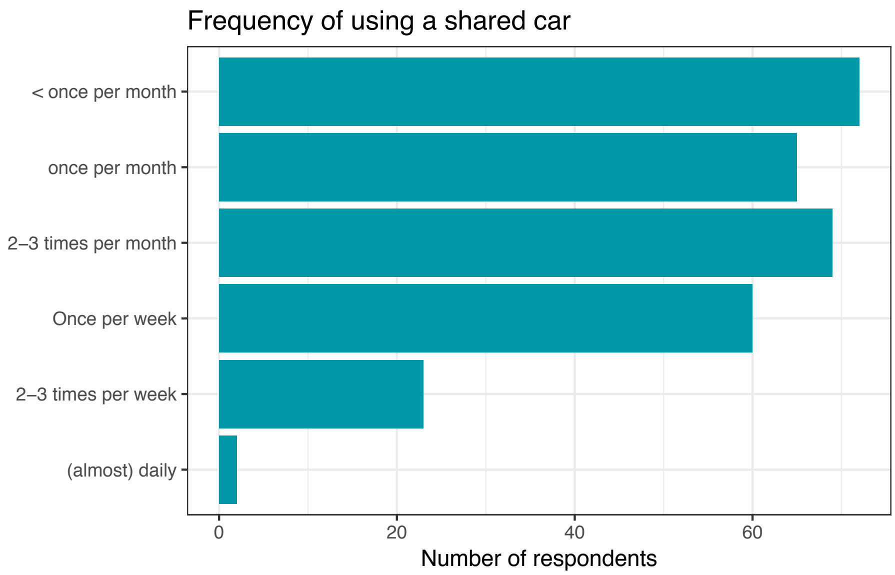


Figure 16: How often people use the shared car.

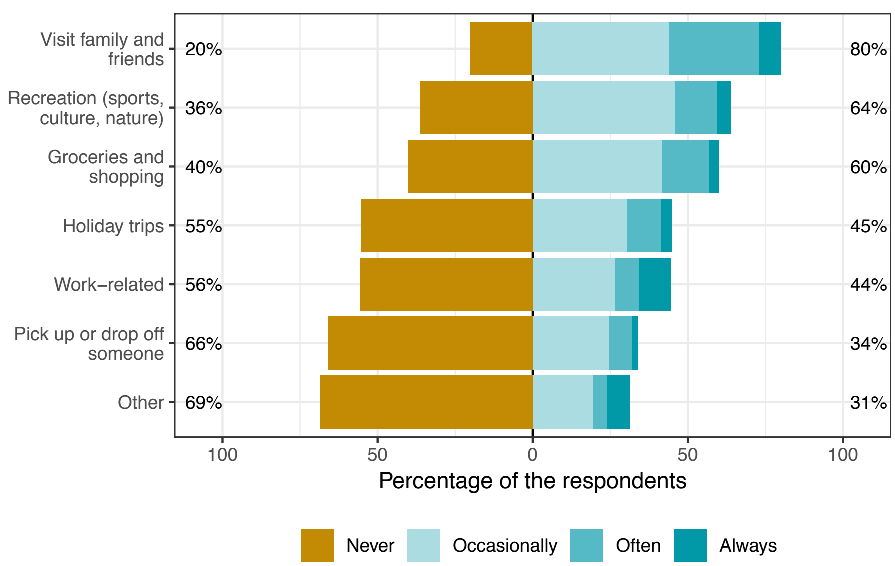


Figure 17: Trips for which the shared car is used.

A trip with a shared car is usually combined with some other transportation mode; the shared car may be use for the 'last mile' to take you where public transportation is not available, or the shared car may be located for from the user's home. Figure 18 shows that walking and biking is the preferred transportation mode which is good from an environmental point-of-view. The people who chose 'Other' mentioned taxi, metro, electric scooter, carpooling, or 'none'. Over 30% say they use the train in combination with a shared car. This vouches for Mobihubs close to railway stations Mobihubs (2019).

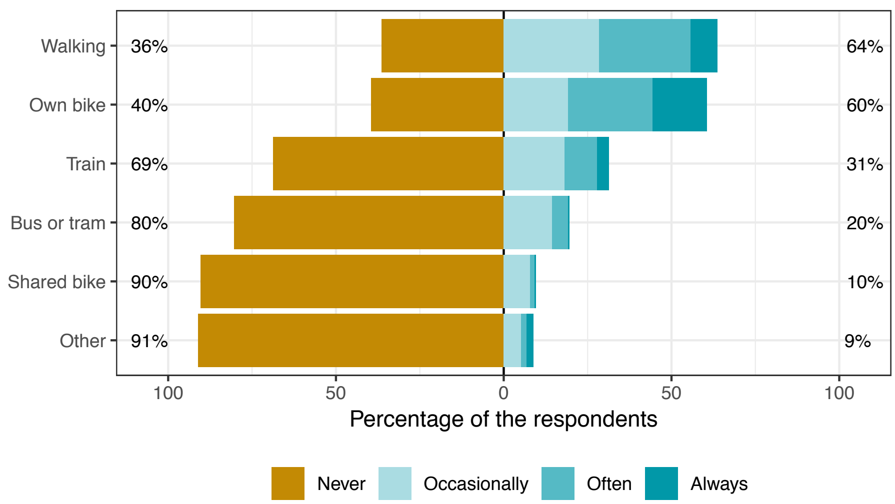


Figure 18: Other transportation modes with which the shared car trip is combined.

Section 4.2 already described in detail some difference between sharers and non-sharers with respect to the number of cars that are owned and recent car purchases or disposal of personal cars (Figure 11). We additionally asked car-sharers how many cars they bought, leased, sold or scrapped *since they started sharing* (Figure 19). Overall, there is an (almost negligible) increase in the number of cars that are owned by the sharers. But this graph should be nuanced as some may have only just become a member and thus have not have the chance to get rid of a car. It is encouraging, however, that many say they bike, walk, and use public transport more in lieu of private cars since joining a car-sharing firm (Figure 20).

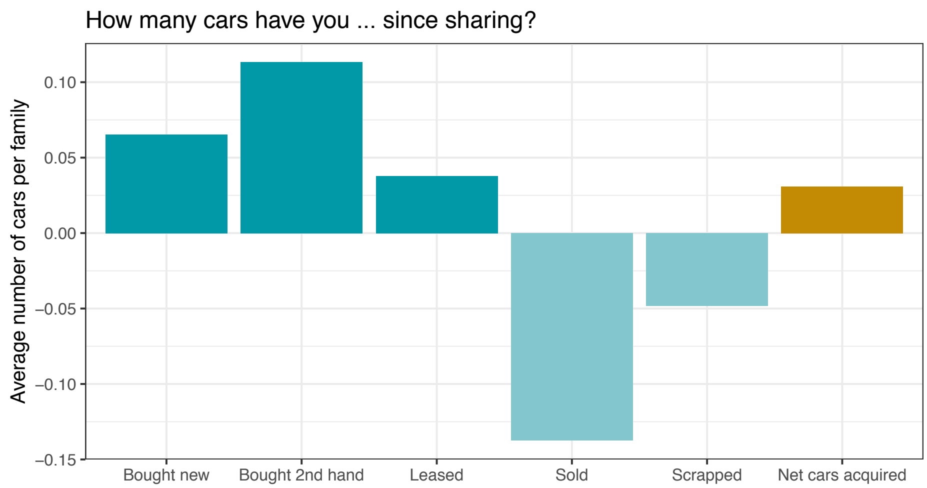


Figure 19: Changes in car ownership since joining a car-sharing system.

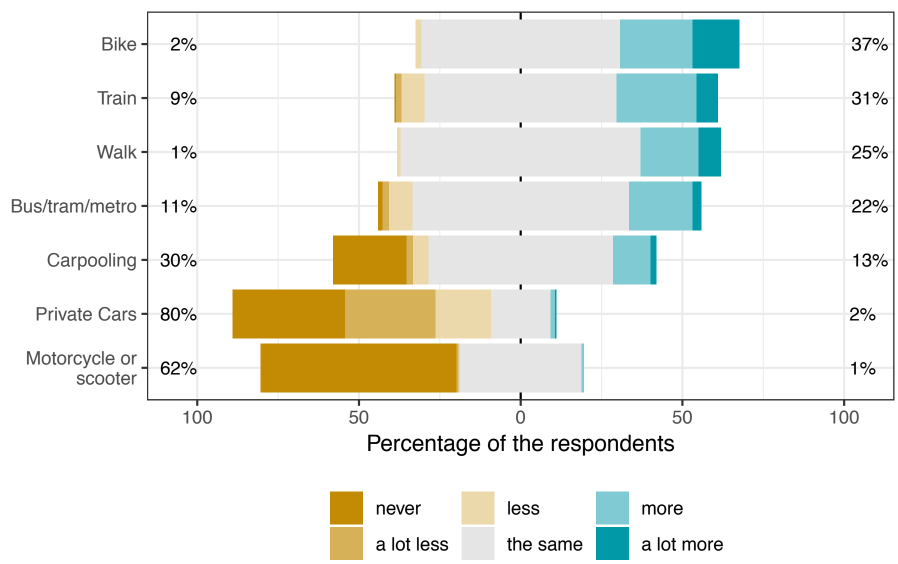


Figure 20: Changes in mobility choices since joining a car-sharing system.

If sharers had gotten rid of a car, they were asked how important the fact that they share cars was in their decision to buy, scrap, or sell a car since they started sharing cars. Figure 21 shows that car-sharing was particularly important in the decisions to sell or scrap a car. We should note that there are less observations here because these questions were only asked to sharers who bought (32), sold (41), or scrapped (14) a car in the last years. Next, we asked all sharers how likely it is that they will decide to scrap, sell, buy, or not replace a car in the near future because of car-sharing (Figure 22). Car-sharing seems to be taken into consideration the most when it come to replacing a broken car.

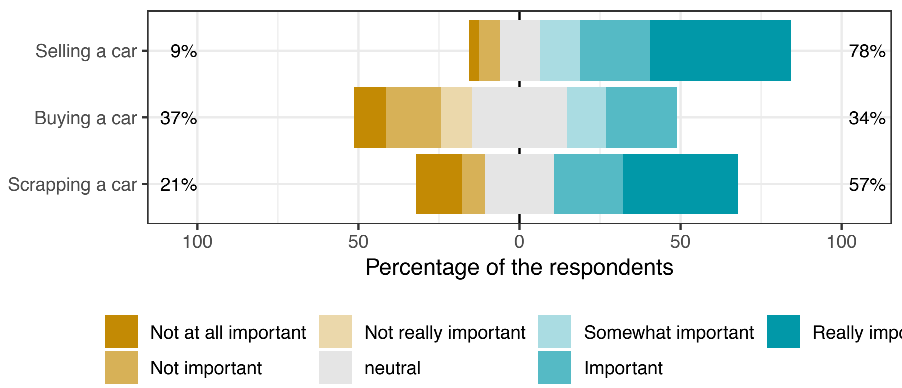


Figure 21: The importance of car-sharing in the decision to buy, sell, or scrap a car.

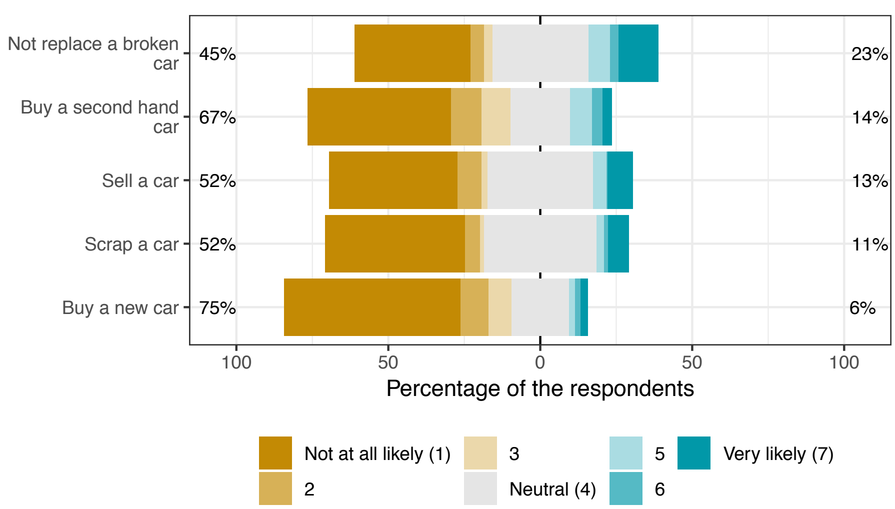


Figure 22: Likelihood of changes in car ownership in the near future because of car-sharing.

Although we need to be careful in blindly following what people *say* they would do (see also Section 1.2), we did include some hypothetical questions. We asked respondents the following question: *"If I was not a car-sharing member, I would..."* (Figure 23). Many of those who had gotten rid of their car since joining a car-sharing scheme say they wouldn't have done that had they not be able to share cars. Over 40% also said they they might or certainly would buy a second hand car. Given that they currently drive a certain amount of kilometers with the shared car, we asked them how they would change their mobility choices is car-sharing if they could no longer share cars. Figure 24 shows with which modes of transport sharers would replace their current shared car kilometers if car sharing was no longer available for them. The percentages on the left indicate the percentage of respondents that said they would not use that particular transportation mode to replace shared car kilometers. It can be seen that About 66% of the sharers would (partly) switch to public transport and/or private car. Also, quite a large group of people said that they would replace 100% of their current shared car kilometers with private car kilometers.

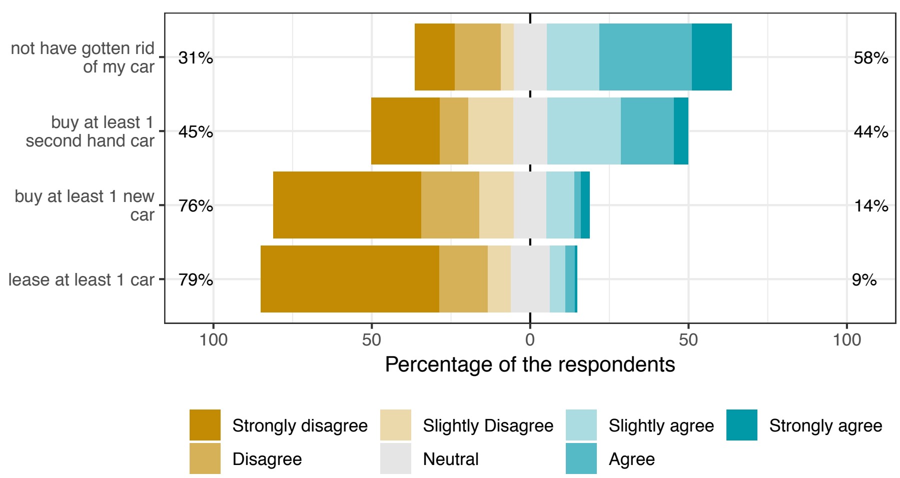


Figure 23: "If I was not a car-sharing member, I would..."

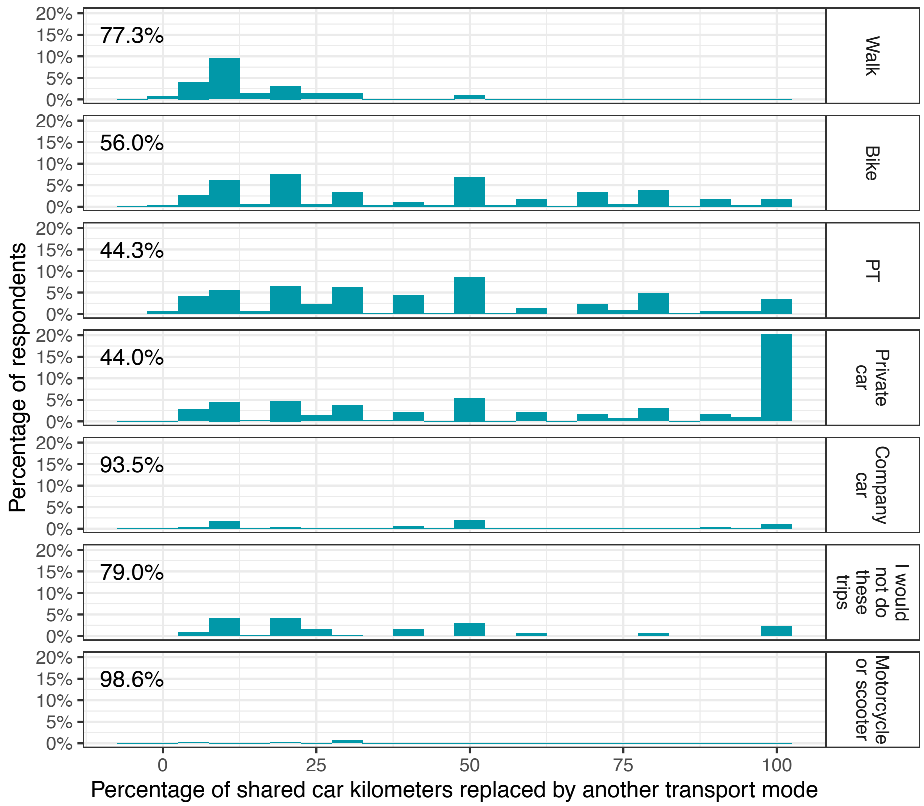


Figure 24: "If you could no longer share cars, how would you make the trips for which you currently typically use the shared car? "

Lastly, the sharers were asked whether they are considering to quit sharing cars. 12 said yes and 15 said 'maybe'; all other sharers would keep sharing cars. Figure 25 shows that changes in the family situation (a baby, an adult child that leaves the parental home,...) are most important. The fact that sharing cars is expensive and not practical (car is too far, too much red tape,...) are also considered important reasons to quit.

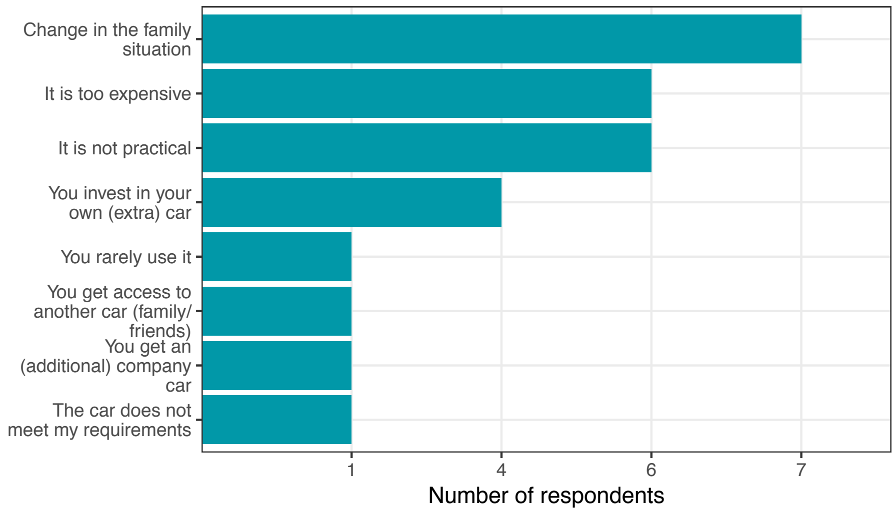


Figure 25: Reasons why sharers would quit sharing cars.

4.4. Closing questions

Non-car-sharers do not get any questions about shared cars in particular until after they finished the DCE. This is to avoid any bias that may occur if the respondent would feel the need to 'please' the researchers by answering that they'd choose the shared car.

Non-car-sharers were asked whether they would ever joining a car-sharing system (see also Section 5.2) and what is holding them back to share cars (Figure 26). The first most important barrier was a lack of shared cars in the neighborhood. This reason was also mentioned by many people who used to be a car-sharer but recently quit; they often moved to a place where car-sharing was simply not available or practical. Secondly, many indicated that are too much uncertainties about responsibilities or liabilities in case of an accident or theft. Next, car-sharing is perceived to be too complicated. Uncertainties about the availability of a car when needed and the costs rank fourth and fifth (Figure 26).

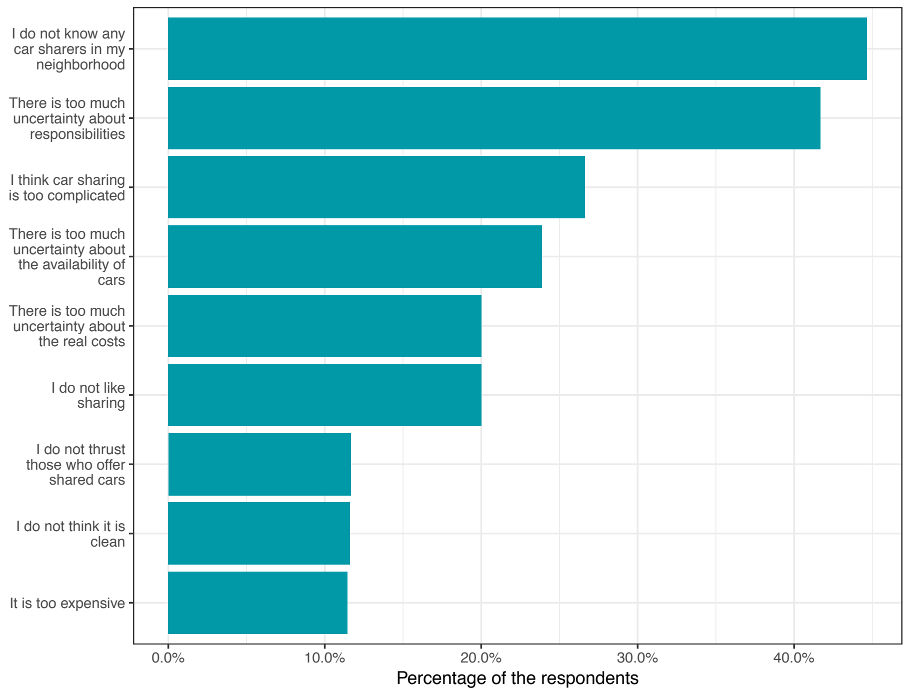


Figure 26: Reasons why respondents are not sharing cars.

