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Explaining Regional Adoption Differentials in Dutch Car Sharing Markets

Abstract

As response to the financial crisis and global warming, a movement called the collaborative economy *or* sharing economy*, has risen which promotes the use and enjoyment of products and services, without actual ownership. An evident example of this movement is the phenomenon* car sharing*. Car sharing is the organized use of a publically available car, owned by a company or private owner, which multiple persons or households can use for a monthly fee, a fee per hour, and/or a fee per mileage. This study aims to answer the question why the adoption of car sharing in The Netherlands is regionally very uneven distributed. To answer this question this study takes a spatial perspective on this phenomenon, and therefore complements the very recent literature on* the geography of transitions*. According to other studies the success of car sharing is highly dependent on specific regional factors. A first investigation reveals that these factors differ per region and therefore most likely explain the regional adoption differentials. By means of a negative binomial regression analysis, this research analyses to what extent these regional factors influence the adoption of car sharing, and investigates the effects of local policies on the adoption of car sharing. The results of this study indicate that especially high education and one-person households are important for the adoption of car sharing in general. Concerning policy, only the allocation of parking space and general information on the municipal website seem to have a positive influence. Distinguishing between the most prevalent forms of car sharing, i.e. traditional and peer-to-peer, the results show that traditional car sharing is much more influenced by regional factors than peer-to-peer car sharing. Especially concerning policy and density of daily facilities.*

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1. Introduction

Today, purchase power and consumerism no longer seem to be the solutions to the world's environmental and financial problems. As response to the financial crisis and global warming, a movement, called the *collaborative economy* or *sharing economy*, has risen which promotes the use and enjoyment of products and services, without actual ownership. Streaming services like Spotify and Netflix have gained an enormous share in the media-industry at the expense of owning actual music cd's or movies. The renting of private houses organized by companies like Airbnb, is becoming a serious competitor in the tourism sector, and the organized sharing of products and services between consumers is becoming more and more popular. Driven by inspiring speeches of e.g. Rachel Botsman (Botsman, 2010), people start to share simple products to share costs, reduce waste, save valuable materials and increase value for money efficiency. This study focuses on a comparable phenomenon: *car sharing*. Car sharing is the organized use of a publically available car, owned by a company or private owner, which multiple persons or households can use for a monthly fee, a fee per hour, and/or a fee per mileage.

Amongst others, car sharing is a reaction to the large ecological footprint of the transport industry. In 2010 the share of road transport in total CO_2 emission in OECD European countries was 22.9% (IEA, 2012), from which 52.4% was emitted by passenger transportation (EC, 2014). On average, the production of a car accounts for 10% of the total CO_2 emission of a car's life cycle (Hawkins e.a., 2012; SMMT, 2013). Car sharing reduces the use of a car all together, and every shared vehicle replaces about 11 other manufactured vehicles (Buczynski, 2011). Car sharing is therefore a promising addition to the CO_2 reduction programs of different national and local governments and an attractive philosophy for the environmental minded car user (Martin and Shaheen, 2011). Other benefits of car sharing are its cost reduction, especially for households that drive less than 15,000 kilometres per year (Shaheen and Cohen, 2007), and the fact that its users do not need their own parking space, which is especially convenient in city centres. The reduction of cars and necessary parking space makes car sharing an interesting topic for city governments trying to improve their city mobility (Frenken, 2012). For this reason, cities like Bremen, Amsterdam, Utrecht and The Hague promote and have incorporated car sharing in their mobility policies (Glotz-Richter, 2013; KpVV, 2013a).

There is a variety of business models for car sharing, ranging from neighbourhood initiatives to international corporations. Car sharing companies, such as Connectcar and Greenwheels have their own parking spaces in e.g., city centres or train stations, where a vehicle can be picked up and dropped. Users pay for the time between the pickup and delivery of the car at its own parking space and the total distance covered. A more recent alternative business model is applied by Car2Go in Amsterdam and selected cities outside The Netherlands, where cars do not have a fixed parking place and users only pay for the time they drive the car. Apart from 'traditional' car sharing services offered by companies, there is also peer-to-peer car sharing, normally organized by Ebay-like intermediary internet companies like Getaround or Mywheels. These shared cars can be picked up and dropped at the owner's home. Some other forms of car sharing exist, like business car sharing or private car sharing. This study focuses on the most prevalent forms of car sharing: traditional and peer-to-peer car sharing, which include most other forms as well.