Figure 27 shows which actions were indicated as possible catalysts to start sharing. In line with the answers in Figure 26, more shared cars in the neighborhood are the most important catalyst while neighbors offering cars are third most important. Cities may motivate people by offering more convenient parking facilities for shared cars and/subsidies. It should be noted that more cities in Flanders (such as Ghent) already have both; parking shared cars is free and membership fees can be reimbursed.

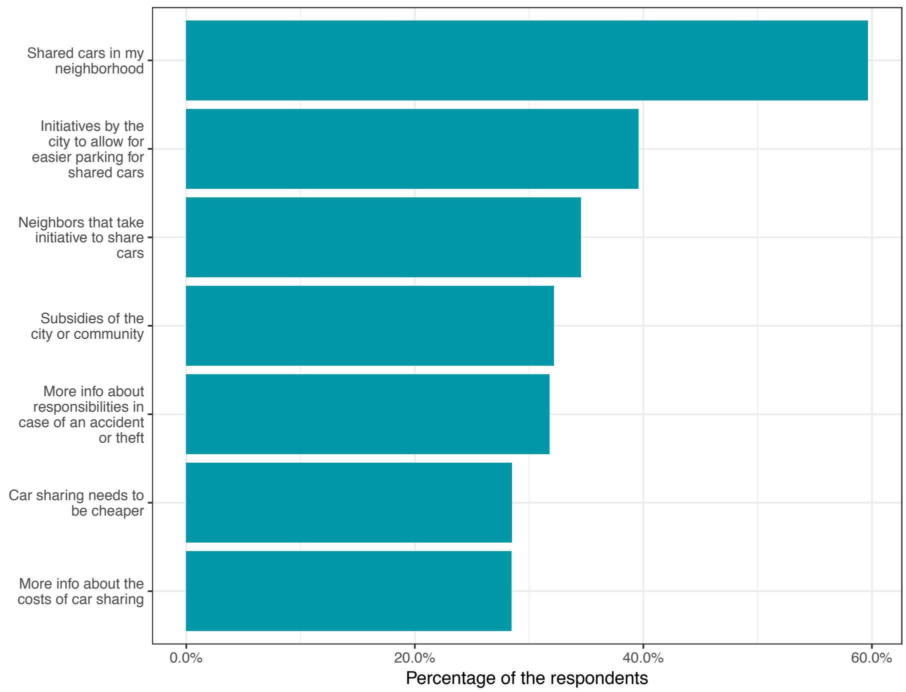


Figure 27: Actions that might help people to start sharing cars.

We also asked respondents which features were not taken into account in the DCE. Although we will also use statistical methods to find out whether some attributes really were insignificant or not considered by the respondents, this might give a rough idea of what people find important. Figure 28 shows that the majority took all attributes into account; there are only three attributes for private cars. For the shared car, there are seven attributes which makes it harder to take everything in consideration in making a choice. The attributes that were overlooked the most, according to the respondents, are whether it's a B2C or P2P system, the kilometer cost and the fuel type for the shared cars. Figure 29 also indicated B2C/P2P and the fuel type as the attributes that were neglected the most among the car-sharing group of respondents. The sharers could not choose a private car in their DCE and, thus, they do not have private car attributes.

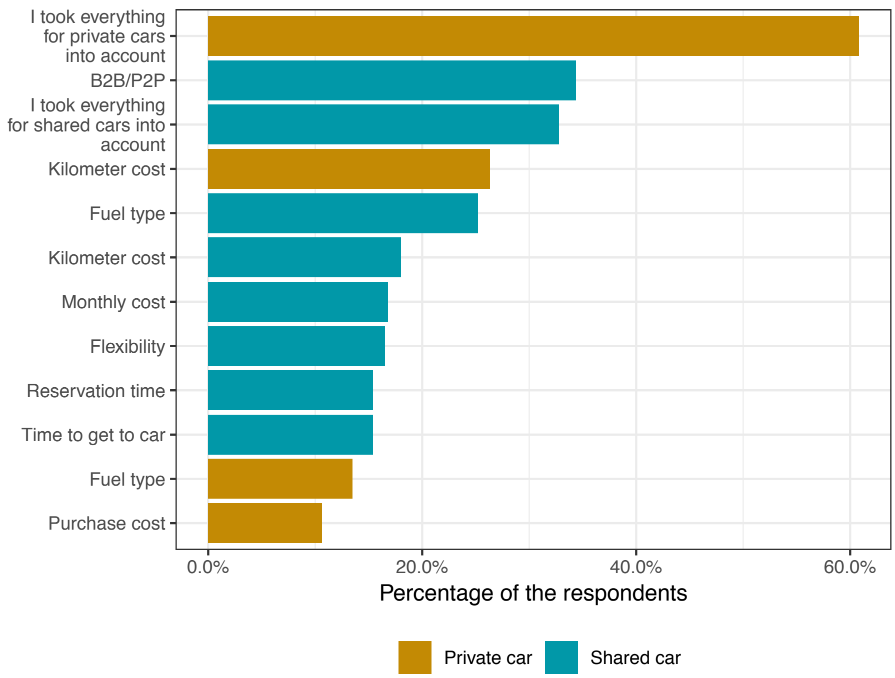


Figure 28: The attributes that non-sharers did not take into account in the DCE.

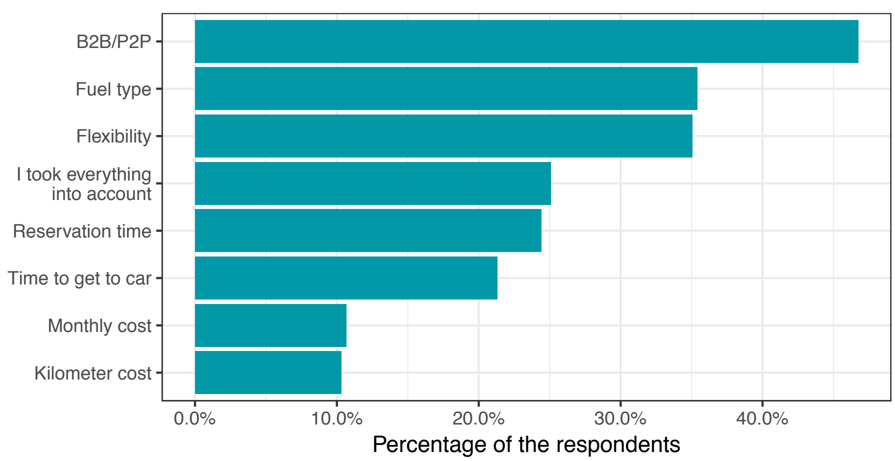


Figure 29: The attributes that sharers did not take into account in the DCE.

4.5. Quitting car-sharing

There were 43 respondents that indicated that they used to share cars but (recently) quit. Most of the respondents used to be a member of Cambio before they quit (see Table 6). Since Cambio is active in Belgium for years and is currently still the biggest car sharing firm (in number of members), this is not a surprise.

Car sharing system	Number of respondents
Cambio	31
Informal	6
Cozycar	3
Drivy	3
Partago	1
Community	1
Dgage!	1

Table 6: Former carsharing system of those who quit carsharing

In open questions, respondents were asked why they quit sharing cars and what would have to change for them to start sharing cars again. The answers to these answers were analyzed and categorized.

Table 7 shows how often several reasons for quitting car-sharing were mentioned by those who quit. The cost of car-sharing, and moving house to a (more rural) region with less shared cars were the most important reasons. The distance or time to get to the shared car was the third biggest hurdle. Some people quit as they realized they actually did not use the shared cars that often; infrequent use itself may be related to practical hurdles such as having to travel quite a lot to get to the car. Especially if the CS system has high fixed (monthly or yearly) costs, it may be financially better to quit because of infrequent use. Changes in the family car ownership and family composition obviously also played a large role. For P2P systems, three people mentioned that the car provider quit which meant they could no longer use the car. Lastly, two respondents quit after an accident/serious defect with the shared car.

Table 8 shows what might help people switch back to car-sharing. Cars closer to their home is, by far, the most important. Next, better guarantees that a car is available whenever needed and quick reservations are also important. With respect to the price, no fixed costs were mentioned in particular.

Reason	Number
It is too expensive	8
Moved house	8
It is too far	7
I used it too little	3
I got a company car	3
Kids	3
I got a new private car	3
Peers/car owners quit	3
Accidents with the shared car	2

Table 7: Reasons for quitting car sharing

Most people mentioned that they might not replace (one of) their private car(s) if it broke down and choose a shared car instead but none would get rid of their car as long as it if still operational.

Motivation	Number
Cars closer by	13
Better availability guarantees and flexible reservation	6
It should be cheaper	5
Less private cars	4
I'd never share cars again	4
Others	2
Better revenues if I share my car	1
A mobility budget at work	1
Better public transportation	1

Table 8: 'What could make you share cars again?'

5. Statistical analyses

In this section, we use our data set in statistical models to explore significant factors that affect the willingness to share cars and that make car-sharing systems more or less attractive. Section 5.1 first describes three factor analyses; for the full dataset, only the non-sharers, and only the sharers. Section 5.2 describes an ordinal model that explains the willingness to share cars. Lastly, Section 5.3 and 5.4 analyze the responses to the DCEs for the non-sharers and sharers respectively.

5.1. Factor analysis

The survey contains several statements about the environment, cars, driving, and sharing which respondents were asked to rate according to their agreement on a scale from 1 to 5. There are 46 statements in total that people were asked to rate on a 5 or 7-point scale. 6 of these statements were only presented to car-sharers as they were not relevant for non-car-sharers (for instance *'Thanks to car-sharing, I meet new and interesting people'*). All of these statements contain valuable information about the ideologies, character, and opinions of the respondent which might also drive the choices they made in the DCE. Instead of adding the score to each statement as a separate variable in further statistical models, we will look for correlations among multiple statements and thus reduce the number of variables to just a few underlying explanations, or factors.

First, we test whether a factor analysis is sensible using the Measure of Sampling Adequacy (MSA) for individual statements and the Kaiser-Meyer-Olkin (KMO) Criterion that both rely on the Anti-Image-Correlation Matrix. These are easily obtained in R using the **REdaS** package.

Next, determining the appropriate number of factors can be tricky and several methods exist to make a good choice (see (Horn and Engstrom 1979), for instance). The following methods were considered and they often suggested different numbers of factors to be chosen:

1. Parallel analysis: extracting factors until the eigenvalues of the real data set are less than the corresponding eigenvalues of a random data set of the same size (Horn 1965).
2. Using the Very Structured Criterion (VSS) (Revelle and Rocklin 1979)
3. Scree test: a sudden drop in eigenvalues analogous to the change in slope seen when scrambling up the talus slope of a mountain and approaching the rock face (Cattell 1966).
4. Minimum Average Partial (MAP) (Velicer 1976).
5. We check the communalities for each of the variables (statements). These are the sum of the squared loadings for the variable and can be interpreted as the proportion of variation in that variable explained by the factors. If they are low for some statements, we might want to add more factors.

6. Lastly, a quite simple but effective method adds factors as long as they seem to have a logical interpretation or explanation.

The following three sections present a factor analysis based on (1) all respondents' answers to the 40 statements that were offered to everyone, (2) the non-car-sharers' answers to the 40 statements they were offered, and (3) the car-sharers' answers to all 46 statements. The first approach will give us the most complete picture of the general dataset since all responses can be used. As the DCEs are analyzed separately for sharers and non-sharers, we also perform factor analyses on the separate groups for consistency. The third factor analysis additionally allows us to use more statements that are likely important to distinguish different motivations to share cars. All analyses were performed in R, using the *psych* package. Based on the chosen factors, a least squares regression approach (Thurstone method) is used to predict factor score(s) for all respondents and all factors (Distefano et al. 2009).

5.1.1. Full dataset factor analysis

First, we check whether a factor analysis is appropriate for our dataset. Kaiser-Meyer-Olkin (KMO) is 0.889 and all of the statements had a Measure of Sampling Adequacy (MSA) above 0.5 so none were removed.

In determining the appropriate number of factors, the advices of the different methods are wide apart. While parallel analysis suggests 10 factors, VSS and MAP suggest 3 and 4 respectively. The Scree plot (Figure 30) would suggest something between 4 and 8 factors (it is not entirely clear where the curve levels off). We thus resorted to adding one factor at a time as long as the factors seem to have a clear interpretation. We settled for the four factors that are shown with the factor loadings in Figure 31. The first factor was named *Ecological concern* because factor loadings were high on concern statements about the climate, traffic, and fine dust pollution and low on the environmental friendliness of private cars. The second factor was named *Driving enjoyment* because the relevant statements show that driving is not stressful and makes you feel free and independent. The third one is called *Public transport (PT) positivism* as all relevant statements look positively at public transportation; it is flexible, reliable, clean and not stressful. Lastly, for some, a private car is a status symbol that has a more than instrumental function; it forms the owner's identity. This factor is called *Car-dependent identity.*

Table 9 shows the correlation between the different factors. It should come as no surprise that high ecological concern is positively correlated with

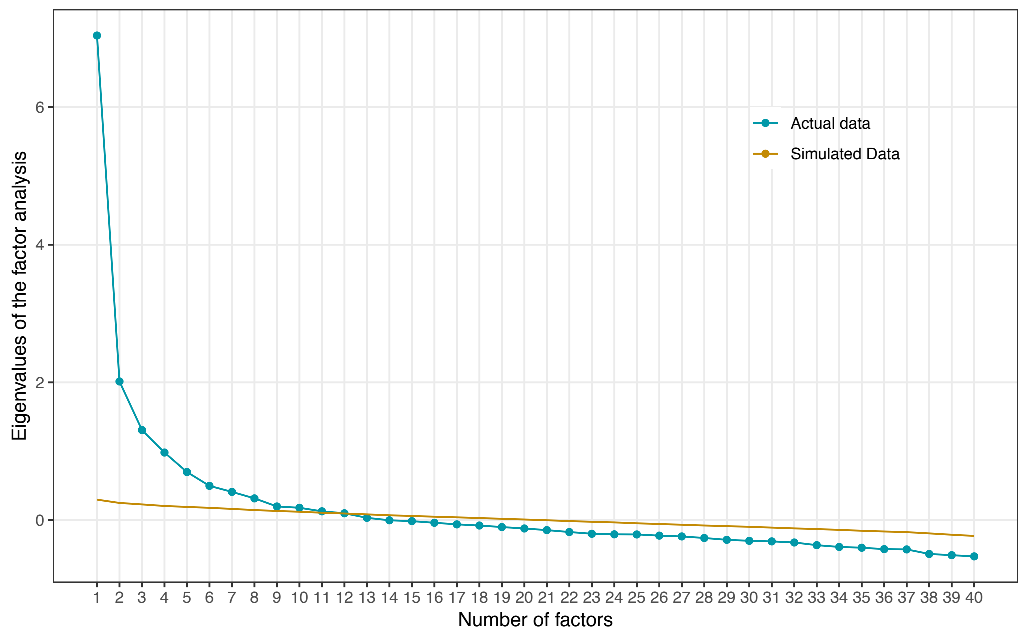


Figure 30: Scree plot for the full dataset.

high PT positivism but not with car-dependent identity. Likewise, high car-dependent identity is positively correlated with driving enjoyment; respondents that like owning a nice car for a status symbol, often also tend to like driving.

	Ecological concern	Driving enjoy- ment	PT positivism	Car-dependent identity
Ecological concern	1.00	-0.50	0.46	-0.26
Driving enjoyment	-0.50	1.00	-0.31	0.42
PT positivism	0.46	-0.31	1.00	-0.06
Car-dependent identity	-0.26	0.42	-0.06	1.00

Table 9: Correlation matrix for the factors from the full-data factor analysis

Table 10 shows how well the chosen factors fit the data and how well they explain the variance. Firstly, the sum of squared loadings (SS loadings) are all greater than 1 which means they are worth keeping (the higher, the more valuable the factor). In total, our 4 factors explain 30% of the variance, 39% of this is explained by the first factor, *ecological concern*.

Cronbach alphas measure internal consistency. The higher they are, the more related the underlying statements for a factor are. Values can vary

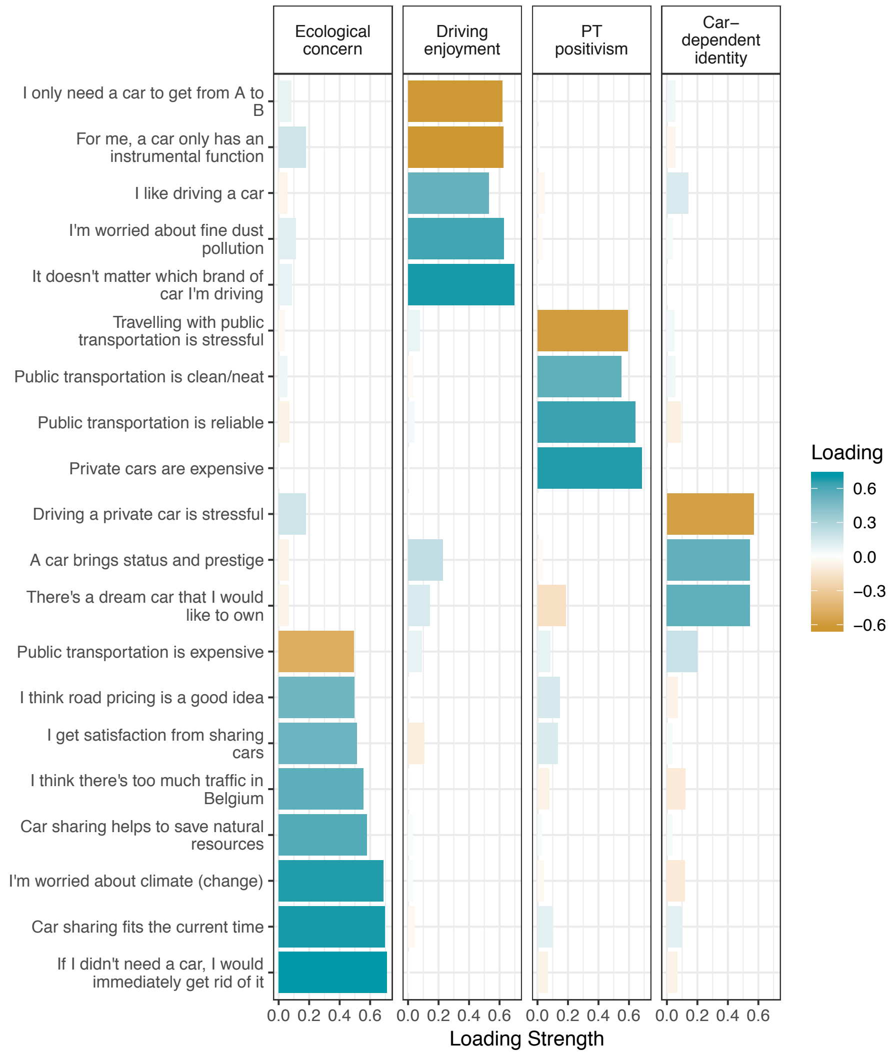


Figure 31: Factor loadings for each of the statements and each of the factors for the full dataset.

between 0 and 1 and values above 0.7 are considered sufficient. Table B.42 in the appendix shows alpha values between 0.749 and 0.832.

	Ecological concern	Driving enjoyment	PT positivism	Car-dependent identity
SS loadings	4.60	2.76	2.70	1.94
Proportion Var	0.11	0.07	0.07	0.05
Cumulative Var	0.11	0.18	0.25	0.30
Proportion Explained	0.38	0.23	0.23	0.16
Cumulative Proportion	0.38	0.61	0.84	1.00

Table 10: Explanatory power and performance of the full-data factor analysis

5.1.2. Non-car-sharers' factor analysis

KMO is 0.880 and 1 of the statements had a MSA below 0.5. Statements with a MSA below 0.5 are removed for the FA. Like in Section 5.1.1, we next explore the appropriate number of factors. While parallel analysis suggests 11 factors, VSS and MAP suggest 3 and 5 respectively. The Scree plot (Figure 32) suggest between 4 and 8 factors. We opted for 4 factors, as shown in Figure 33. The four factors are similar to the ones in Section 5.1.1. This is good because it means that these factors are prevalent, even in a smaller subset of the data.

29% of the variance is explained by these four factors and all SS loadings are above 1 which means all factors are valuable enough to keep (Table 12). Table 11 shows the same trend in the correlation matrix; Ecological concern and PT positivism are positively correlated, as are Car-dependent identity and Driving enjoyment. But these two pairs of factors are negatively correlated among each other. Cronbach alpha values are slightly lower than those where the full dataset is considered but still sufficiently high (Table B.43 shows alpha values between 0.746 and 0.821).

	Ecological concern	Driving enjoyment	PT positivism	Car-dependent identity
Ecological concern	1.00	-0.48	0.40	-0.26
Driving enjoyment	-0.48	1.00	-0.29	0.41
PT positivism	0.40	-0.29	1.00	-0.06
Car-dependent identity	-0.26	0.41	-0.06	1.00

Table 11: Correlation matrix for the factors from the non-car-sharers' factor analysis

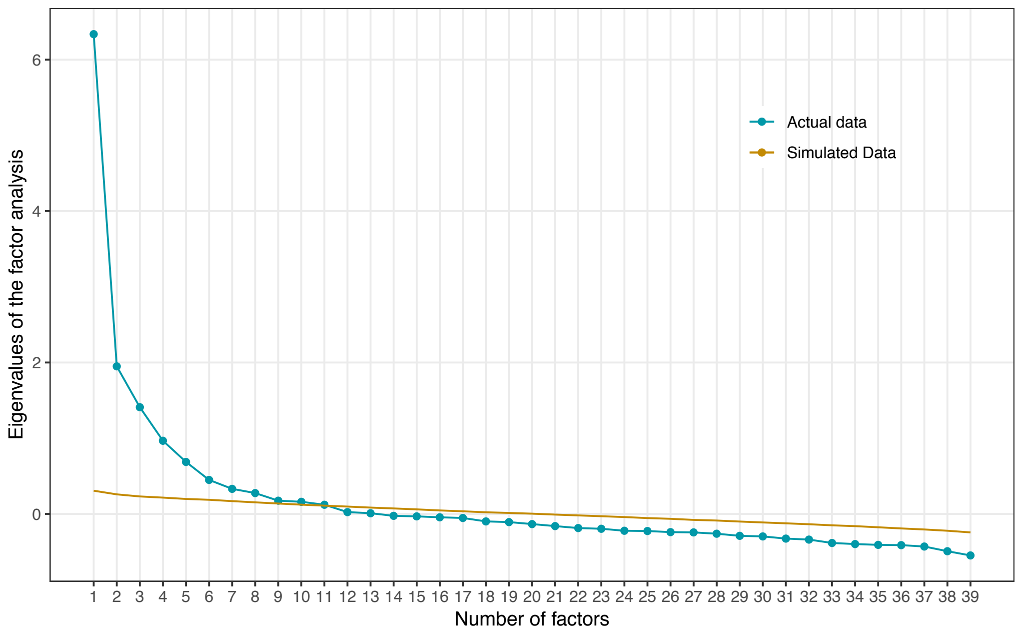


Figure 32: Scree plot for the non-car-sharers.

	Ecological concern	Driving enjoyment	PT positivism	Car-dependent identity
SS loadings	4.09	2.79	2.61	1.86
Proportion Var	0.10	0.07	0.07	0.05
Cumulative Var	0.10	0.18	0.24	0.29
Proportion Explained	0.36	0.25	0.23	0.16
Cumulative Proportion	0.36	0.61	0.84	1.00

Table 12: Explanatory power and performance of the non-car-sharers' factor analysis

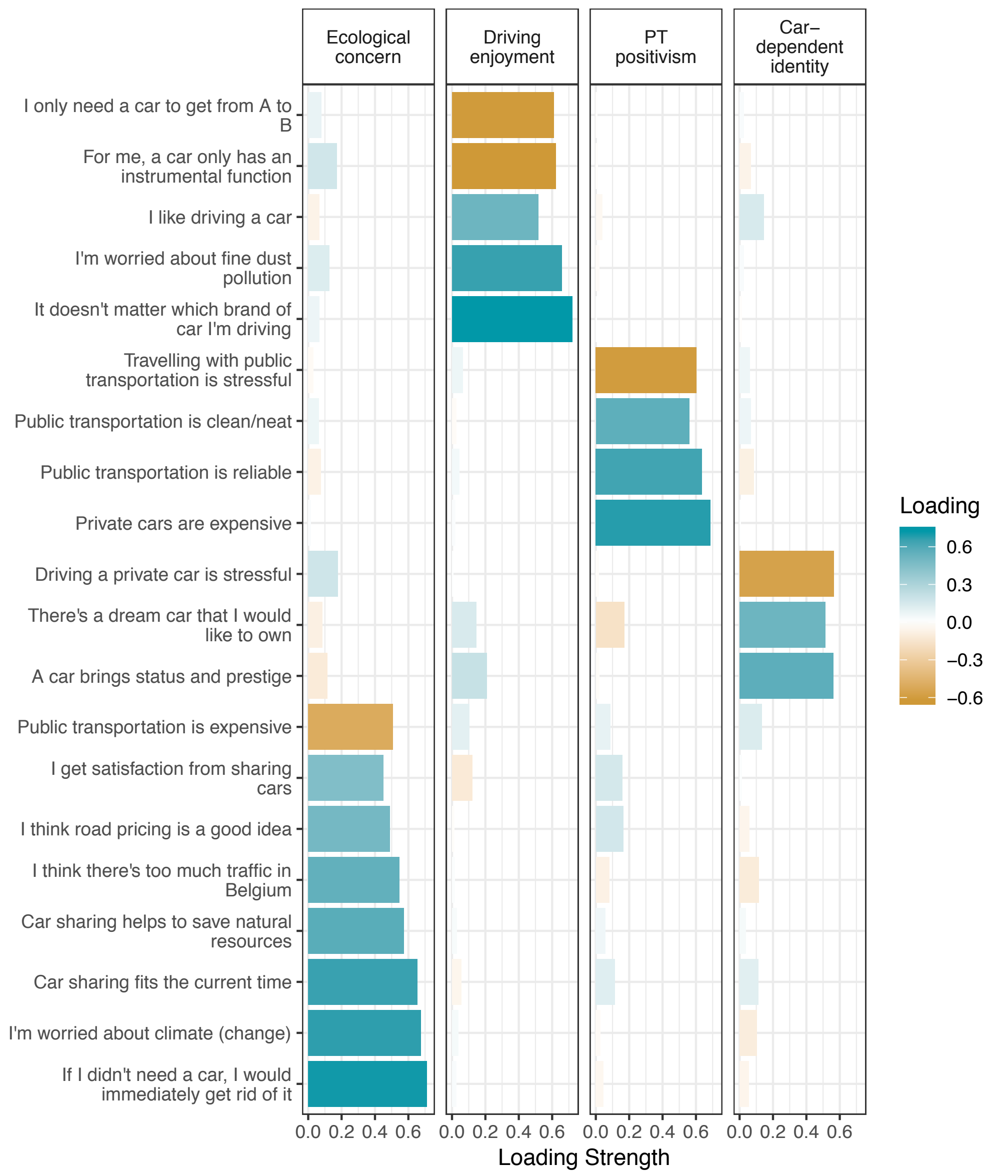


Figure 33: Factor loadings for each of the statements and each of the factors.

5.1.3. Car-sharers' factor analysis

This section focuses on people who currently share cars. This means there are substantially less respondents than in the previous analyses but there are some additional statements; 46 in total in stead of 40. KMO is 0.685 and 1 of the statements had a MSA below 0.5. Statements with a MSA below 0.5 are removed for the FA..

VSS and MAP suggest 8 and 3 factors respectively while parallel analysis and the Scree plot find 6 to be a good number of factors for our data (Figure 34). Figure 33 shows the final choice with, again, 4 factors that have similar interpretations as the factors in the previous sections. The correlations are in line with what was seen in the previous section (Table 13) and the factors explain 23% of the variance (Table 14). Some statements that were only included in sharers' surveys also have high factor loadings (for instance *'Thanks to car-sharing, I meet new and interesting people'* and *'I get satisfaction from sharing car'*, see Figure 35).

The Cronbach alpha values are now slightly lower; between 0.681 and 0.769 (see Table B.44). As the dataset is much smaller, we have to accept these slightly disappointing alpha values.

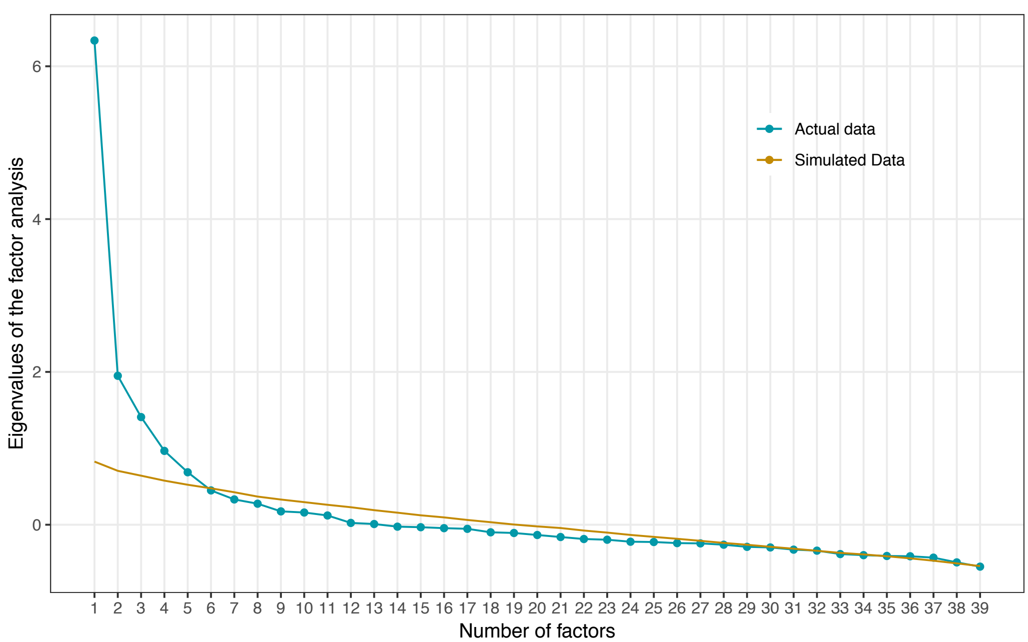


Figure 34: Scree plot for the car-sharers.

	Social & ecological concern	Shared mobility	Driving enjoyment	Car-dependent identity
Social & ecological concern	1.00	-0.27	-0.04	0.28
Shared mobility	-0.27	1.00	0.31	-0.16
Driving enjoyment	-0.04	0.31	1.00	0.01
Car-dependent identity	0.28	-0.16	0.01	1.00

Table 13: Correlation matrix for the factors from the car-sharers' factor analysis

	Social & ecological concern	Shared mobility	Driving enjoyment	Car-dependent identity
SS loadings	2.94	2.56	2.34	2.33
Proportion Var	0.07	0.06	0.05	0.05
Cumulative Var	0.07	0.12	0.18	0.23
Proportion Explained	0.29	0.25	0.23	0.23
Cumulative Proportion	0.29	0.54	0.77	1.00

Table 14: Explanatory power and performance of the car-sharers' factor analysis

Figure 35: Factor loadings for each of the statements and each of the factors.

5.2. Predicting the car-sharing intention

The sensitivity analyses in section 4 already investigated factors that might influence whether a respondent shares cars or not. We also asked respondents whether they would ever consider becoming a member of a car-sharing system (Figure 36). This not only allows us to look for significant factors that determine current car-sharing membership but also possible membership in the future.

Researchers have previously hypothesized that younger, highly-educated people are more likely to share cars. To investigate these and other hypotheses, an ordered multinomial regression model was fit on the data[1]. The outcome or dependent variable is the car-sharing intention which is ordered; car-sharing intention is highest for current car-sharers and lowest for those who answered *'No, I would never [share cars]'* (this is category 0). People in higher categories (categories 1, 2, 3 and 4) are more likely to share cars. Therefor, positive coefficients for independent variables indicate that the model would predict a higher probability for higher categories i.e. a higher car-sharing intention. As explanatory variables, all variables that were found significant in previous research (see literature review and Section 4) were tested. In addition, we included the factors of section 5.1.1.

The model was fit using the the *vglm* function from the **VGAM** package in R[2]. The results can be found in Table 15. The table also included odds ratios. For a unit increase in a continuous predictor or when changing levels of a categorical predictor, the odds for cases in a group that is greater than k versus less than or equal to k are 'odds times' larger.

The multinomial logit model shows that:

1. Males are more likely to share cars. This is similar to Prieto et al. (2017). Although this might seem counter-intuitive given that materialism has often been found to be higher for men than women (Eastman et al. 1997, Rimple et al. 2015, Segal and Podoshen 2013), one should consider that that this model already corrects for these attitudes through the four factors from section 5.1.1.

[1]Respondents that did not know enough about car-sharing or those who indicated that they used to be a member were left out.

[2]other functions exist, such as the *polr* function from the **MASS** package, the *clm* function from the **ordinal** package, the *lrm* function from the **rms** package, or the *oglmx* function from the **oglmx** package. The *multinom* function from the **nnet** package fits regular(not ordered) multinomial regressions

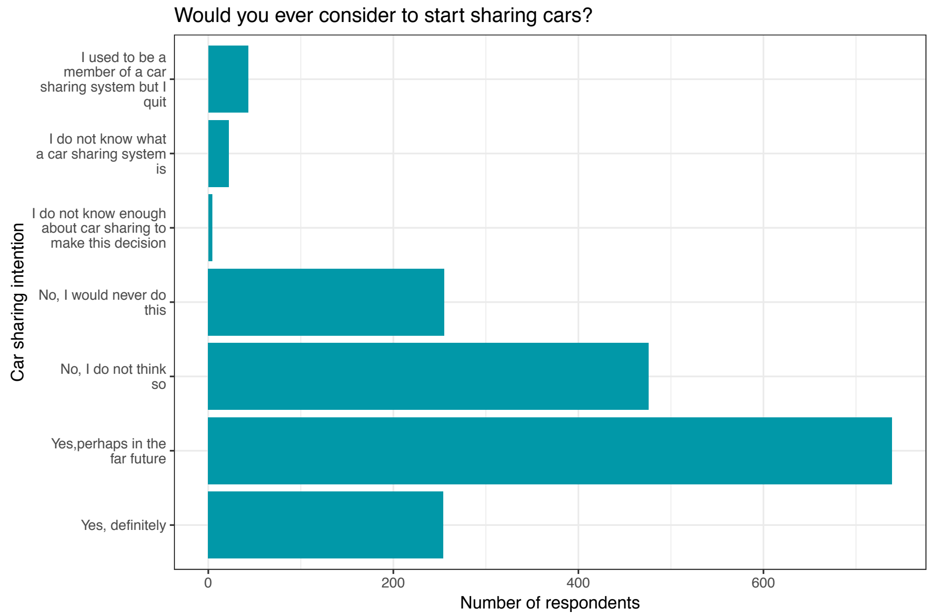


Figure 36: car-sharing intention among all respondents.

2. The factors of section 5.1.1 are good predictors for the car-sharing intention. People who enjoy driving have lower car-sharing intention. High scores on any of the other three factors increases car-sharing intention. Similar conclusions have been drawn in previous research. Burkhardt and Millard-Ball (2006), Efthymiou and Antoniou (2016) showed that people who are environmentally conscious (this may coincide with people with high environmental concern in our study) are more likely to share cars. Efthymiou and Antoniou (2016) also showed that positive attitude towards public transport and high use of public transport encourages car-sharing.
3. People that had higher education are more likely to share cars. Education is incorporated through four dummy variables. Primary or secondary education is the baseline. The model shows that, the higher the education, the higher the car-sharing intention (Bachelor's education is higher than secondary, then there's the Master's degree, and those with more than a Master's degree ($>$*Master*) have the highest car-sharing intention).
4. We have five employment categories in the model. Unemployed (the baseline), students, part-time workers, full-time workers and retired

	Coefficient	Odd ratios	P-value
Intercept1: No, probably not	2.858	17.427	0.000 ***
Intercept2: Yes, perhaps	0.742	2.1	0.001 **
Intercept3: Yes, definitely	-2.002	0.135	0.000 ***
Intercept4: Car sharer	-3.352	0.035	0.000 ***
Male	0.361	1.434	0.000 ***
Rural	-0.387	0.679	0.000 ***
Urban	0.404	1.498	0.001 ***
Public transport quality	0.083	1.086	0.077
Parking facilities	0.153	1.165	0.001 ***
Bike & Walk friendliness	-0.037	0.964	0.404
Bachelor	0.292	1.339	0.015 *
Master	0.591	1.806	0.000 ***
>Master	0.646	1.908	0.000 ***
Student	-0.316	0.729	0.070
Parttime	0.313	1.368	0.396
Fulltime	-0.131	0.878	0.248
Retired	-0.819	0.441	0.000 ***
Nb Private cars	-0.558	0.573	0.000 ***
Nb company cars	-0.68	0.507	0.000 ***
FA Car-dependent identity	0.19	1.209	0.001 ***
FA Driving enjoyment	-0.145	0.865	0.016 *
FA PT positivism	0.607	1.835	0.000 ***
FA Ecological concern	1.584	4.874	0.000 ***

Table 15: Ordinal multinomial logit model for the car sharing intention with factors

people. The model only shows a significant effect for retired people; they are less likely to share cars.

5. The number of private cars is included as a continuous variable. Families with few private cars are more likely to step into a car-sharing system, which is in line with Burkhardt and Millard-Ball (2006).
6. For the environment where the family lives, suburban areas are the baseline. The model shows that people living in the city center are more likely to become a car-sharing member while those in rural areas are less likely to share cars (Prieto et al. 2017).

We decided to exclude variable that were not significant from the model to avoid redundancy and minimize multicollinearity. Multicollinearity was checked through generalized variance inflation factors and did not seem to be a problem in the final model as shown in section 5.2.1. Interestingly, the age and the family composition appeared not to be significant in any form, as shown in the extended model in Table B.45 in the appendix

We tried a continuous age variable (linear and quadratic), and categorical age variables with different cut-off points. None appeared significant and since the correlation with 'student' and 'retired was high, we decided to exclude it from the model. This contrasts with Loose (2010), Shaheen et al. (1998), Prieto et al. (2017), who concluded that being younger increases the likelihood of sharing cars.

While Efthymiou and Antoniou (2016) showed that households with few (or no) kids are more likely to share cars, we found no significant effects for the family composition. We tested a continuous variable for the total number of family members, the total number of kids, or a dummy variable that was 1 for families with kids. All attempts failed to deliver any significant effects. It is possible that smaller/younger kids that are still in a car seat pose a bigger barrier to start sharing cars but our data did not allow us to test this hypothesis. We only asked for the number of minors (younger than 18) in the family.

5.2.1. Multicollinearity check

As the model includes many categorical variables, generalized Variance Inflation Factors (VIFs) were calculated, displayed in Table 16. The generalized VIF is the VIF, corrected by the number of degrees of freedom (Df) of the predictor variable and may be compared to thresholds of $10^{\frac{1}{2*Df}}$ to assess collinearity (Fox and Monette 1992). Some variables that are included as higher-order terms or in interaction terms have high VIF values, as expected. Overall, multicollinearity seems to be of little concern in the model.

	GVIF	Degrees of freedom (Df)	$\text{GVIF}^{(1/(2*Df))}$
Male	1.16	1	1.08
Living area	1.55	3	1.08
Public transport quality	1.36	1	1.17
Parking facilities	1.21	1	1.10
Bike & Walk friendliness	1.16	1	1.08
Education	1.28	4	1.03
Work	1.37	4	1.04
Nb Private cars	1.31	1	1.15
Nb company cars	1.14	1	1.07
FA Car-dependent identity	1.30	1	1.14
FA Driving enjoyment	1.61	1	1.27
FA PT positivism	1.46	1	1.21
FA Ecological concern	1.80	1	1.34

Table 16: Generalized variance inflation factor (GVIF). The transformation $\text{GVIF}^{(1/(2*Df))}$ makes the VIFs comparable across different number of parameters

The correlation matrix in Figure 37 confirms that collinearity does not appear to be a problem. The highest correlations appear between binary dummy variables that represent categorical variables. High correlations between these variables are to be expected.