Although the first documented car sharing act was in 1948 in Zurich, Switzerland (Harms and Truffer, 1998), the phenomenon only reached significant attention in scientific literature and governmental publications in 2012[1]. With less than 1% market share in personal transportation in Western countries, car sharing is still in its early stages of development, and theoretically only adopted by so called innovators (Rogers, 2010). However, due to factors like increasing returns, word-to-mouth publicity, and low switching costs, it has the potential to become a serious competitor in the transportation sector (Frenken, 2012). Despite of anti-car sharing lobby acts from taxi companies or conventional car rental companies, and the cultural embeddedness of car ownership, there is no particular reason to expect that car sharing will not develop to become a new mobility regime (Frenken, 2013). The pace by which car sharing has developed is, nevertheless, slower than previously expected. The adoption rate of car sharing is 20 to 100 times lower than initially estimated (Ball, 2005). Even more interesting for contemporary innovation scholars are the regional differences in adoption rate. Amsterdam for example, adopted 185 shared vehicles per 100,000 habitants, while other large cities in The Netherlands share on average only 40 cars per 100,000 habitants (KpVV, 2013b). Hence, the research question for this study is:

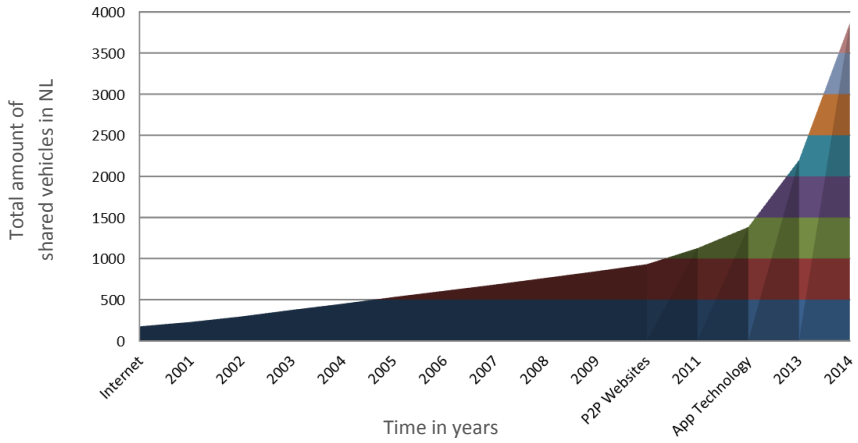
- *What explains the regional adoption differentials in the Dutch car sharing market?*

Car sharing and the organized sharing of products and services in general are relative new research topics, but have gained much interest of innovation scholars (Costain e.a., 2011; Frenken, 2013; Shaheen e.a., 2006; Truffer, 2003). The products in itself are not always particularly innovative but the idea of sharing instead of owning is radically innovative all the more and has the potential to be very disruptive. Previous studies regarding the adoption of car sharing are mostly qualitative in nature and have focussed on the development of car sharing through time (Shaheen e.a., 2006; Shaheen e.a., 2009; Shaheen and Cohen, 2007; Truffer, 2008) or have focussed mainly on the user (Costain e.a., 2011; Shaheen and Rodier, 2005; Truffer, 2003). By means of interviews with car sharing users these latter studies identified characteristics of typical car sharing users and locations. Until now however, a thoroughly statistical analysis of factors explaining the regional adoption differentials of car sharing has not been performed. Neither has there been a study with sufficient focus on the impact of local governmental policies on car sharing, which is expected to be very important for the development of car sharing. This research aims to statistically test the qualitative findings of earlier studies about car sharing users and locations and investigate the influence of local policies on the adoption of car sharing. Although many municipalities have shown their willingness to implement car sharing policies, there is still a lack of knowledge about what effective policies are and what they actually induce (AEF, 2014; KPVV, 2014).

Scientifically this research complements the literature on sustainable transitions, and the adoption of sustainable innovations. The study of transitions and adoption of innovations long focussed on the socio-technical system and interactions between its individual parts. Regarding development, focus was mainly on development through time, as visualized in figure 1. Although crucial, the spatial aspects of transition and adoption have been mostly neglected (Coenen e.a., 2012). As indicated by the regional differences, the study of car sharing evidently requires a

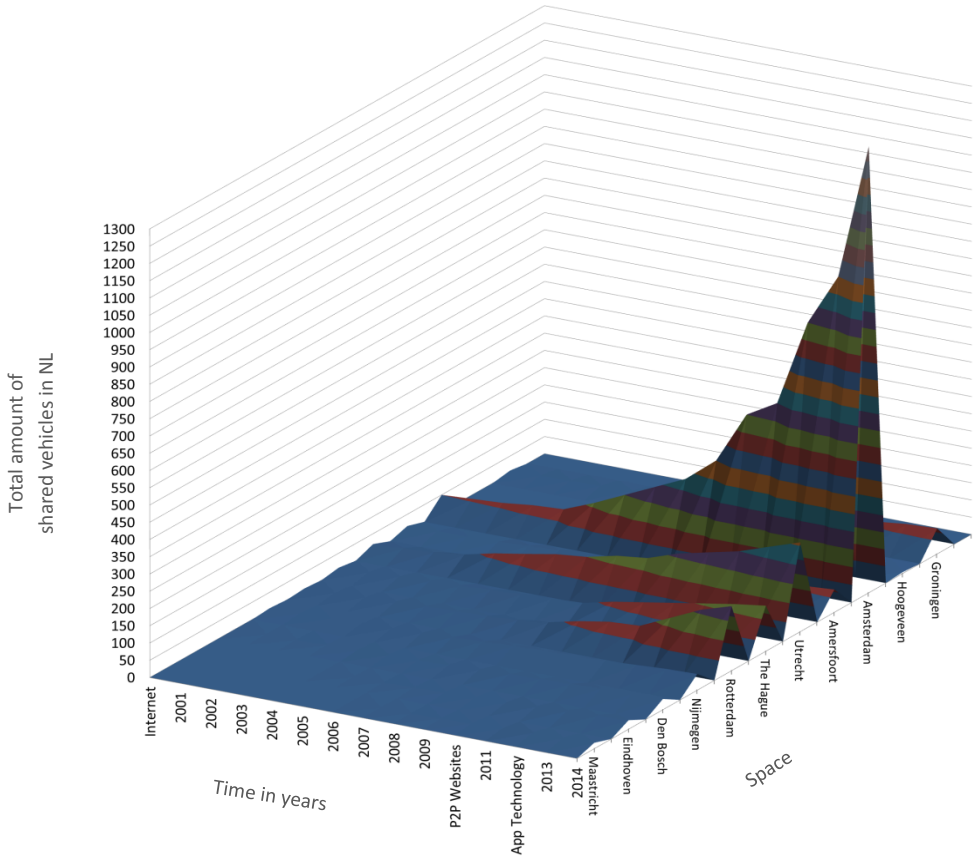
[1] On Web of Science the term 'car sharing' occurred from 1980 to 2011, as a topic, on average 2 times per year while in 2012 alone 21 times. The same distribution can be found in publications on the website of the European Commission. (consulted on 12 March 2014)