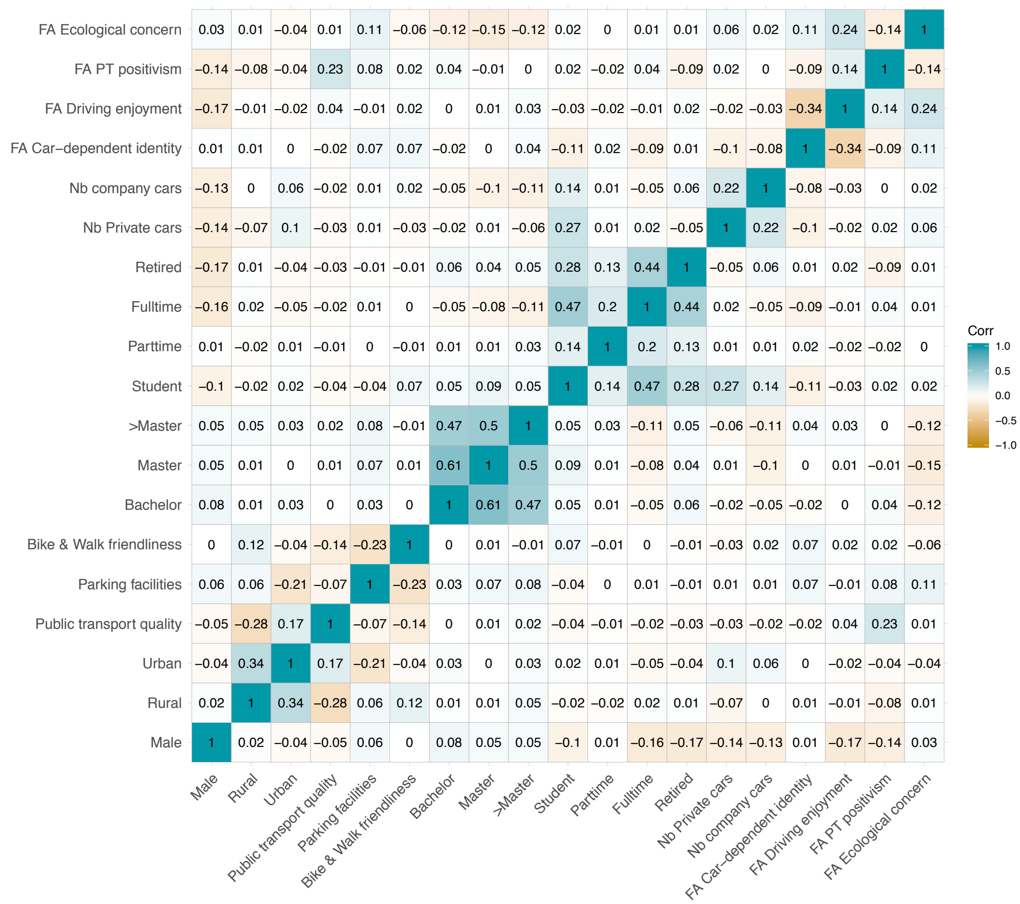


Figure 37: Correlation matrix for all explanatory variables that are in the model of Table 15

5.3. Non-sharer's discrete choice experiment

As described in section 2.5, we asked each of the non-sharers to imagine that they want to expand their mobility options and let them choose between either buying or sharing a car (or to opt-out). Each respondent was asked to make eight such choices and, in each choice, the attributes that are listed in Table 3 were varied. Random utility theory poses that a choice depends on the utilities associated with all attributed and attribute levels. A respondent's utility function is assumed to consist of a deterministic and random component (ϵ_i) (Christie et al. 2004) and to take the form of a linear function of the form (Day et al. 2012, Ryan et al. 2008)

$$U_i = ASC_i + X_i'\beta + \beta_M M + \epsilon_i \tag{1}$$

Where X_i represents a vector of attribute levels for alternative i, where β is a vector of coefficients capturing generic marginal (dis)utilities of attributes, where M represents the monetary attribute (we have purchase cost, monthly cost and kilometer costs), and where ASC_i the alternative specific constant captures the effect of unobserved factors for each of the alternatives.

Using a conditional logit model[3], we can derive the utility non-sharers get from the different attributes. We first fit a simple model to the data that only includes the attributed of Table 3 as explanatory variables. The model is shown in Table 17, together with some summary statistics. The BIC of this model is 26555.69.

	Conditional logit model, coefficient and standard errors
Electric	0.229 (0.031)***
Purchase cost	-0.104 (0.007)***
Kilometer cost	-0.641 (0.059)***
Monthly cost	-0.023 (0.002)***
B2C	0.231 (0.040)***
Free floating	0.318 (0.051)***
2km radius	0.102 (0.049)*
Time to car(in minutes)	-0.052 (0.004)***
Reservation time (in hours)	-0.021 (0.001)***
BuyPrivateCar	1.903 (0.058)***
SharedCars	1.799 (0.093)***
AIC	26472.246
R^2	0.119
Max. R^2	0.519
Num. events	14560
Num. obs.	43680
Missings	0

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Table 17: Results for the non-car-sharers

[3]The model was fit using the *clogit* functions from the **survival** package in R

It can be seen that all costs have a negative coefficient. This is logical as higher costs typically mean a lower utility for consumers. We can also see that non-sharers get a positive utility from electric cars (over petrol or diesel cars), from a B2C car-sharing organization (as opposed to P2P), and flexible car-sharing systems such as a free-floating system or one where the car can be left behind in a 2km radius (as opposed to systems where the car needs to be left behind in exactly the same parking spot). The utility of a car-sharing offering for consumers decreases if the time to get to the car increases of if the car needs to be reserved a long time in advance.

We can also derive the willingness to pay (WTP) for the different attributes from the model in Table 17. The marginal WTP for a particular change in one specific attribute level, i.e. the marginal rate of substitution, can be estimated as a ratio of estimated coefficients:

$$WTP = -\frac{\text{coefficient of the attribute level}}{\text{coefficient of price}} \tag{2}$$

As the kilometer cost applies to both the car-sharing and car buying option, we used the coefficient of the kilometer costs to calculate the WTP values that are shown in Table 18. It shows, for instance, that people are willing to pay approximately 50 cents per kilometer more for a free-floating system than a station-based system. For each additional minute longer one needs to get to the shared car, people want to pay 8 cents less per kilometer.

	WTP	
Electric	0.36	***
Purchase Cost	-0.16	***
B2C	0.36	***
Free-floating	0.50	***
2km radius	0.16	*
Time to car (in minutes)	-0.08	***
Reservation time (in hours)	-0.03	***
Buy a car	2.97	***
Shared car	2.81	***

Table 18: Willingness to pay in euros per kilometer

5.3.1. Non-sharer's DCE with latent classes

The model of Table 17 only includes the attributes as explanatory variables and assumes homogeneity in preferences. However, it is highly likely that the choices also depend on respondent characteristics. This section therefor explores a latent class model. In a latent class model, we assume that there are different classes of respondents who will make different choice in the DCE. Although class membership is not directly observable, we can derive a lot of information on class membership based on the choices that were made and, possibly, also observable respondent characteristics such as demographics and attitudes. The best BIC value was obtained from a model with three class, which is shown in Table 19. Factor scores were used to help allocate respondents to classes; Table 20 provides some more insights in the type of people that belong to each of the classes, it shows that:

- Class one is the smallest group because the intercept for the other classes is positive
- Respondents with high car-dependent identity are most likely to belong to class 2 and least likely to belong to class 3
- Class 1 enjoys driving the least
- Class 1 has the lowest ecological concern and class three has the highest.
- Class 3 is most positive about PT and class 2 the least.

In the appendix, Table B.46 and Table B.47 show additional summary tables for each of the classes' demographics.

The first class prefers a B2C system over a P2P system the most and, since the ASC for the shared car is negative, they seem to rather choose the opt-out than the shared car. Summary tables B.46 and B.47 show that this class is typically older and expressed low car-sharing intention. Most retired respondents are in this first class.

The second class, is the only class that has a negative WTP for electric cars. They consider cars to be status symbols and do not like public transportation. Table B.46 shows that this class has the largest group of full-time working people.

The third class has, on average, more public transport subscriptions in the family, owns more bikes and less (company) cars (Table B.47). They also are less likely to live in an urban environment, are higher educated and most of the respondent who used to share cars but stopped are in this class (Table B.46).

Table 19: Coefficient estimates, p-values and WTP per kilometer for each class

	Class 1			Class 2			Class 3		
	coefficient	p-value	WTP/km	coefficient	p-value	WTP/km	coefficient	p-value	WTP/km
Electric fleet	0.196	0.011	0.271	-0.230	0.079	-0.424	0.432	0.000	0.328
Purchase cost	-0.116	0.000		-0.180	0.000		-0.141	0.000	
Kilometer costs	-0.723	0.000		-0.542	0.018		-1.317	0.000	
Monthly costs	-0.061	0.000		-0.077	0.000		-0.025	0.000	
B2C	0.609	0.002	0.842	0.403	0.035	0.742	0.130	0.062	0.099
Free-floating	0.118	0.579	0.163	1.197	0.000	2.208	0.385	0.000	0.292
2km radius	-0.602	0.022	-0.833	0.177	0.544	0.326	-0.102	0.219	-0.078
Availability (in minutes)	-0.055	0.008	-0.076	-0.120	0.000	-0.221	-0.076	0.000	-0.058
Reservation time (in hours)	-0.024	0.000	-0.034	-0.022	0.000	-0.041	-0.032	0.000	-0.024
ASC, Purchase Car	0.510	0.000	0.706	5.392	0.000	9.943	2.317	0.000	1.759
ASC, Shared car	-0.275	0.392	-0.380	3.390	0.000	6.251	3.960	0.000	3.007
Class share (%)	22.532			31.698			45.769		

	Class 2		Class 3	
	coefficient	p-value	coefficient	p-value
Class (intercept)	0.341	0.00	0.709	0.00
Car-dependent identity	0.402	0	-0.078	0.04
Driving enjoyment	0.415	0.00	0.391	0.00
Ecological concern	0.140	0.00	1.379	0.00
PT positivism	-0.144	0.00	0.306	0.00

Table 20: coefficient estimates and p-values for class assignment

5.4. Sharer's discrete choice experiment

As discussed in section 2.5, the sharers were asked eight times to choose between two fictitious CS systems or staying with their own, current, CS system. It is particularly interesting to see whether sharers valued the different attributes in the same way as the non-sharers.

The sharers' DCE required a bit of extra data cleaning since the third option in each choice is not not just an opt-out, it is the current car-sharing system of the respondent. We asked respondents what their primary CS system is, how long it takes them to get to the shared car, and the costs they pay. The type of fleet, reservation time, type of system (B2C vs P2P), and flexibility was then derived from the data that is available online for each of the CS companies (Table 1 and Table 2). Due to typing mistakes or missing values in the costs, we had to adjust some outliers.

As with the non-sharers' analysis, we first fit a basic conditional logit model that only includes the attributes of the DCE. Table 21 shows the coefficients, p-values, and the willingness to pay for each attribute. Just like non-sharers, respondents are willing to pay more for electric cars than petrol or diesel cars and free-floating car-sharing systems are considered to be significantly better than station-based systems. However, there are some interesting differences with the model of Table 17 (the simple model for the non-sharers). Firstly, while B2C CS systems were considered to be significantly more attractive than P2P systems by non-sharers, sharers don't mind P2P systems at all. This may be partly because many of the sharers in our data set were currently in a P2P system (see Section 4). Secondly, the reservation time is not significant in the model. This observation may indicate that sharers already made a mind-switch where they do not mind thinking ahead about when they would like to use a shared car. For non-sharers, it

Table 21: Coefficient estimates, p-values and WTP for car sharers

	coefficient	p-value	WTP/km
Electric fleet	0.451	0.000	2.531
B2C	-0.028	0.640	-0.157
Monthly costs	-0.003	0.000	
Kilometer costs	-0.178	0.000	
Free-floating	0.241	0.001	1.350
2km radius	0.139	0.042	0.778
Availability (in minutes)	-0.016	0.000	-0.088
Reservation time (in hours)	0.000	0.870	-0.001
ASC, own CS system	1.032	0.000	5.791

is harder to imagine that they may not be able to get a car on the spot whenever they decide they'd like to use one. Lastly, the model now has just one alternative specific constant (ASC); one for staying with the current CS system. The ASCs for the two fictitious CS systems, that were constructed according to a D-efficient design using Ngene software, were not significantly different so it was decided to only leave the ASC for the respondent's current CS system. As this is positive, it seems like people usually prefer to stick to their current system rather than switching to another one.

5.4.1. Sharer's DCE with latent classes

One of the biggest shortcomings of the model in Table 21 is that it only reports the average utility or willingness to pay over all respondents. A latent class model is able to identify different groups of respondents that have similar choice patterns in the experiment. The chosen latent class model is shown in Table 22.

Table 22: Coefficient estimates, p-values and WTP per kilometer for each class

	Class 1			Class 2			Class 3		
	coefficient	p-value	WTP/km	coefficient	p-value	WTP/km	coefficient	p-value	WTP/km
Electric fleet	1.358	0.000	0.322	0.488	0.000	0.574	0.567	0.000	0.709
B2C	-0.141	0.447	-0.033	0.472	0.000	0.555	0.373	0.002	0.466
Monthly costs	-0.171	0.000		-0.006	0.000		-0.011	0.063	
Kilometer costs	-4.214	0.000		-0.851	0.000		-0.800	0.000	
Free-floating	0.167	0.446	0.040	0.026	0.860	0.031	0.270	0.048	0.337
2km radius	-0.111	0.603	-0.026	-0.258	0.082	-0.304	-0.103	0.445	-0.129
Availability (in minutes)	-0.019	0.001	-0.005	-0.010	0.165	-0.011	-0.034	0.000	-0.042
Reservation time (in hours)	-0.002	0.056	-0.001	-0.004	0.007	-0.004	-0.010	0.000	-0.013
ASC, own CS system	-0.667	0.005	-0.158	3.870	0.000	4.549	-1.438	0.000	-1.798
Class share (%)	27.920			46.657			25.423		

We chose three groups, or 'classes', of respondents because this model yielded the lowest BIC value; the model of Table 17 has a BIC of 4468.5, a model with 2, 3, 4, or 5 latent classes has a BIC value of 3728.859, 3546.28, 3667.16, and 3555.109 respectively. We tried adding the factor scores and demographic information (age, education, employment) as explanatory variables for class membership but none of those variables appeared significant or resulted in a decrease of the BIC value so they were left out.

Despite the fact that demographics or factor score did not appear to have enough explanatory power to withhold them for the final model, it is still interesting to look at the differences in respondent characteristics between the classes. Section Appendix B.4 in the appendix summarizes demographics, factor scores, mobility options, and the current CS systems for the three classes.

The most important conclusions for each of the classes are the following:

- 27% of our sharers are in the first class. They are the only class that does not prefer B2C systems over P2P systems which makes sense as over three quarters are P2P users (Table B.50). Furthermore, they do not seems to care about how flexible the systems is because free-floating, station based and systems where the car can be left in a 2km radius are all considered equally attractive. Table B.50 in the appendix shows that more than half of these people are currently with Dégage and none have a free-floating CS provider.

- The second class is the biggest with 46.7% of the respondents. Just like the first class, they prefer electric vehicles and the flexibility of the car drop-off is not important for them. They are the only class that clearly prefers to stay with their current CS provider; Cambio, Dégage, and Partago are the most common with 45%, 20%, and 8% respectively of the people in this class. They also do not mind spending some time to get to the car (availability). As 70% of these respondents live in an urban environment, they are likely used to have everything at close walking distance.

- The third class has the highest utility for electric cars and free-floating systems and they are not very attached to their current CS system. They also have the highest sensitivity for availability and reservation time. This class appears to be living in a significantly more rural environment than the other two classes. Over half of these respondents are

Cambio members and Cozycar is the second most popular with 13%. The factor scores in Table B.48 show that this class also has the highest car-dependent identity and the lowest ecological and social concern.

5.5. Conclusion

Cars move people; not just literally but also emotionally. The factor analysis of section 5.1 shows that a large part of our respondents have very strong opinions about cars: cars are part of their identity, and driving a car makes them feel good and happy. Others factors that could be identified were environmental concern and a positive perception of public transportation. The ordinal model of section 5.2 shows that these factors are just as (or even more) valuable predictors for someones car-sharing intention than demographics.

Knowing which type of person might have a high intention to share cars is important for car-sharing companies to expand their business and for a government that wants to stimulate sharing. The ordinal model of section 5.2 showed that males, people living in urban areas with a higher education are significantly more likely to have a high car-sharing intention. Retired people or people with more private or company cars, on the other hand, will have lower car-sharing intention. However, the explanatory variable with the biggest positive effect on the car-sharing intention is the factor 'ecological concern'. Urban environments will therefore not only be more interesting for car-sharing companies because of the higher population density (which makes running a CS business easier) but also because of the mindset of people in the city. Bringing CS to rural areas is a challenge for both CS firms and local governments. Our results show that it would be a good idea to focus on highly educated people, particularly men, with a high ecological concern. Belgian government might also make company cars or private cars less financially interesting, thus increasing car-sharing intention with many.

While the ordinal model gave some insights in the general CS intention, there are many different ways of running a CS business and each of those ways might appeal to a different audience. The two discrete choice experiments of section 5.4 and 5.4 provide new insights in this area. There are two important differences between sharers and non-sharers:

1. Non-sharers prefer a B2C system over a P2P system while sharers are indifferent. Attracting more people to share cars may thus be easier

for B2C systems or if P2P systems are better known/ more familiar. Informing customers about P2P sharing and annihilating insecurities (about liabilities, insurance and costs, for example) might help.

2. Sharers do not mind reserving a car in advance while non-sharers do not like long reservation times. This might mean that the sharers have already made a mind-switch where they are used to not having the car available at all times and jumping in the car whenever they feel like it. Just like PT, shared cars require a bit more mobility planning than private cars.

Other than those differences, all respondents prefer electric cars, more flexibility for where to pick up or leave behind the car, and good availability of cars close-by.

6. Environmental Impact

The environmental impact of car-sharing works through two channels: technical changes and behavioural changes. Technical changes are the differences in the technologies of cars used by car-sharing relative to private car ownership. For example, shared cars might be lighter, more fuel efficient, be used for longer (i.e. increased lifetime kms) or be more likely to be electric or use lower impact fuels. That said, these effects could also work in reverse: private cars may be used for longer since owners may be more willing to tolerate an older car or a car with small defects than would a user of a car-sharing service.

The other channel through which environmental impacts may work is behavioural change. As discussed in section 1.2.2, car-sharing induces changes in how people fulfill their mobility needs. Some users may sell a car and replace their car-use with car-sharing, and in doing so, they reduce their car use, perhaps due to higher marginal costs or the reduced convenience relative to private cars. Others, however, for whom car-sharing does not affect car-ownership, may use car-sharing to substitute for public transport or other modes, creating greater environmental impacts compared to without car-sharing.

In this research, the focus is on the behavioural change induced by car-sharing, specifically, changes to car-use and car ownership. Due to a lack of data, there is no empirical measurement of differences in technical parameters, such as fuel efficiency and vehicle lifetime; however they have been considered in a sensitivity analysis.

The environmental impact of car-sharing was calculated by first estimating the impact of car-sharing on users' behaviour (car-ownership and car-use) based on the survey results, and second, converting this into environmental impacts using life-cycle analysis. As discussed in section 1.2.2, estimating the impact of car-sharing on behaviour is not straightforward. Since car-sharing users choose to join car-sharing for certain reasons, comparing users to non-users will introduce selection bias and reverse causality, i.e. car-sharing users may be systematically different to non-users, and these differences may also be the cause of different behaviour.

Thus, in order to estimate the treatment effect of car-sharing, all alternative explanations for a change in behaviour should be eliminated, leaving only the effect of car-sharing. Specifically, the aim is to remove the influence of factors that may affect both behaviour and the decision to join car-sharing. To do so, we estimate what the car-use and car-ownership of a car-sharing user would be *if (s)he was not a member of car-sharing*. This hypothetical outcome is known as the counterfactual.

6.1. Method

This section outlines the approach taken to estimate the counterfactual. First, a control group was formed consisting only of non-users who showed an interest in car-sharing based on the discrete choice experiment. Second, both car-sharing users (treatment group) and non-users were sub-divided into different categories based on car-ownership. Third, any remaining differences based on observed characteristics between treatment and control groups within each category were controlled for through regression analysis.

6.1.1. Formation of treatment and control groups

The use of treatment and control groups to find impacts of an intervention is a recognised method in impact evaluation. The aim is to find a control group that is as similar as possible to the treatment group, thereby reducing selection bias, ensuring the comparison between groups is more fair.

In this study, only non-users who said they would be interested in joining car-sharing in the near or far future were kept to form the control group. In addition, any non-user who did not choose car-sharing in at least 3 of the 8 instances in the discrete choice experiment were removed from the control group. By choosing only those with an interest in car-sharing to form the control group, we remove some selection bias that would otherwise be unobserved.

The treatment group of car-sharing users was trimmed to only include those who were defined as active (i.e. users who were deemed to have been affected by car-sharing), since there are many users who may be members of car-sharing but who do not use it, and including these non-active users would bias results. Active users were defined as those who:

1. Used car-sharing in a typical week; or
2. Sold or scrapped a car because of car-sharing; or
3. Did not purchase a car because of car-sharing

Using this definition of an active user, the sample size of the treatment group is 215. The control group consists of 359 observations.

6.1.2. Decomposition of treatment and control groups

The impact of car-sharing on car-use is directly related to car-ownership. Car-sharing changes the way one has access to a car – it either increases or decreases access, compared to the counterfactual where car-sharing doesn't exist. However, car-ownership may also affect the decision to join car-sharing: someone without a car may join a car-sharing scheme to gain access to a car i.e. *a lack of car-ownership* causes the decision to join car-sharing, rather than car-sharing causing someone to sell a car. If we fail to capture this reverse causality, then we will overestimate the impact of car-sharing. To avoid these issues, we directly ask users what they did because of car-sharing, or what they would do in the absence of car-sharing with respect to car ownership. Concretely, respondents to the survey were asked:

- How important was car-sharing when deciding to sell or scrap a car?
- If I was not a member of car-sharing, I would buy/lease/not have sold a car. Do you agree or disagree?

This is a self-assessed question, and thus is open to bias. However, we justify the use of this for two reasons: first, we anticipate that users are able to better make a judgement regarding the effect of car-sharing on large decisions like car-ownership than much smaller decisions such as car-use, data which other studies rely on (e.g. Martin and Shaheen (2011), Firnkorn and Müller (2011). Second, this self-assessment is captured with uncertainty embedded in the question: users are asked the extent to which car-sharing was responsible on a 7 point scale. Thus, we can capture this degree of uncertainty, and in tandem, account for the size of any bias.

Based on this observation, different categories of car-sharing users can be defined based on how car-sharing affected car-ownership in each user's household. Note that it is the *household* level car-ownership that is used to define these categories, rather than individual car-ownership, since cars are often shared among members of a household rather than exclusively driven by one individual.

Car-sharing users have been sub-divided into the following categories:

- **Would-be car-owner (WCO):** these users do not own a car or do not have access to one within their household, but have either sold a car or would have bought one had they not been members of car-sharing. Compared to the situation where they owned a car, these users are expected to reduce their car-use.

- **Would-be additional car-owner (WACO):** users own, or have access to, at least one car in the household, but have sold a car or would have bought an additional car had they not been members of car-sharing. They are expected to reduce their car-use, since the user would have had easier access to a car compared to car-sharing.

- **Car-owner (CON):** these users own at least one car, or have access to one within the household, but their car-ownership has not been affected by car-sharing. They are expected to increase their car-use since they now use car-sharing in addition to their private car-use.

- **Non-car-owner (NCO):** these users do not own a car or do not have access to one within the household, and would not have bought a car without car-sharing. They increase their car-use since they would not have access to a car without car-sharing. Their increase in car use is directly measurable.

The advantage of the discrete choice experiment in the survey is that we can identify members of the control group that are the best matches for car-sharing users. Each respondent who was not a car-sharing member was asked about the scenario under which they imagined the choice, i.e. were they imagining the need for an additional car, or a replacement car. This allows us to find control users who are most similar to car-sharing users:

User category	Number of observations	
	Treatment	Control
WCO	110	180
WACO	39	108
CON	19	32
NCO	47	N/A

Table 23: The breakdown of the sample by user category

Threshold	WCO	WACO	CON	NCO
Agree a little	110	39	19	47
Agree	51	26	28	88
Totally agree	17	4	41	114

Table 24: The number of users in each category depending on the threshold used to determine effects of car-sharing on car-ownership.

only those who said they considered car-sharing as a replacement vehicle were compared to *would-be car-owners* or *would-be additional car-owners*.

The breakdown of the user categories is shown in table 23. The largest treatment group is *would-be car-owners*, followed by non-car-owners.

The distribution in table 23 is based on a looser interpretation of the causal impact of car-sharing on car-ownership: car-sharing users who indicated that they "agree a little" that they sold/scrapped a car because of car-sharing are considered as would-be (additional) car-owners. A stricter definition of the causal effect of car-sharing on car-ownership changes the distribution of car-sharing users towards non-car-owners and car-owners. Table 24 shows how the distribution of users changes depending on the answer to the question; for example, if users that only answer "Agree" and "Totally agree" are considered to have sold/scrapped/not bought a car, then the number of WCO users drops by more than half, while the number of WACO users drops by a third. This table is the basis for two different scenarios, covered in section 6.4.

6.1.3. Beta regressions to estimate effect

The final stage of the estimate of the treatment effect is to use regressions to control for differences in characteristics between treatment and control groups that were recorded in the survey. Such characteristics include: the location of the household, the size of the household, the distance the individual lives from work, etc. Each of these is expected to influence *both* the decision to join car-sharing *and* car-use and car-ownership. Controlling for these factors in a regression model should further reduce any selection bias present between treatment and control groups.

The dependent variable in the regression model (i.e. the effect we are estimating) is the proportion of total km in a typical week travelled by private car and additionally, for car-sharing users, shared cars. Since the proportion is bounded between 0 and 1, linear regression methods such as ordinary least squares are inappropriate. Thus, a method known as beta regression was used, allowing for a more accurate calculation of the effect of car-sharing.

Of the four categories of users outlined above, a beta regression was performed for three: would-be car-owners, would-be additional car-owners, and car-owners. A regression is not necessary for non-car-owners since the effect of car-sharing is directly observed (i.e. the km driven by car).

Table 25 lists the control variables used in the models. These were selected under the assumption that they affect both car-sharing and car-use, but that they themselves are not affected by car-sharing or car-use. For example, if a two person household lives without children, they may decide that car-sharing is preferable to owning a car since their need for a car is relatively predictable. Thus, the number of children in a household may affect car-sharing membership. But it is extremely unlikely that the reverse is true, i.e. that being a member of a car-sharing system or the amount one uses a car will influence the number of children in a household.

Three models were estimated for each user category. In the first model, an average treatment effect is calculated. The second model estimates different treatment effects for users of b2c and p2p systems. In the third model, we estimate the additional effect of a car-sharing user living in an urban, suburban, or rural area.

6.2. Treatment effects

By using beta regressions, the treatment effect for each user will differ depending on the proportion of km currently travelled by car. In addition, in models 2 and 3, the treatment effects also differ depending on the type of car-sharing and the user location, respectively. To illustrate the effect of these parameters, simulated effects have been calculated. The simulations

Variable name	Description	Applicable user categories
Age	The respondent's age	WCO, WACO, CON
Urban, Rural, Suburban	The location of the user's household, as defined by the user	WCO, WACO, CON
hhadults	The number of persons in the household aged 18 or older	WCO, WACO, CON
hhchildren	The number of persons in the househol aged 17 or younger	WCO, WACO, CON
fulltime, parttime, student	The employment status of the respondent	WCO, WACO, CON
companycar	Whether the respondent has access to a company car or not	WCO, WACO, CON
avgWorkDistance	The distance between the respondent's work and his/her household (if applicable)	WCO
avgSchoolDistance	The distance between the respondent's school/university and his/her household (if applicable)	WCO
work.trips	The number of return trips to work per week (used instead of avgWorkDistance)	WACO, CON
school.trips	The number of return trips to school per week (used instead of avgSchoolDistance)	WACO, CON
Q36-3	Answers to the question: "I am worried about climate change" (5 point likert scale)	WCO, WACO, CON
Q36-12	Answers to the question: "There is a dream car that I would like to have" (5 point likert scale)	WCO, WACO, CON
Q174-18	Answers to the question: "Public transport is environmentally friendly" (5 point likert scale)	WCO, WACO, CON
pop.density.cat	The population density of the postcode area in which the user lives, split into different levels with cut off points (people/km^2): < 350, 550, 1000, 1500, 2000, 10000, 20000	WCO
district	The district (*arrondissements*) where the user lives	WCO, WACO, CON
hhcars.pre.cs	The number of cars in the household (before car-sharing if they are a user, otherwise at present)	WACO
hhpcars	The number of cars in the household	CON

Table 25: Control variables used in the regression models

are based on 1000 random draws of the treatment effect from a normal distribution based on the results of the regression, incorporating the uncertainty inherent in the model.

The results of the simulations show what the expected proportion of km driven by car would be for a user if (s)he was not a member of car-sharing. Each treatment effect is estimated with a margin of error. For some of the treatment effects, we cannot be certain that it is different from 0, i.e. that there is any effect of car-sharing on behaviour.

6.2.1. Model 1: Simulated average treatment effects

The results of the simulated average treatment effects are presented in Table 26. The table should be interpreted as follows: a WCO user who travels 10% of his/her weekly km by car (both private and shared) would be expected to drive 22% of his/her weekly by car *if they were not a member of car-sharing*, on average. Thus, for a such a user, car-sharing causes a reduction of 12% of km driven by car. The mean effect for CON users shows that car-sharing causes an increase in the amount they use a car, e.g. a CON user who drives 10% of his/her km by car with car-sharing would be expected to drive just 3.1% of km by car without car-sharing.

The 95% confidence intervals for all three effects are shown in table 27. For both WCO and WACO users, the lower bound of the 95% confidence interval shows that car-sharing is expected to reduce car-use. For CON users, however, the upper bound of the confidence interval is greater than the "With CS" column, meaning that we cannot conclude with certainty that CON users increase their car-use because of car-sharing. This is due to the low number of CON users in the sample (see table 24.

6.2.2. Model 2: Simulated treatment effects for p2p vs b2c systems

The aim of model 2 is to see if the effect of car-sharing on p2p and b2c car-sharing users differs. The average treatment effects based on different car-use proportions for both p2p and b2c systems are given in table 28. The results can be interpreted as follows: a p2p WCO who currently drives 10% of his/her km by car would drive 25.2% of his/her km by car if (s)he was not a member of car-sharing. Thus, as a result of car-sharing, this user has reduced his/her car-use by 15.2%. Car-sharing causes a reduction in car-use for both WCO and WACO users. However, for CON users, car-sharing causes an increase in car-use: a p2p CON user who drives 10% of his/her

With CS (% of km by car)	Counterfactual (%) WCO	WACO	CON
10	22.0	33.0	3.1
20	37.0	50.0	7.7
30	49.4	62.5	13.4
40	60.1	72.2	20.1
50	69.5	80.0	27.9
60	77.7	86.3	37.0
70	84.9	91.4	47.6
80	91.2	95.4	60.1
90	96.3	98.3	75.7

Table 26: Estimated mean counterfactual proportions of km by car (model 1)

With CS	Counterfactual (%)					
(% of km by car)	WCO		WACO		CON	
	LB	UB	LB	UB	LB	UB
10	16.2	28.9	22.0	45.8	0.4	13.1
20	29.2	45.4	37.0	63.1	1.5	24.8
30	40.9	58.0	49.4	74.3	3.2	35.9
40	51.6	68.2	60.1	82.2	5.6	46.4
50	61.6	76.6	69.5	88.0	9.1	56.4
60	70.8	83.6	77.8	92.4	14.0	66.1
70	79.3	89.4	85.0	95.6	21.0	75.4
80	87.2	94.1	91.2	97.8	31.2	84.2
90	94.2	97.8	96.3	99.3	48.0	92.6

Table 27: 95% Upper and lower bound (UB, LB) estimates of counterfactual proportions of km by car (Model 1)

With CS (% of km by car)	Counterfactual (%)					
	WCO		WACO		CON	
	P2P	B2C	P2P	B2C	P2P	B2C
10	25.2	19.0	15.2	32.9	5.3	5.3
20	40.9	33.1	27.8	49.9	11.9	12.0
30	53.5	45.2	39.3	62.4	19.4	19.6
40	64.0	56.0	50.0	72.1	27.7	27.9
50	73.0	65.7	60.0	80.0	36.7	37.0
60	80.7	74.5	69.4	86.3	46.6	46.8
70	87.2	82.4	78.2	91.4	57.4	57.6
80	92.7	89.4	86.3	95.4	69.3	69.4
90	97.1	95.4	93.8	98.3	82.7	82.9

Table 28: Estimated mean counterfactual proportions of km by car (Model 2)

km by car is expected to drive 5.3% of his/her km by car if he/she was not a member of car-sharing.

There are no clear trends in the differences between p2p and b2c users for each user category. Amongst WCO users, p2p car-sharing shows a larger treatment effect compared to b2c car-sharing; however the reverse is true for WACO users. Amongst CON users, the effect of b2c and p2p car-sharing is very similar.

6.2.3. Simulated treatment effects for urban, suburban, and rural users

The aim of model 3 is to see whether the effect of car-sharing differs for urban, suburban and rual users. Table 29 shows the results of simulated treatment effects for each user type, differentiated by the location of the user. The effect of user location on the impact of car-sharing on car-use does appear important: users living in suburban locations appear to reduce their car-use by more than both urban and rural users. However, we cannot tell if these differences are statistically significant.

Table 30 shows the difference in the regression coefficients between users from different locations. From these results, it can be judged whether there is a statistically significant difference between car-sharing users from different locations. Amongst WCO and WACO users, suburban users are expected to reduce their car-use because of car-sharing by more than both urban users, significant at the 10% level. Although the treatment effect for rural users is least, the differences between rural and other users are not significant due to the small number of rural car-sharing users. Amongst CON users, suburban users are expected to increase their car-use by most. However, none of the effects for CON users are significant, again due to the small amount of CON users.

With CS (% of km by car)	Counterfactual (%)								
	WCO			WACO			CON		
	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural
10	18.7	30.6	12.3	37.0	41.7	20.7	7.3	1.7	10.2
20	32.7	47.3	23.6	54.3	59.1	35.3	15.5	4.7	20.3
30	44.8	59.8	34.3	66.4	70.8	47.6	24.2	8.7	30.4
40	55.5	69.8	44.7	75.7	79.4	58.3	33.4	13.8	40.4
50	65.3	78.0	54.8	82.9	85.8	67.8	43.1	20.1	50.4
60	74.1	84.8	64.6	88.5	90.7	76.3	53.1	28.0	60.4
70	82.0	90.3	74.1	93.0	94.5	83.8	63.7	37.7	70.4
80	89.1	94.7	83.2	96.3	97.2	90.4	74.7	50.2	80.3
90	95.3	98.0	92.0	98.7	99.1	96.0	86.6	67.2	90.2

Table 29: Estimated mean counterfactual proportions of km by car by user's household location (Model 3)

User category	Suburban - Urban	p-value ($\neq 0$)	Suburban - Rural	p-value ($\neq 0$)	Urban - Rural	p-value ($\neq 0$)
WCO	-0.38	0.060	-0.65	0.130	-0.27	0.675
WACO	-0.12	0.740	-0.61	0.123	-0.49	0.434
CON	0.66	0.386	0.85	0.361	0.19	0.779

Table 30: Difference in mean regression coefficients between urban and suburban users (suburban - urban)

6.3. The environmental impacts of car-sharing in Belgium

Using the estimate of the change in proportion of km driven by car, the overall impact of car-sharing on the environment for the sample of car-sharing users can be estimated. In this analysis, the impacts considered are contributions to climate change and resource use.

The impacts are calculated using life-cycle analysis (LCA). The system modelled is the manufacture of a generic car, the production of petrol, and the use of a car. Thus, emissions are generated from three main processes: car production, petrol production, and direct exhaust emissions from the car. Maintenance and end-of-life processes have not been considered in this analysis. Note that the use of other modes of transport, such as public transport, have not been included, and thus the overall of effect on total emissions caused by car-sharing cannot be concluded from this data alone. It is likely that emissions due to car-sharing would be slightly larger (but still negative) if these impacts were included. However, relative comparisons between different users (based on categories, b2c/p2p or user location) can be judged.

To complete the LCA, a number of assumptions are made:

1. There is no change in overall km travelled by a car-sharing user
2. Shared cars and private cars have the same weight, fuel efficiency (0.0621kg petrol per km) and lifetimes (in 250,000 km)
3. Cars are modelled as Euro 5 petrol cars of medium size (1600kg)
4. Inventories for the cars are based on the generic inventories from the EcoInvent database, v3.5

Using assumption 1, above, allows the estimate of the counterfactual km driven by car-sharing users to be calculated as detailed in equation 3, where $\hat{Km}_i^{CF}$ is the counterfactual km travelled by car, $\hat{PP}_i^{CF}$ is the counterfactual proportion of total km driven by car, and $Km_{Total/wk,_i}$ is the total number of km travelled in a typical week.

$$\hat{Km}_i^{CF} = \hat{PP}_i^{CF} \cdot Km_{Total/wk,_i} \tag{3}$$

The results of the LCA have been calculated based on the different regression models listed above. In each LCA model, the uncertainty in the treatment effects have been propagated through the model, enabling robustness checks for conclusions. However, it should be noted that the models

Scenario	Threshold	WCO	WACO	CON	NCO
Best case	Agree a little	110	39	19	47
Middle	Agree	51	26	28	88

Table 31: The number of users from each category for both scenarios

including separate effects for b2c and p2p users (model 2), and those depending on location (model 3) have been modelled assuming each effect is independent of the other. That is, that the effect for p2p users is not affected by the estimated treatment effect for b2c users. However, whether these effects are truly independent is debatable. Most obviously, there may be a systematic bias in the model, meaning that each effect (b2c and p2p, or urban, suburban, and rural) is affected in the same way, i.e. over or under estimated. Given this possibility, the variance of the results for scenarios 2 and 3 may be underestimated. While this affects absolute conclusions regarding whether car-sharing results in an environmental benefit, it should not affect relative conclusions, for example when comparing urban to rural users.

In addition to the three models, model 1 has been analysed under two different scenarios depending on the number of users in each category. The first scenario includes all users who at least "Agree a little" that they got rid or would have bought a car because of car-sharing as WCO/WACO users. Thus, it can be considered a "best-case" scenario. The second scenario assumes that only those who "Agree" or "strongly agree" that car-sharing affected their car-ownership are counted as WCO/WACO users. This is called the "middle" scenario.

6.4. Aggregate results under different scenarios

Comparing the composition of the two scenarios (table 31), there is large rise in NCO users in the "middle" scenario. This increase comes from those who were considered WCO users in the best-case scenario.

Table 32 shows the aggregate results of both scenarios, broken down by user type. In the best-case scenario, the reduction in environmental impact of WACO and WCO users more than compensates for the increase in environmental impact of CON and NCO users, leading to an overall environmental benefit in 97.5% of simulations, with a total average reduction of 1064kg of CO_2eq. emissions. In the middle scenario, car-sharing leads to an environmental benefit in 30.7% of scenarios. Consulting table 32, this divergence

	Best-case scenario		Middle Scenario	
User category	Average	standard deviation	Average	standard deviation
WCO	-960.4	225.3	-396.6	139.3
WACO	-901.9	170.0	-573.5	131.6
CON	241.8	153.2	209.7	234.5
NCO	556.3	-	998.2	-
Total	-1064.3	547.0	237.9	504.7

Table 32: Aggregate change in of Kg CO_2eq. emissions per user category per week

between the two scenarios is driven by the concurrent increase and reduction in the impact of NCO and WCO users respectively.

These results show that the environmental impacts of car-sharing are very sensitive to the effect of car-sharing on car-ownership. The impacts of those whose car-ownership is not affected by car-sharing (NCO and CON) are large and may offset those who have fewer cars because of car-sharing (WCO and WACO).

6.4.1. Model 1: Average treatment effect

Model 1 represents the assumption that car-sharing users in each category regardless of their location or the type of car-sharing are affected in the same manner. These are the same effects listed in table 26: the proportion of km currently travelled by car affects the estimation of the counterfactual proportion without car-sharing.

The average impact for a user in each category is shown in table 33. The impact of NCO users is not estimated by a model, thus these results have no uncertainty attached. The distributions of the three user types show that the average WACO user has a larger overall reduction in GHG emissions compared to the average WCO user. The average WACO user reduces his/her CO2eq emissions by more than an average WCO user, and this difference is significant ($p \approx 0.00$). Car-sharing causes the average CON user to increase their emissions, although this is not significant.

6.4.2. Model 2: separate effects for p2p and b2c users

Table 34 shows the break down of the results of the average user by user category, and figure 38 the distribution. The average p2p WCO user generates fewer emissions compared to b2c WCO users, while the reverse is

User category	mean (kg of CO_2eq.)	standard deviation
WCO	-8.73	2.05
WACO	-23.13	4.36
CON	12.73	8.06
NCO	11.84	-

Table 33: The average change of kg CO_2eq. emissions per user per week for each user category (Model 1)

User type	p2p		b2c	
	mean	std. dev.	mean	std. dev.
WCO	-10.48	2.66	-6.92	2.35
WACO	-4.16	4.19	-27.40	5.68
CON	7.17	6.51	8.20	6.10
NCO	7.43	-	14.58	-

Table 34: The average change in kg of CO_2eq. per user per week by user category and car-sharing type (Model 2).

true for WACO users. The large overlap between the distributions of b2c and p2p WCO users show that there is no statistically significant difference in GHG emissions reduction for these two user types. However, amongst WACO users, b2c users produce significantly lower emissions due to car-sharing compared to p2p users. The impact of p2p WACO users is not statistically significant from 0, evidenced by a large portion of the distribution to the right of 0kg of Co_2eq. There is no discernible difference in GHG emissions reduction between p2p and b2c CON users, evidenced by the very similar distributions.

Based on these results, it is not clear which of P2P or B2C car-sharing systems are preferable with respect to GHG emissions reduction.

6.4.3. Model 3: separate effects for user location

The average impacts per user depending on location are shown in table 35 and the distribution in figure 39. Amongst WCO users, car-sharing has the biggest effect (reduction) for suburban users, in-line with the simulated effects in table 29. For WACO users, car-sharing has the largest effect for urban users.

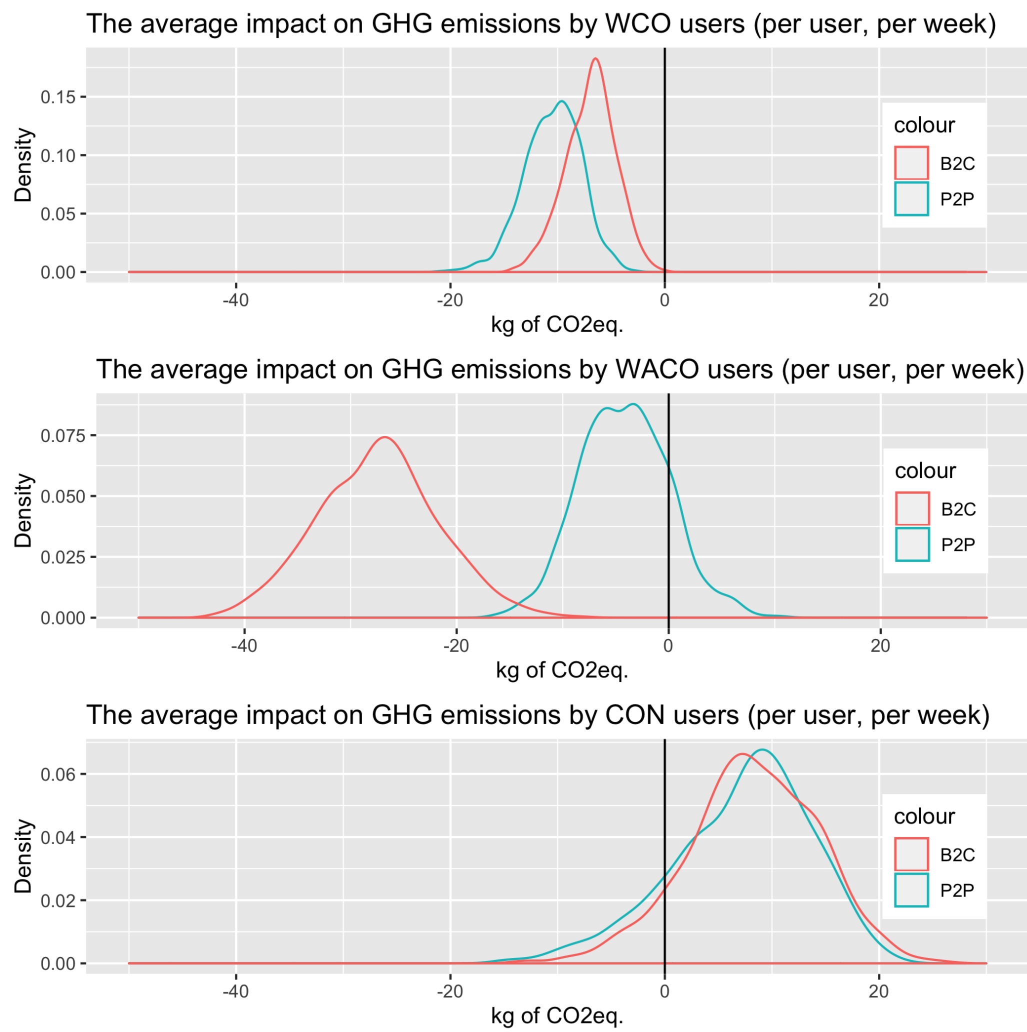


Figure 38: Distribution of kg CO_2eq. per user per week by car-sharing type based on 1000 simulations (Model 2)

User type	Urban		Suburban		Rural	
	mean	std. dev.	mean	std. dev.	mean	std. dev.
WCO	-6.55	2.45	-14.13	3.59	-2.56	6.08
WACO	-26.47	7.44	-21.82	5.59	-17.55	10.43
CON	3.60	8.36	16.88	11.58	-8.00	34.34
NCO	12.91	-	8.71	-	11.57	-

Table 35: Average change in kg of CO_2eq. per person per week by user category and location (Model 3)

Car-sharing produces the least environmental benefit (GHG reduction) amongst rural users across both WCO and WACO users, although the variation in these results is large owing to the small number of rural users. There is no statistically significant effect of car-sharing for rural WCO or CON users either. Amongst NCO users, urban users produce the largest amount of GHG emissions, followed by rural users.

Overall, the results of model 3 show that the impacts of car-sharing do vary according to where users live. It is difficult to draw specific conclusions from these results, however, as the small sample size mean many of the individual effects and the differences between locations are not statistically significant.

6.5. Sensitivity analysis of technical parameters

A sensitivity analysis was conducted to assess the extent to which the technical parameters affect the impact on GHG emissions. Two parameters were modelled: car lifetimes, and fuel efficiency. The former is defined in terms of km, and reflects the number of km a car is used for in its lifetime, from cradle to grave. This number reflects the use-intensity of a car: a car that is used often is likely to travel more km over its useful lifetime relative to one used less. In car-sharing, the lifetime parameter also reflects the number of shared cars needed to provide the service level: more cars spread between the same amount of users will reduce use-intensity, and by extension, overall lifetimes. The lifetime parameter may thus reflect some major differences between car-sharing and private car ownership. However, since no technical data was readily available for this study to include in the LCA models, we instead focused on how these parameters would affect results.

To calculate the sensitivities of these parameters, a generic LCA was

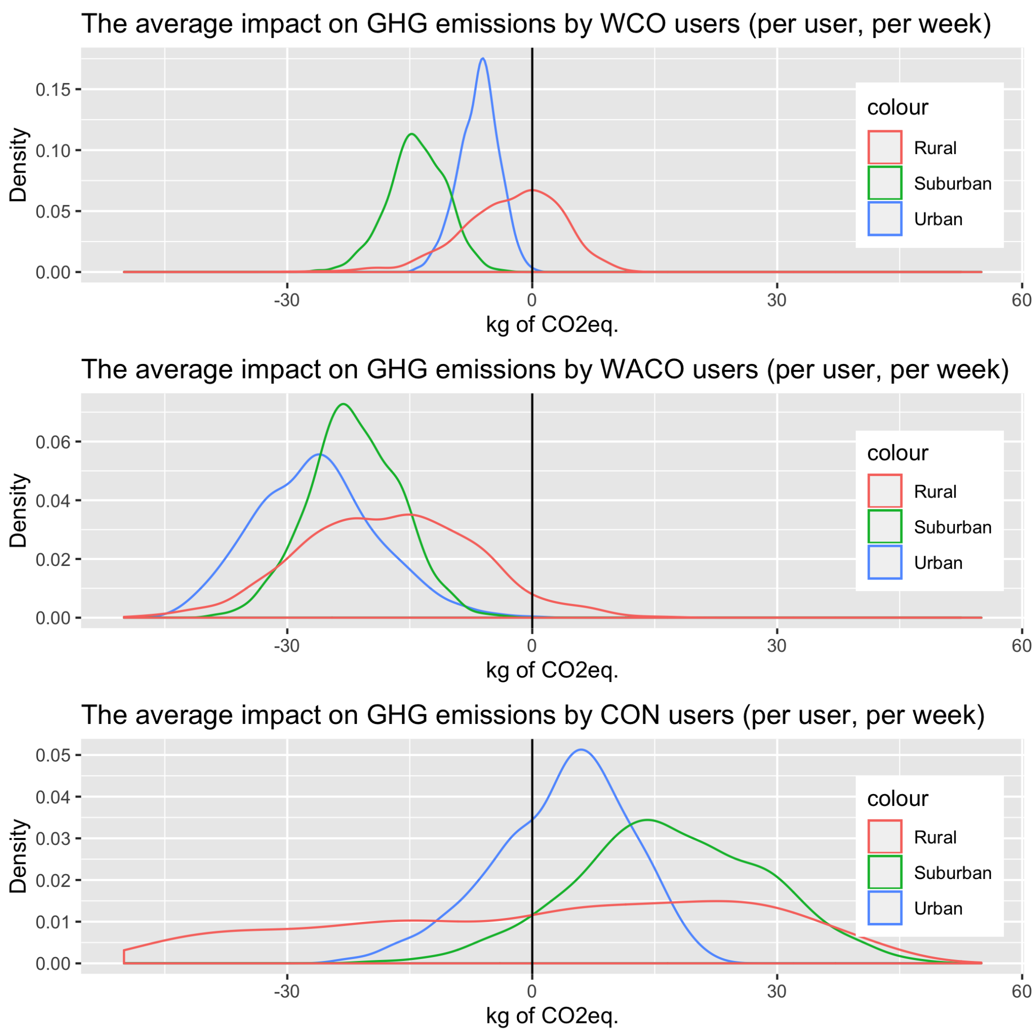


Figure 39: Distribution of kg CO_2eq. per user per week by user location based on 1000 simulations (Model 3)

modelled with simulated data. The results show that fuel efficiency is significantly more sensitive relative to vehicle lifetime. A 1% increase in the lifetime of a vehicle would reduce the GHG emissions by around 0.15%. In contrast, a 1% increase in fuel required to travel 1 km would increase GHG emissions by 0.85%. Of this 0.85%, around 0.15 percentage points are due to the production of the fuel, with the remaining 0.7 percentage points are due to the direct exhaust emissions.

These sensitivity ratios are dependent on the initial values used in the analysis, namely a lifetime of $250,000$km and fuel efficiency of 0.0621kg petrol / km. Since car lifetimes are expected to differ between shared cars and private cars, sensitivity ratios were calculated for a range of different lifetimes. The results are depicted in figure 40. It shows that as lifetime increases, the sensitivity of car production approaches a limit: the marginal effect declines as lifetime increase. Thus, while increasing vehicle lifetimes produces an environmental benefit in terms of GHG emissions, the strength of this effect is progressively smaller. Of all possible changes to vehicles, therefore, increasing fuel efficiency would increase the benefits of car-sharing in terms of GHG emissions more than extending car lifetimes.

6.6. Conclusions

From the above analysis, we can draw the following conclusions:

- The overall impact of car-sharing for this sample depends on the number of users whose car-ownership is affected. In the best case scenario, car-sharing results in an environmental benefit in 97.5% of simulations, with an average reduction of 1064kg of CO_2eq. emissions from cars per week. In the alternative scenario, car-sharing results in an an environmental benefit in 30.7% of simulations, with an average increase of 238kg of CO_2eq. emissions from cars per week.

- Changes to car use induced by car-sharing differ depending on the number of cars they own prior to joining car-sharing. Those who still own a car despite selling or not purchasing a car tend to reduce their car use by more compared to those who do not own any cars.

- There is no consistent statistically significant difference between the effects of peer-to-peer (P2P) and business-to-consumer (B2C) car-sharing

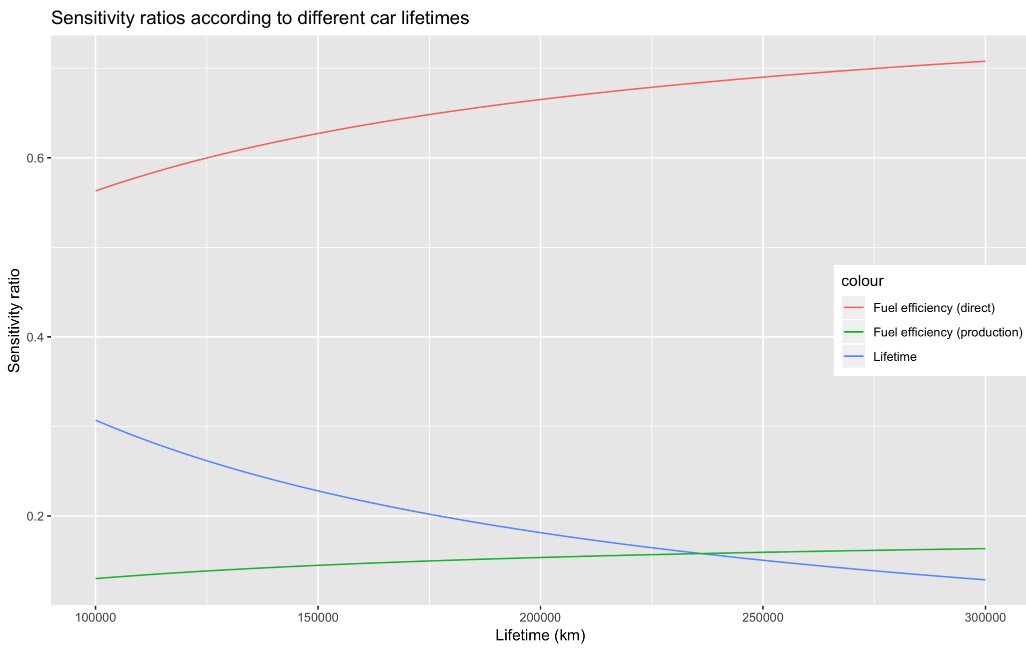


Figure 40: The sensitivity ratios of car lifetime, fuel production and direct fuel emissions for different values of car lifetime

on user behaviour or GHG emissions. P2P car-sharing users who become car-less reduce their emissions more compared to B2C users; however for those users who retain a car, B2C car-sharing users reduce their GHG emissions by more.

- Among users who have fewer cars because of car-sharing, suburban users are expected to reduce car-use by more compared to both urban and rural users all else being equal. The environmental benefits of car-sharing are greatest for suburban and urban users.

- The production of cars has a progressively smaller relative effect on overall emissions as a car's lifetime increases, while the relative effects of both fuel production and direct vehicle emissions increase as lifetime increases.

- Increasing fuel efficiency of shared cars would have a larger impact on the reduction of GHG emissions compared to increasing lifetimes, regardless of the car's lifetime.

7. Policy conclusions

The transition to sustainable transport

On the evidence of this report, car-sharing *could* help to reduce the environmental impacts associated with mobility, but only under certain conditions. There is a danger that car-sharing adds to environmental pressures if it is used as an additional form of mobility, rather than as a replacement for private car ownership. Thus, in order to maximise the environmental benefits of car-sharing, and to minimise the risk of increasing environmental burdens, car-sharing should only be encouraged at the expense of car ownership. It is important to note that it is replacing private car-ownership that is key, not private car-use. The discussion that follows is based on the premise that mobility policies affecting car-sharing should aim to reduce environmental impact and resource use, policies that promote a sustainable and circular economy.

Subsidies and other financial incentives

There is little evidence that reducing the cost of car-sharing for users will have environmental benefits. Evidence from those who already use car-sharing show that 91% do so because it is cheaper than owning and using a private car (figure 15). Moreover, of those who are not-sharing, cost was the least important barrier (figure 27). Evidence from other studies also show that people who drive less than 6000-10000km per year would save money by switching to car-sharing (see section 1.2); people who drive more than this are unlikely to switch to car-sharing anyway. Reducing the cost of car-sharing to consumers will lead to a greater risk of increasing car-use, at the expense of public transport and cycling. Thus, policy should avoid subsidies, both for firms and consumers, whether in the form of direct cash transfers, refunds, or beneficial tax treatment, unless governments can be certain car-sharing is replacing car ownership (see next paragraph). From an environmental perspective, it would make more sense to invest in improving cycling infrastructure and/or public transport, either to lower its cost or improve the service, rather than in lowering the cost of car-sharing.

One way to encourage car-sharing as a replacement for car-ownership is through incentives when car-owners scrap (one of) their car(s). The Flemish government used to provide benefits for families that get rid of their all personal cars. Currently, there are some initiatives at the local (city) level but the regional benefits have been abolished. Some examples of local initiatives can be found in the city of Gent where people get up to 1000 euros if they scrap an old/ polluting car [4]. The city of Antwerpen pays back 10% of a MaaS subscription (up to 50 euros per month) to people who get rid of their car [5], while Brussel offers a Cambio subscription for a year and either a year subscription for all public transportation in the city or a bike subsidy (up to 505 euros)[6]. Of these, the policy of Brussels and Antwerp would, in theory, be the most effective at preventing a return to car-ownership since they offer in-kind benefits for cycling, public transport or car-sharing. Gent's cash transfer, instead, may be used to offset the cost of a replacement vehicle. Applying the general principle outlined above, any incentives should focus on in-kind cycling or public transport benefits, with in-kind car-sharing benefits limited to low-cost incentives, such as the refunding of registration fees. Even in-kind benefits, however, may not prevent former owners from purchasing a car at a later date unless car-ownership is made less attractive.

[4]https://stad.gent/mobiliteit-openbare-werken/producten/slooppremie
[5]http://www.slimnaarantwerpen.be
[6]http://www.brusselair-premie.be/

Parking

Many cities in Flanders have restrict car use in city centres, while parking spaces in the city centre are either extremely limited or very expensive. Almost 40% of the respondents (figure 27) said that they might be more willing to share cars if the city would make it easier to park shared cars. Some cities such as Gent, Antwerpen and Leuven reserve parking spaces for station-based systems and / or allow parking permits for shared cars. The interviewees also commented that clear demarcation of car-sharing spaces together with regular patrols around the parking spaces is also necessary to avoid (mis)use by private car owners. However, the underlying principle expressed earlier means that any ease of parking restrictions or increase of spaces must be at the expense of private cars. That is, if parking for shared cars is to be eased, parking for private cars should be reduced and restricted concurrently. Otherwise, car-sharing risks being used as a substitute for public transport or cycling, for example, by enabling an easier route to reach city centres relative to public transport/cycling.

Currently, real estate developers in Flanders are required by law to provide 1.2 or even 2 parking spaces per residential unit for a new-build apartment. They are required to do so because municipal authorities fear that residents will park in the streets in the vicinity of the new building if there is not enough parking space in the building itself. This not only drives up the price of these new buildings, but recent research has shown that about 1 in 5 of these parking spaces remain empty (Van Neck (2018)). Following neighbouring countries, municipalities should relax the minimum amount of parking spaces in new residential projects and could rather consider providing one or more shared cars that can be used by all residents.

Enabling multi-modal lifestyles

Good public transport and extensive cycling infrastructure are key for users to lead more multi-modal lifestyles. Car-sharing, however, has ambiguous effects on public transport. In our survey, 70% of car-sharing users joined car-sharing because it is faster than public transport (figure 15). This suggests that for some members, car-sharing could substitute for public transport, a negative outcome for the environment.[7] Moreover, those who are not

[7]Further evidence is presented in Figure 24: when car-sharing users were asked how they would replace car-sharing journeys if they were not members, 56% of users would

yet car-sharing members but are interested in joining have positive views of public transport, suggesting they are already or willing to be regular users. Whilst the outcome of these potential members is not known, it cannot be discounted that such users would substitute public transport with car-sharing. To avoid this substitution effect, public transport, as well as active modes such as cycling, must continue to be supported as much as possible by policies, even at the expense of car-sharing. One interviewee suggested in section 3 that shared cars should be allowed to use priority lanes currently reserved for public transport; however, such a policy puts car-sharing and public transport on an equal footing, whereas the emphasis should be on making public transport, as well as cycling, more attractive at the expense of *all* car-use, including sharing.

The last miles to get to a destination are often hard when one is limited to public transportation. This hurdle is usually overcome by avoiding public transport altogether and using a personal car for the whole trip. Mobihubs are one solution to counter this problem, helping the transition to multi-modal lifestyles; they bring public transportation, electric charging stations, shared cars, and shared bikes all in one spot or hub, meaning that shared cars or bikes can be used for the last mile, complementing public transport. However, careful planning of such systems is necessary so that the hubs are easily accessible themselves by public transport or bike, so that cars are not necessary to reach the hub for most users.

Disincentivising car-ownership

The place of car-sharing in sustainable mobility is only as a transition tool away from car-ownership and towards cycling and public transport. An effective way of encouraging this transition is to make car-ownership more unattractive. For example, policies that increase taxes on car-ownership or

replace at least some of their journeys with public transport. Note that this does not mean that 70% or 56% of users substitute car-sharing for public transport. Rather, it implies that for some users, for some journeys, car-sharing may replace public transport. The overall, aggregate, effect of car-sharing on public transport cannot be concluded on the basis of this. It should also be emphasised that car-sharing users who sell or do not buy a car (WCO and WACO) will increase their use of public transport, a positive effect for the environment. Regardless of whether car-sharing ultimately substitutes or complements public transport, and/or cycling, investment in public transport and cycling infrastructure is necessary to continue to help car-owners transition away from car-ownership, and car-use (shared or otherwise).

congestion charges that target car-use, can benefit car-sharing by proxy. Note that in this scenario, it would also make sense to subject car-sharing to the congestion charge, to ensure car-use in general is not incentivised. The effects of such taxes or charges would probably be regresssive, hitting the poorest hardest; thus, measures to redress the balance should be part of the policy mix. This could include discounted public transport passes or (electric) bikes for those with low incomes.

Information and communication

Results from the survey suggest that non-sharers are confused about aspects of car-sharing, such as costs and liability. More clarity about these issues form car-sharing firms could help. Regarding costs, there is substantial variation amongst car-sharing firms and their cost structures: a mix of membership fees, monthly fees, km costs, time costs, reservation costs etc. This makes it difficult for users to compare different car-sharing schemes, and crucially to compare it to car-ownership. Many firms already offer a cost calculator; however, a non-partisan price comparison website may ease decisions for potential users. Clear guidance regarding responsibilities, especially the procedure in the case of accidents, may also help ease concerns of potential users.

One obvious hurdle for people to share cars is unfamiliarity with the concept and the existence of alternatives in their neighbourhood. It can therefore greatly help if local government actively promotes shared cars. Leaflets, flyers, or articles on the citys website or in local newspapers are all examples of how to get the word out. However, simply making the shared cars more visible in the city with clearly signalized parking spaces for shared cars or eye-catching vehicles can also help to build trust.

A finding from the survey is that those who are most concerned about the environment were also the most interested in car-sharing. Moreover, a 94% of car-sharing users joined partly because they believe it is better for the environment. Thus, if such potential users were more informed about the impacts of car-sharing, particularly that its environmental benefits only accrue when car-sharing replaces car-ownership, then more users may be more willing to forgo private cars. There is a danger that car-sharing users feel they are doing something that benefits the environment, without actually realising those benefits in reality. Clear communication of the principle that car-sharing should replace ownership could help to realise more pro-environmental behaviour.

Car availability and fleet size

A common concern amongst non-sharers is the availability of cars, both geo-spatially (e.g. in their neighbourhood) and to meet demand (e.g. availability of a car when they need it), as highlighted in figures 26 and 27. These issues can be overcome by expanding the number of cars in the fleet; however, this will negatively affect the environmental impact and resource efficiency, as cars will be left unused for longer. This is a delicate balancing act for car-sharing firms to manage, as investing in the size of the fleet requires significant capital outlay, as discussed in section 3.However, p2p car-sharing can potentially take advantage of a large fleet if it can attract car-owners to the platform. In addition, some local governments share their own fleet. Sharing an already existing fleet should reduce additional demand (and production) of cars, avoiding some environmental impact and material use. Another solution is used by Partago, which uses a co-operative model: new users are asked to pay a large up-front cost to become a member, refundable when users decide to leave. This may give smaller firms the start-up capital necessary to secure further financial backing to expand the size of the fleet.

Electrification

The analysis in section 6 showed that increasing fuel efficiency is more important than lifetime extension when trying to reduce GHG emissions. While electric vehicles are not a panacea, combined with a renewable energy mix, they would offer greater environmental benefits over fossil-fuel based cars (both GHG emission and air pollution reduction).

Although the correspondent from Cambio stated that they opt for a mixed fleet because they believe not everyone is open to electrification, results from this research suggest that both existing car-sharers and potential car-sharers are willing to pay more for electric (shared) cars. Moreover, 94% of users joined car-sharing because they think it is better for the environment (figure 15). Thus, there appears to be an opportunity to use car-sharing to help the transition towards car electrification by improving infrastructure and breaking down the cultural norms that resist electrification. However, charging stations are expensive to install and a lack thereof may pose a significant barrier for electric car-sharing firms. Local governments, in conjunction with car-sharing firms, may expand charging stations in the area to increase the supply of electric shared vehicles. Having charging stations, however, is not enough. Having just one parking spot with a charging station means that the charging station can often not be used as long as the parking spot is occupied. If parking spots in the city are scarce, it is a common problem that charging spots are taken just for parking space. Local government could support car-sharing by greater enforcement of rules punishing this practice.

Rural areas

It is very difficult and expensive to provide public transportation close to inhabitants in rural areas. Many people in rural areas feel like they need a car to go to work, shop for groceries, etc. because the distances are too large to travel by bike and public transportation is not (sufficiently) available. Likewise, getting shared cars to rural areas appears to be difficult (and possibly not even desirable) because it is less profitable for CS firms and the car sharing intention is lower. Mobihubs (see above) could be a particularly useful solution in rural areas. However, as discussed in section 6, rural users produce the least environmental benefits, as car-sharing has the lowest substitution for private car use. More research is needed to examine whether mobihubs could help rural inhabitants switch from a car-dominated to a more multi-modal lifestyle.

Regulatory framework

Our statistical analysis shows that company cars are one of the biggest hurdles for ones car sharing intention. Talks are ongoing to change the system towards a mobility budget or to, at least, decrease the benefits that are currently on company cars.

The regulatory framework for shared cars is currently underdeveloped which means that there is no consistent set of rules across municipalities. However, it would be easier for car sharing firms if the same rules would apply for the whole region or country. A unified view and regulatory framework would greatly reduce the costs that car sharing firms incur for researching the local rules, negotiating with the cities, and implementing their business each time they want to expand to a different location.

Improving the evidence base: Data needs

This research has been conducted despite limited access to third-party data. Assessing the environmental impact of car-sharing, or its place in the circular economy, is difficult to do without extensive data. To improve policy making in the domain of car-sharing, and mobility more generally, data collection and availability has to be improved. Car-sharing companies currently hold a lot of data about the use of their cars, how often they are used, how often they break down, etc.; however, it is not easy to tell from this whether car-sharing is having a positive impact on the environment. Moreover, access to this data for researchers is restricted. Greater collaboration between different levels of governments, car-sharing firms and universities/research institutes would enable a greater evidence base for policy making. One step towards this is the inclusion of open data clauses in the permits or contracts between (local) governments and CS firms.

The data required to calculate the environmental impact of car-sharing is extensive. As a step towards a better understanding of environmental impacts, car-sharing firms could keep track of whether their users have given up a car because of car-sharing. Whilst not ideal, it could act as an indicator that car-sharing is helping to reduce the car hegemony. A better solution would be to gather mobility data from the same panel of participants every year, both car-sharing users and non-sharers, which would enable researchers to have a much clearer understanding of the impact of car-sharing.

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Appendix

Appendix A. Appendices to section 4

Table A.36 shows the difference between sharers and not sharers with respect to several categorical, demographic variables. Fisher's exact test was used as some categories had very few observations.

Variable	**Levels**	$\mathbf{n}_{\mathrm{NCS}}$	$\%_{\mathrm{NCS}}$	$\mathbf{n}_{\mathrm{CS}}$	$\%_{\mathrm{CS}}$	$\mathbf{n}_{\mathrm{all}}$	$\%_{\mathrm{all}}$
Gender	Man	688	38.1	112	38.6	800	38.2
	Woman	1109	61.5	177	61.0	1286	61.4
	X	7	0.4	1	0.3	8	0.4
$p = 0.96$	all	1804	100.0	290	100.0	2094	100.0
Education	Secundary school	486	26.8	16	5.5	502	23.9
	Bachelor degree	611	33.7	77	26.5	688	32.7
	Master degree	530	29.3	154	52.9	684	32.5
	>Master	184	10.2	44	15.1	228	10.8
$p = 0.0005$	all	1811	100.0	291	100.0	2102	100.0
Degree of urbanisation	Rural	756	41.8	27	9.3	783	37.3
	Urban	454	25.1	189	65.0	643	30.6
	Suburban	598	33.1	75	25.8	673	32.1
$p = 0.0005$	all	1808	100.0	291	100.0	2099	100.0
Profession	Other	217	12.0	13	4.5	230	10.9
	Blue collar worker	67	3.7	5	1.7	72	3.4
	White collar worker	1054	58.1	191	65.6	1245	59.1
	Education	119	6.6	38	13.1	157	7.4
	Self-employed	104	5.7	21	7.2	125	5.9
	Civil servant	34	1.9	6	2.1	40	1.9
	Retired	154	8.5	7	2.4	161	7.6
	Incapacitated	19	1.0	3	1.0	22	1.0
	Unemployed	28	1.5	6	2.1	34	1.6
	Stay-at-home (wo)man	19	1.0	1	0.3	20	0.9
$p = 0.0005$	all	1815	100.0	291	100.0	2106	100.0
Employment	Student	198	10.9	14	4.8	212	10.1
	Part time job	291	16.1	71	24.5	362	17.2
	Full time job	1076	59.5	184	63.5	1260	60.0
	Not working	245	13.5	21	7.2	266	12.7
$p = 0.0005$	all	1810	100.0	290	100.0	2100	100.0

Table A.36: Demographics compared between not car sharers (NCS) and car sharers (CS). p-values of Fisher's exact test added. Missing data is left out.

Table A.37 summarize several continuous variables for the sharing (CS) and non-sharing (NCS) population. it shows the number of respondents (n), minimum (Min), first quartile (q_1), mean ($\bar{x}$), third quartile (q_3), maximum (Max), and standard deviation (s). p-values are based on a t-test of Mann-Whitney test if the data cannot be assumed to be normally distributed. The table shows that sharing respondents are significantly younger than non-sharing people. Sharing families also tend to have less adults and more minor in the family. For the factor scores, we see that sharers have significantly lower scores for driving enjoyment and car dependent enjoyment and significantly higher scores for ecological concern and public transport positivism.

Variable	**Levels**	**n**	**Min**	$\mathbf{q_1}$	$\bar{\mathbf{x}}$	$\mathbf{q_3}$	**Max**	**s**
Age	NCS	1814	18.0	29.0	41.1	52.0	85.0	14.3
	CS	291	18.0	30.0	38.4	44.0	73.0	10.2
$p = 0.03$	all	2105	18.0	29.0	40.8	51.0	85.0	13.8
Number of adults	NCS	1798	1.0	2.0	2.2	2.0	9.0	1.0
	CS	290	1.0	1.2	1.9	2.0	6.0	0.8
$p < 0.0001$	all	2088	1.0	2.0	2.2	2.0	9.0	1.0
Number of minors	NCS	1798	0.0	0.0	0.7	1.0	5.0	1.0
	CS	290	0.0	0.0	0.9	2.0	5.0	1.1
$p = 0.04$	all	2088	0.0	0.0	0.8	2.0	5.0	1.0
Car dependent identity	NCS	1815	-3.2	-0.5	0.0	0.6	2.9	0.8
	CS	291	-2.6	-0.9	-0.2	0.5	2.2	1.0
$p < 0.0001$	all	2106	-3.2	-0.5	0.0	0.6	2.9	0.9
Ecological concern	NCS	1815	-4.4	-0.7	-0.2	0.5	2.2	0.9
	CS	291	-1.5	0.6	1.0	1.4	2.2	0.6
$p < 0.0001$	all	2106	-4.4	-0.6	0.0	0.7	2.2	0.9
Driving enjoyment	NCS	1815	-1.9	-0.6	0.1	0.7	3.1	0.9
	CS	291	-1.7	-1.1	-0.4	0.0	2.6	0.8
$p < 0.0001$	all	2106	-1.9	-0.7	0.0	0.6	3.1	0.9
PT positivism	NCS	1815	-3.2	-0.7	-0.1	0.5	3.1	0.8
	CS	291	-1.9	0.3	0.8	1.3	3.1	0.8
$p < 0.0001$	all	2106	-3.2	-0.6	0.0	0.6	3.1	0.9

Table A.37: Age, family composition, and factor scores compared between not car sharers (NCS) and car sharers (CS). Missing data is left out.

Table A.38 shows the average number of kilometers travelled in a week. The 'informal car' indicates rides that were travelled with a friends' or relatives' car without any formal contract or payment. p-values are based on a t-test of Mann-Whitney test if the data cannot be assumed to be normally distributed. The table shows that sharers travel significantly less with private cars, company cars and significantly more by bike, by public transportation, on foot, and with shared cars.

Table A.39 shows the number of cars, bikes, PT subscriptions, scooters and motorcycles a family owns. Car-sharers appear to own significantly less private and company cars and motorcycles, and slightly less electric bikes. On the other hand, they tend to have slightly more regular bikes and significantly more people in the family had public transportation subscriptions. p-values are based on a t-test of Mann-Whitney test if the data cannot be assumed to be normally distributed.

Appendix A.1. Comparing respondents in rural, suburban, and urban environments

Following a recent report, published by Flanders' government environment department on the urban sprawl (Vermeiren et al. 2019), we supplement this report with some summary data that we got from our questionnaire. Vermeiren et al. (2019) discusses how the urban sprawl and the environment people live in influences, among other things, car ownership. Previous research indicated that rural areas, longer distances to all facilities, less PT options and better parking facilities might increase car ownership and overall travel distance (Kuzmyak 2012, Litman et al. 2018).

TableA.40 seems to support the hypothesis that people that live in less urban environments travel more with private cars and bike and walk less.

Table A.41 shows that people in rural areas also have more private and company cars in the family.

Variable	**Levels**	**n**	**Min**	$\mathbf{q_1}$	$\bar{\mathbf{x}}$	$\mathbf{q_3}$	**Max**	**s**
Private car	NCS	1815	0	10	195.0	270	2600	271.6
	CS	291	0	0	31.6	10	800	88.2
$p < 0.0001$	all	2106	0	0	172.4	250	2600	260.4
Company car	NCS	1815	0	0	65.9	0	1700	196.8
	CS	291	0	0	6.0	0	560	44.8
$p < 0.0001$	all	2106	0	0	57.6	0	1700	184.6
PT	NCS	1815	0	0	52.9	25	1000	125.8
	CS	291	0	0	112.3	190	1200	175.8
$p < 0.0001$	all	2106	0	0	61.1	45	1200	135.4
Informal Car	NCS	1815	0	0	6.8	0	600	34.5
	CS	291	0	0	2.2	0	100	9.4
$p = 0.63$	all	2106	0	0	6.2	0	600	32.2
As a passenger	NCS	1815	0	0	15.1	10	500	41.9
	CS	291	0	0	10.1	6	250	26.2
$p = 0.44$	all	2106	0	0	14.4	10	500	40.1
Taxi	NCS	1815	0	0	0.2	0	200	5.1
	CS	291	0	0	0.2	0	20	1.6
$p < 0.0001$	all	2106	0	0	0.2	0	200	4.7
Shared car	NCS	1815	0	0	0.0	0	0	0.0
	CS	291	0	0	26.5	40	500	47.2
$p < 0.0001$	all	2106	0	0	3.7	0	500	19.8
Bike	NCS	1815	0	0	28.7	40	800	48.6
	CS	291	0	20	51.1	70	300	47.7
$p < 0.0001$	all	2106	0	0	31.8	45	800	49.1
Walking	NCS	1815	0	0	9.1	10	200	13.8
	CS	291	0	2	9.6	15	60	10.5
$p = 0.00025$	all	2106	0	0	9.1	10	200	13.4
Motorcycle	NCS	1815	0	0	7.4	0	9000	212.5
	CS	291	0	0	3.6	0	600	39.8
$p = 0.19$	all	2106	0	0	6.9	0	9000	197.8
Scooter	NCS	1815	0	0	0.3	0	100	3.8
	CS	291	0	0	0.1	0	30	1.8
$p = 0.42$	all	2106	0	0	0.2	0	100	3.6
Other	NCS	1815	0	0	7.6	0	12000	282.9
	CS	291	0	0	0.0	0	0	0.0
$p = 0.18$	all	2106	0	0	6.6	0	12000	262.6

Table A.38: Average number of kilometers driven in a week with different transportation modes by not car sharers (NCS) and car sharers (CS). Missing data is left out.

Variable	**Levels**	**n**	**Min**	$\mathbf{q_1}$	$\bar{\mathbf{x}}$	$\mathbf{q_3}$	**Max**	**s**
Private car	NCS	1812	0	1	1.3	2	6	0.9
	CS	291	0	0	0.4	1	3	0.6
$p < 0.0001$	all	2103	0	1	1.2	2	6	0.9
Company car	NCS	1815	0	0	0.4	1	10	0.7
	CS	291	0	0	0.1	0	2	0.3
$p < 0.0001$	all	2106	0	0	0.3	1	10	0.7
Bike	NCS	1815	0	1	2.9	4	34	2.2
	CS	291	0	1	3.1	4	16	2.2
$p = 0.03$	all	2106	0	1	2.9	4	34	2.2
Electric bike	NCS	1815	0	0	0.4	1	7	0.7
	CS	291	0	0	0.3	0	5	0.6
$p = 0.01$	all	2106	0	0	0.4	1	7	0.7
Bus subscription	NCS	1815	0	0	0.4	1	10	0.8
	CS	291	0	0	0.7	1	5	1.0
$p < 0.0001$	all	2106	0	0	0.4	1	10	0.8
Train subscription	NCS	1815	0	0	0.4	1	4	0.6
	CS	291	0	0	0.5	1	3	0.6
$p = 0.0012$	all	2106	0	0	0.4	1	4	0.6
Scooter	NCS	1815	0	0	0.0	0	3	0.2
	CS	291	0	0	0.0	0	1	0.1
$p = 0.43$	all	2106	0	0	0.0	0	3	0.2
Motorcycle	NCS	1815	0	0	0.1	0	5	0.4
	CS	291	0	0	0.0	0	2	0.2
$p = 0.0034$	all	2106	0	0	0.1	0	5	0.3

Table A.39: The number of cars, bikes, public transportation subscriptions, scooters and motorcycles a family owns. Missing data is left out.

Variable	Levels	n	Min	q_1	$\bar{x}$	q_3	Max	s
Private car	Rural	783	0	30	243.8	350.0	2600	311.8
	Urban	643	0	0	96.5	100.0	1450	191.6
	Suburban	673	0	2	158.9	220.0	1500	224.5
$p < 0.0001$	all	2099	0	0	171.5	250.0	2600	259.5
Company car	Rural	783	0	0	76.9	0.0	1700	225.0
	Urban	643	0	0	31.6	0.0	1000	122.5
	Suburban	673	0	0	60.7	0.0	1500	179.8
$p < 0.0001$	all	2099	0	0	57.8	0.0	1700	184.9
PT	Rural	783	0	0	51.3	20.0	1000	122.2
	Urban	643	0	0	78.4	85.0	1200	153.9
	Suburban	673	0	0	56.3	30.0	1000	130.0
$p < 0.0001$	all	2099	0	0	61.2	47.5	1200	135.5
Informal Car	Rural	783	0	0	5.5	0.0	300	25.9
	Urban	643	0	0	6.0	0.0	250	26.6
	Suburban	673	0	0	7.0	0.0	600	42.0
$p = 0.11$	all	2099	0	0	6.1	0.0	600	32.1
As a passenger	Rural	783	0	0	14.8	10.0	500	43.4
	Urban	643	0	0	12.2	5.0	400	34.3
	Suburban	673	0	0	16.2	12.0	500	41.5
$p = 0.09$	all	2099	0	0	14.5	10.0	500	40.2
Taxi	Rural	783	0	0	0.1	0.0	50	1.8
	Urban	643	0	0	0.6	0.0	200	8.3
	Suburban	673	0	0	0.0	0.0	15	0.6
$p < 0.0001$	all	2099	0	0	0.2	0.0	200	4.7
Shared car	Rural	783	0	0	1.0	0.0	155	9.2
	Urban	643	0	0	8.4	0.0	500	31.1
	Suburban	673	0	0	2.2	0.0	160	13.0
$p < 0.0001$	all	2099	0	0	3.7	0.0	500	19.8
Bike	Rural	783	0	0	28.4	32.0	800	56.1
	Urban	643	0	0	33.3	50.0	300	37.4
	Suburban	673	0	0	34.6	50.0	450	50.3
$p < 0.0001$	all	2099	0	0	31.9	46.0	800	49.2
Walking	Rural	783	0	0	7.8	10.0	100	12.5
	Urban	643	0	2	10.7	15.0	200	14.5
	Suburban	673	0	0	9.2	10.0	100	13.1
$p < 0.0001$	all	2099	0	0	9.2	10.0	200	13.4
Motorcycle	Rural	783	0	0	3.1	0.0	590	28.3
	Urban	643	0	0	2.3	0.0	600	28.5
	Suburban	673	0	0	15.6	0.0	9000	347.5
$p = 0.18$	all	2099	0	0	6.9	0.0	9000	198.1
Scooter	Rural	783	0	0	0.4	0.0	100	5.0
	Urban	643	0	0	0.1	0.0	30	1.2
	Suburban	673	0	0	0.2	0.0	65	3.1
$p = 0.28$	all	2099	0	0	0.2	0.0	100	3.6
Other	Rural	783	0	0	0.1	0.0	17	0.9
	Urban	643	0	0	2.2	0.0	1000	42.5
	Suburban	673	0	0	18.4	0.0	12000	462.7
$p = 0.95$	all	2099	0	0	6.6	0.0	12000	263.0

Table A.40: Average number of kilometers driven in a week with different transportation modes by not car sharers (NCS) and car sharers (CS). Missing data is left out.

Variable	**Levels**	**n**	**Min**	$\mathbf{q_1}$	$\bar{\mathbf{x}}$	$\mathbf{q_3}$	**Max**	**s**
Private car	Rural	781	0	1	1.5	2	6	0.9
	Urban	642	0	0	0.8	1	5	0.8
	Suburban	673	0	1	1.2	2	6	0.8
$p < 0.0001$	all	2096	0	1	1.2	2	6	0.9
Company car	Rural	783	0	0	0.4	1	10	0.8
	Urban	643	0	0	0.2	0	4	0.5
	Suburban	673	0	0	0.3	1	4	0.6
$p < 0.0001$	all	2099	0	0	0.3	1	10	0.7
Bike	Rural	783	0	1	3.0	4	12	2.1
	Urban	643	0	1	2.6	4	34	2.4
	Suburban	673	0	1	3.0	4	16	2.2
$p < 0.0001$	all	2099	0	1	2.9	4	34	2.2
Electric bike	Rural	783	0	0	0.5	1	7	0.8
	Urban	643	0	0	0.2	0	5	0.6
	Suburban	673	0	0	0.4	1	4	0.7
$p < 0.0001$	all	2099	0	0	0.4	1	7	0.7
Bus subscription	Rural	783	0	0	0.4	1	4	0.7
	Urban	643	0	0	0.5	1	4	0.8
	Suburban	673	0	0	0.5	1	10	0.9
$p = 0.15$	all	2099	0	0	0.4	1	10	0.8
Train subscription	Rural	783	0	0	0.3	1	4	0.6
	Urban	643	0	0	0.4	1	3	0.6
	Suburban	673	0	0	0.4	1	4	0.7
$p = 0.03$	all	2099	0	0	0.4	1	4	0.6
Scooter	Rural	783	0	0	0.0	0	3	0.2
	Urban	643	0	0	0.0	0	2	0.2
	Suburban	673	0	0	0.0	0	1	0.2
$p = 0.25$	all	2099	0	0	0.0	0	3	0.2
Motorcycle	Rural	783	0	0	0.1	0	5	0.4
	Urban	643	0	0	0.0	0	2	0.2
	Suburban	673	0	0	0.1	0	2	0.3
$p = 0.0024$	all	2099	0	0	0.1	0	5	0.3

Table A.41: The number of cars, bikes, public transportation subscriptions, scooters and motorcycles a family owns. We distinguish families in urban, suburban, and rural environments. Missing data is left out.

Appendix B. Appendices to section 5

Appendix B.1. Factor analysis

The Tables below show, for each factor, the Cronbach alpha which is a measure of internal consistency, i.e., it indicates how closely a set of items are related as a group. Ideally the Cronbach alpha is at least 0.7. The Cronbach alpha's were calculated using the *psych* package in R. Each of the three tables is the result of a factor analysis on a different set of observations. The first table (Table B.42) shows the factors for the full data set with all respondents. Table B.43 and Table B.44 show the factors for only the non-sharers or sharers respectively.

Factor	Statement	Major factor loading	Cronbach alpha
Ecological concern	If I didn't need a car, I would immediately get rid of it	0.711	0.833
	Car sharing fits the current time	0.698	
	I'm worried about climate (change)	0.686	
	Car sharing helps to save natural resources	0.579	
	I think there's too much traffic in Belgium	0.555	
	I get satisfaction from sharing cars	0.514	
	I think road pricing is a good idea	0.498	
	Public transportation is expensive	-0.495	
Car-dependent identity	There's a dream car that I would like to own	0.545	0.749
	A car brings status and prestige	0.544	
	Driving a private car is stressful	-0.569	
PT positivism	Private cars are expensive	0.683	0.754
	Public transportation is reliable	0.641	
	Public transportation is clean/neat	0.549	
	Travelling with public transportation is stressful	-0.593	
Driving enjoyment	It doesn't matter which brand of car I'm driving	0.698	0.774
	I'm worried about fine dust pollution	0.628	
	I like driving a car	0.531	
	For me, a car only has an instrumental function	-0.626	
	I only need a car to get from A to B	-0.619	

Table B.42: Overview of factor loadings and internal consistency (Cronbach's alpha) for the full dataset

Factor	Statement	Major factor loading	Cronbach alpha
Ecological concern	If I didn't need a car, I would immediately get rid of it	0.712	0.822
	I'm worried about climate (change)	0.676	
	Car sharing fits the current time	0.655	
	Car sharing helps to save natural resources	0.574	
	I think there's too much traffic in Belgium	0.548	
	I think road pricing is a good idea	0.491	
	I get satisfaction from sharing cars	0.45	
	Public transportation is expensive	-0.508	
Car-dependent identity	A car brings status and prestige	0.562	0.746
	There's a dream car that I would like to own	0.515	
	Driving a private car is stressful	-0.563	
PT positivism	Private cars are expensive	0.688	0.755
	Public transportation is reliable	0.635	
	Public transportation is clean/neat	0.56	
	Travelling with public transportation is stressful	-0.602	
Driving enjoyment	It doesn't matter which brand of car I'm driving	0.722	0.778
	I'm worried about fine dust pollution	0.658	
	I like driving a car	0.516	
	For me, a car only has an instrumental function	-0.622	
	I only need a car to get from A to B	-0.61	

Table B.43: Overview of factor loadings and internal consistency (Cronbach's alpha) for non-sharers

Factor	Statement	Major factor loading	Cronbach alpha
Social & ecological concern	I get satisfaction from sharing cars	0.686	0.707
	Car sharing helps to save natural resources	0.555	
	Car sharing fits the current time	0.527	
	If I didn't need a car, I would immediately get rid of it	0.485	
	I'm worried about climate (change)	0.462	
Car-dependent identity	There's a dream car that I would like to own	0.582	0.769
	A car brings status and prestige	0.557	
	Driving a private car is stressful	-0.782	
	Driving a shared car is stressful	-0.646	
Shared mobility	Private cars are expensive	0.555	0.686
	Public transportation is clean/neat	0.502	
	Public transportation is environmentally friendly	0.5	
	Shared cars are clean/neat	0.485	
	Private cars are flexible	0.484	
	Public transportation is reliable	0.448	
	Travelling with public transportation is stressful	-0.413	
Driving enjoyment	I like driving a car	0.557	0.681
	It doesn't matter which brand of car I'm driving	0.507	
	I'm worried about fine dust pollution	0.503	
	For me, a car only has an instrumental function	-0.542	
	I only need a car to get from A to B	-0.532	

Table B.44: Overview of factor loadings and internal consistency (Cronbach's alpha) for car-sharers

Appendix B.2. car-sharing intention

Table B.45 shows an extension of the model in Table 15. It includes age as a discrete variable and also the number of kids in the family. Neither is significant which is why they were left out in the chosen model.

	Coefficient	Odds ratio	P-value
Intercept1: No, probably not	2.838	17.087	0.000 ***
Intercept2: Yes, perhaps	0.716	2.047	0.002 **
Intercept3: Yes, definitely	-2.024	0.132	0.000 ***
Intercept4: Car sharer	-3.38	0.034	0.000 ***
Age35-65	0.064	1.067	0.539
Age>65	-0.369	0.691	0.212
No. Kids	-0.004	0.996	0.926
Male	0.363	1.438	0.000 ***
Rural	-0.388	0.678	0.000 ***
Urban	0.409	1.506	0.000 ***
Public transport quality	0.084	1.088	0.073
Parking facilities	0.147	1.159	0.001 **
Bike & Walk friendliness	-0.04	0.961	0.365
Bachelor	0.303	1.354	0.012 *
Master	0.607	1.836	0.000 ***
>Master	0.661	1.936	0.000 ***
Student	-0.313	0.731	0.098
Parttime	0.32	1.377	0.385
Fulltime	-0.125	0.883	0.281
Retired	-0.581	0.559	0.020 *
Nb Private cars	-0.564	0.569	0.000 ***
Nb company cars	-0.678	0.508	0.000 ***
FA Car-dependent identity	0.191	1.21	0.001 ***
FA Driving enjoyment	-0.146	0.865	0.016 *
FA PT positivism	0.612	1.844	0.000 ***
FA Ecological concern	1.58	4.856	0.000 ***

Table B.45: Ordinal multinomial logit model for the car sharing intention with factors

Appendix B.3. Non-car-sharers' DCE

The latent-class conditional logit model of Table 19 shows that three classes of non-sharers can be distinguished with significantly different willingness to pay for each of the attributes. The following tables describe how each of the classes differ with respect to demographics and mobility options that are available to them.

Variable	**Levels**	$\mathbf{n}_1$	$\%_1$	$\mathbf{n}_2$	$\%_2$	$\mathbf{n}_3$	$\%_3$	$\mathbf{n}_{\text{all}}$	$\%_{\text{all}}$
Gender	Man	141	37.5	229	39.8	318	37.3	688	38.1
	Woman	234	62.2	344	59.7	531	62.3	1109	61.5
	X	1	0.3	3	0.5	3	0.3	7	0.4
$p = 0.85$	all	376	100.0	576	100.0	852	100.0	1804	100.0
Education	Secundary school	144	38.0	170	29.5	172	20.1	486	26.8
	Bachelor degree	109	28.8	215	37.3	287	33.5	611	33.7
	Master degree	101	26.6	141	24.5	288	33.6	530	29.3
	>Master	25	6.6	50	8.7	109	12.7	184	10.2
$p = 0.0005$	all	379	100.0	576	100.0	856	100.0	1811	100.0
Degree of urbanisation	Rural	164	43.2	285	49.5	307	36.0	756	41.8
	Urban	93	24.5	102	17.7	259	30.4	454	25.1
	Suburban	123	32.4	189	32.8	286	33.6	598	33.1
$p = 0.0005$	all	380	100.0	576	100.0	852	100.0	1808	100.0
Profession	Other	31	8.2	81	14.0	105	12.2	217	12.0
	Blue collar worker	21	5.5	25	4.3	21	2.4	67	3.7
	White collar worker	218	57.4	331	57.3	505	58.9	1054	58.1
	Education	12	3.2	36	6.2	71	8.3	119	6.6
	Self-employed	20	5.3	40	6.9	44	5.1	104	5.7
	Civil servant	7	1.8	10	1.7	17	2.0	34	1.9
	Retired	59	15.5	34	5.9	61	7.1	154	8.5
	Incapacitated	4	1.0	8	1.4	7	0.8	19	1.0
	Unemployed	2	0.5	9	1.6	17	2.0	28	1.5
	Stay-at-home (wo)man	6	1.6	4	0.7	9	1.0	19	1.0
$p = 0.0005$	all	380	100.0	578	100.0	857	100.0	1815	100.0
Employment	Student	30	7.9	71	12.3	97	11.3	198	10.9
	Part time job	71	18.7	79	13.7	141	16.5	291	16.1
	Full time job	205	54.1	362	63.0	509	59.5	1076	59.5
	Not working	73	19.3	63	11.0	109	12.7	245	13.5
$p = 0.0015$	all	379	100.0	575	100.0	856	100.0	1810	100.0
Car sharing intention	Yes, certainly	20	5.4	10	1.8	228	27.1	258	14.5
	Yes, perhaps	110	29.9	175	30.8	461	54.7	746	41.9
	No, probably not	142	38.6	241	42.4	95	11.3	478	26.9
	No, never	90	24.5	138	24.2	27	3.2	255	14.3
	Used to be a sharer	6	1.6	5	0.9	32	3.8	43	2.4
$p = 0.0005$	all	368	100.0	569	100.0	843	100.0	1780	100.0

Table B.46: Demographics compared between latent classes. p-values of Fisher's exact test added. Missing data is left out.

Variable	Levels	n	Min	q_1	$\bar{x}$	q_3	Max	s
Age	1	380	18	33	44.8	57.0	80	15.2
	2	578	18	28	40.1	51.0	81	14.1
	3	856	18	29	40.2	50.0	85	13.8
$p < 0.0001$	all	1814	18	29	41.1	52.0	85	14.3
Number of adults	1	374	1	2	2.2	2.0	5	0.9
	2	573	1	2	2.3	3.0	8	1.0
	3	851	1	2	2.2	2.0	9	1.0
$p = 0.0017$	all	1798	1	2	2.2	2.0	9	1.0
Number of minors	1	374	0	0	0.5	1.0	4	0.9
	2	573	0	0	0.8	1.0	5	1.0
	3	851	0	0	0.8	2.0	4	1.1
$p = 0.00014$	all	1798	0	0	0.7	1.0	5	1.0
Private car	1	379	0	1	1.4	2.0	6	0.9
	2	578	0	1	1.5	2.0	6	0.9
	3	855	0	1	1.2	2.0	6	0.8
$p < 0.0001$	all	1812	0	1	1.3	2.0	6	0.9
Company car	1	380	0	0	0.3	0.0	3	0.6
	2	578	0	0	0.5	1.0	10	0.9
	3	857	0	0	0.3	1.0	6	0.6
$p = 0.0004$	all	1815	0	0	0.4	1.0	10	0.7
Bike	1	380	0	1	2.6	4.0	34	2.6
	2	578	0	1	2.8	4.0	10	2.0
	3	857	0	1	3.0	4.0	14	2.2
$p = 0.0017$	all	1815	0	1	2.9	4.0	34	2.2
Bus subscription	1	380	0	0	0.3	0.0	3	0.7
	2	578	0	0	0.3	0.0	4	0.7
	3	857	0	0	0.5	1.0	10	0.9
$p = 0.0024$	all	1815	0	0	0.4	1.0	10	0.8
Train subscription	1	380	0	0	0.3	0.0	3	0.5
	2	578	0	0	0.3	0.0	4	0.7
	3	857	0	0	0.4	1.0	4	0.7
$p < 0.0001$	all	1815	0	0	0.4	1.0	4	0.6
PT subscriptions per adult	1	374	0	0	0.3	0.5	3	0.5
	2	573	0	0	0.3	0.5	2	0.4
	3	851	0	0	0.4	0.7	3	0.6
$p < 0.0001$	all	1798	0	0	0.3	0.5	3	0.5

Table B.47: Age, family composition, mobility options compared between different latent classes. p-values are for a Kruskal-Wallis H test. Missing data is left out of the analysis.

Appendix B.4. Car-sharers' DCE

The latent-class conditional logit model of Table 22 shows that three classes of sharers can be distinguished with significantly different willingness to pay for each of the attributes. Tables B.48 and B.49 describe how each of the classes differ with respect to demographics, factor scores, and the mobility options that are available to them. Table B.50 additionally describes the characteristics of the current CS system of the respondents.

Variable	**Levels**	$\mathbf{n}_1$	$\%_1$	$\mathbf{n}_2$	$\%_2$	$\mathbf{n}_3$	$\%_3$	$\mathbf{n}_{\text{all}}$	$\%_{\text{all}}$
Gender	Man	28	33.3	53	40.5	29	42.0	110	38.7
	Woman	55	65.5	78	59.5	40	58.0	173	60.9
	X	1	1.2	0	0.0	0	0.0	1	0.3
$p = 0.45$	all	84	100.0	131	100.0	69	100.0	284	100.0
Education	Secundary school	4	4.7	7	5.3	5	7.2	16	5.6
	Bachelor degree	22	25.9	34	25.9	20	29.0	76	26.7
	Master degree	47	55.3	67	51.1	36	52.2	150	52.6
	>Master	12	14.1	23	17.6	8	11.6	43	15.1
$p = 0.93$	all	85	100.0	131	100.0	69	100.0	285	100.0
Degree of urbanisation	Rural	6	7.1	6	4.6	12	17.4	24	8.4
	Urban	57	67.1	92	70.2	38	55.1	187	65.6
	Suburban	22	25.9	33	25.2	19	27.5	74	26.0
$p = 0.04$	all	85	100.0	131	100.0	69	100.0	285	100.0
Profession	Other	1	1.2	5	3.8	6	8.7	12	4.2
	Blue collar worker	1	1.2	1	0.8	3	4.3	5	1.8
	White collar worker	57	67.1	87	66.4	43	62.3	187	65.6
	Education	9	10.6	18	13.7	11	15.9	38	13.3
	Self-employed	10	11.8	7	5.3	3	4.3	20	7.0
	Civil servant	3	3.5	0	0.0	3	4.3	6	2.1
	Retired	1	1.2	6	4.6	0	0.0	7	2.5
	Incapacitated	1	1.2	2	1.5	0	0.0	3	1.0
	Unemployed	2	2.4	4	3.0	0	0.0	6	2.1
	Stay-at-home (wo)man	0	0.0	1	0.8	0	0.0	1	0.3
$p = 0.05$	all	85	100.0	131	100.0	69	100.0	285	100.0
Employment	Student	1	1.2	7	5.3	5	7.3	13	4.6
	Part time job	25	29.4	28	21.4	15	22.1	68	23.9
	Full time job	54	63.5	82	62.6	46	67.7	182	64.1
	Not working	5	5.9	14	10.7	2	2.9	21	7.4
$p = 0.14$	all	85	100.0	131	100.0	68	100.0	284	100.0

Table B.48: Demographics compared between classes of car sharers. p-values of Fisher's exact test added. Missing data is left out.

Variable	Levels	n	Min	q_1	$\bar{x}$	q_3	Max	s
Age	1	85	23.0	31.0	38.7	45.0	64.0	9.7
	2	131	23.0	30.0	38.8	44.5	73.0	10.4
	3	69	18.0	29.0	37.7	43.0	71.0	10.5
$p = 0.76$	all	285	18.0	30.0	38.5	44.0	73.0	10.2
Number of adults	1	85	1.0	1.0	1.9	2.0	4.0	0.7
	2	130	1.0	1.0	1.9	2.0	5.0	0.8
	3	69	1.0	2.0	2.1	2.0	6.0	1.0
$p = 0.14$	all	284	1.0	1.0	1.9	2.0	6.0	0.8
Number of minors	1	85	0.0	0.0	0.9	2.0	4.0	1.0
	2	130	0.0	0.0	0.7	1.0	5.0	1.1
	3	69	0.0	0.0	1.1	2.0	5.0	1.1
$p = 0.05$	all	284	0.0	0.0	0.9	2.0	5.0	1.1
FA Car-dependent identity	1	85	-1.5	-0.8	-0.2	0.4	2.1	0.8
	2	131	-1.9	-0.7	0.0	0.5	2.8	0.9
	3	69	-1.4	-0.5	0.3	0.9	3.4	1.0
$p = 0.02$	all	285	-1.9	-0.7	0.0	0.6	3.4	0.9
FA Social & ecological concern	1	85	-2.8	-0.2	0.2	0.8	1.6	0.8
	2	131	-2.9	-0.4	0.0	0.6	1.5	0.9
	3	69	-3.3	-0.7	-0.3	0.4	1.9	1.0
$p = 0.0047$	all	285	-3.3	-0.4	0.0	0.6	1.9	0.9
FA Shared mobility	1	85	-2.1	-0.7	0.0	0.7	2.5	0.9
	2	131	-1.9	-0.6	0.0	0.7	2.0	0.9
	3	69	-2.2	-0.6	-0.1	0.5	1.9	0.9
$p = 0.91$	all	285	-2.2	-0.6	0.0	0.6	2.5	0.9
FA Driving enjoyment	1	85	-3.0	-0.7	-0.1	0.6	2.2	1.0
	2	131	-2.1	-0.4	0.1	0.8	2.2	0.8
	3	69	-2.4	-0.4	-0.2	0.3	1.3	0.8
$p = 0.05$	all	285	-3.0	-0.5	0.0	0.6	2.2	0.9
Private car	1	85	0.0	0.0	0.4	1.0	3.0	0.6
	2	131	0.0	0.0	0.3	1.0	2.0	0.5
	3	69	0.0	0.0	0.5	1.0	2.0	0.6
$p = 0.06$	all	285	0.0	0.0	0.4	1.0	3.0	0.6
Company car	1	85	0.0	0.0	0.1	0.0	2.0	0.3
	2	131	0.0	0.0	0.1	0.0	2.0	0.3
	3	69	0.0	0.0	0.2	0.0	1.0	0.4
$p = 0.0042$	all	285	0.0	0.0	0.1	0.0	2.0	0.3
Bike	1	85	0.0	2.0	3.2	4.0	9.0	2.1
	2	131	0.0	1.0	2.8	4.0	10.0	2.1
	3	69	0.0	2.0	3.6	5.0	16.0	2.4
$p = 0.05$	all	285	0.0	1.0	3.1	4.0	16.0	2.2
Bus subscription	1	85	0.0	0.0	0.6	1.0	3.0	0.9
	2	131	0.0	0.0	0.7	1.0	4.0	1.0
	3	69	0.0	0.0	0.7	1.0	5.0	1.2
$p = 0.31$	all	285	0.0	0.0	0.6	1.0	5.0	1.0
Train subscription	1	85	0.0	0.0	0.4	1.0	2.0	0.6
	2	131	0.0	0.0	0.5	1.0	3.0	0.7
	3	69	0.0	0.0	0.4	1.0	2.0	0.6
$p = 0.80$	all	285	0.0	0.0	0.5	1.0	3.0	0.7
PT subscriptions per adult	1	85	0.0	0.0	0.5	1.0	3.0	0.7
	2	130	0.0	0.0	0.7	1.0	4.0	0.8
	3	69	0.0	0.0	0.6	1.0	2.5	0.7
$p = 0.32$	all	284	0.0	0.0	0.6	1.0	4.0	0.8

Table B.49: Age, family composition, mobility options, and factor scores compared between different classes of car sharers. p-values are for a Kruskal-Wallis H test. Missing data is left out of the analysis.

Variable	Levels	$\mathbf{n}_1$	$\%_1$	$\mathbf{n}_2$	$\%_2$	$\mathbf{n}_3$	$\%_3$	$\mathbf{n}_{\text{all}}$	$\%_{\text{all}}$
CS provider	Bolides	1	1.2	0	0.0	0	0.0	1	0.3
	Cambio	16	18.8	59	45.0	40	58.0	115	40.4
	Caramigo	1	1.2	1	0.8	0	0.0	2	0.7
	Company	0	0.0	1	0.8	1	1.4	2	0.7
	Cozycar	11	12.9	6	4.6	9	13.0	26	9.1
	Degage	45	52.9	27	20.6	7	10.1	79	27.7
	Drivenow	0	0.0	1	0.8	0	0.0	1	0.3
	Drivy	2	2.4	0	0.0	0	0.0	2	0.7
	EcoMobiliteitGent	0	0.0	2	1.5	0	0.0	2	0.7
	City cars	0	0.0	1	0.8	0	0.0	1	0.3
	Informal	1	1.2	3	2.3	3	4.3	7	2.5
	nonActive	6	7.1	14	10.7	5	7.2	25	8.8
	Partago	2	2.4	11	8.4	0	0.0	13	4.6
	Poppy	0	0.0	4	3.0	2	2.9	6	2.1
	Ubeeqo	0	0.0	0	0.0	2	2.9	2	0.7
	Zipcar	0	0.0	1	0.8	0	0.0	1	0.3
$p = 0.0005$	all	85	100.0	131	100.0	69	100.0	285	100.0
Type of CS system	B2C	19	22.4	79	60.3	45	65.2	143	50.2
	P2P	66	77.7	52	39.7	24	34.8	142	49.8
$p = 0.0005$	all	85	100.0	131	100.0	69	100.0	285	100.0
Flexibility	Free-floating	0	0.0	8	6.1	2	2.9	10	3.5
	2km radius	60	70.6	45	34.4	16	23.2	121	42.5
	Station-based	25	29.4	78	59.5	51	73.9	154	54.0
$p = 0.0005$	all	85	100.0	131	100.0	69	100.0	285	100.0
Use frequency	Daily or almost daily	0	0.0	2	1.5	0	0.0	2	0.7
	2-3 times per month	22	25.9	31	23.7	15	21.7	68	23.9
	once per week	12	14.1	29	22.1	16	23.2	57	20.0
	2 to 3 times per week	8	9.4	11	8.4	4	5.8	23	8.1
	once per month	25	29.4	27	20.6	12	17.4	64	22.5
	less than 1 time per month	18	21.2	31	23.7	22	31.9	71	24.9
$p = 0.49$	all	85	100.0	131	100.0	69	100.0	285	100.0

Table B.50: Characteristics of the current car sharing system. p-values of Fisher's exact test added. Missing data is left out.

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