Figure 1: Two-dimensional perspective on car sharing



spatial approach. Therefore, this study takes a spatial perspective and complements the very recent literature on the geography of transitions. In doing so this study adds another dimension to the study of sustainable transitions, as visualized in figure 2, where we see again the regionally very uneven distribution of cars sharing in The Netherlands. Until now, most research done on the geography of transitions, like the studies on car sharing, are qualitative in nature. This study is unique in that it takes a quantitative approach in researching the spatial distribution of car sharing, combined with a qualitative study of local policies.

Figure 2: Multi-dimensional perspective on car sharing



The next section will discuss relevant literature on sustainable transitions and adoption, with emphasis on the recent literature on the geography of transitions and adoption. Also relevant literature on car sharing will be discussed, from which sub-questions and hypotheses will be derived. The third section of this thesis will describe the methods for the actual research. Section four will display the results of the research while section five will conclude with a short overview of the most important results, theoretical and policy implications, limitations of this study and suggestions for further research.

2. Theory

2.1 The transportation system as a socio-technical system

Adoption and diffusion of a radical innovation in a system like the transportation sector, is a slow and complex process. The transportation sector consists of many interacting parts, like individuals, firms, institutions and knowledge, as well as artefacts (cars, roads, etc.). The social and at the same time technological aspects of the transportation sector make it a socio-technical system, and due to its interconnectedness with society, it takes a long time for such a system to develop, and normally only incremental changes take place (Hegger e.a., 2007; Truffer and Coenen, 2012). However, external forces like environmental concern can set off a process that lead to radical innovations or even a fundamental shift of the system (Markard e.a., 2012). Due to the disrupting consequences of radical innovations, incumbent organizations rather hamper innovation than support or initiate it (Christensen, 1997). If a radical innovation appears however, it firstly develops in a niche market, protected against destructive market forces, and is adopted only by innovators (Rogers, 2010). The second step is to 'cross the chasm' from the early adopters to the early majority (Moore, 2002) which can eventually lead to a socio-technical transition.

The transition from the current mobility regime towards car sharing is not exactly of technological nature, but it is a huge change in a social and cultural way. The idea of public instead of private property entails changes in insurance, taxes, finances, property rights, legislation, policy, etcetera. Furthermore, the car has been a status symbol for a long time, and ownership is deeply embedded in Western culture. Therefore the adoption of car sharing in The Netherlands can be seen as a socio-technical transition and this study builds on the literature on sustainable transitions.

2.2 Towards a spatial perspective on sustainability transitions

Transitions towards a sustainable socio-technical system, and the adoption of sustainable innovations, have been widely studied and discussed in the scientific literature, but have been neglected on one aspect: a spatial perspective. Discussing the theory of technological innovation systems, Coenen et al. (2012) for example argue that it ignores the influence of different characteristics of regions within one system. They state that as a consequence of using mostly concepts of the technological innovation system framework, the often cited article by Garud and Karnøe (2003), on the development of wind industry in the US and Denmark, remains "inconclusive about whether US actors had just selected the wrong strategy out of two equally available alternatives or whether a more strongly embedded development path had simply not been available to US developers" (p. 971). With strongly embedded development path, Coenen et al. (2012) refer to the regional user initiated niche markets in Denmark, which gave it their lead on the US where only a technology driven strategy was possible. In other words, regional factors explain the difference in

development of the wind industry between the US and Denmark and the US simply could not do any better because they lacked these crucial regional factors.

With regard to the transition towards sustainable socio-technical systems, Dewald and Truffer (2011) also recognize the strong focus on national instead of local institutions and policies, within the technological innovation system perspective. While Coenen et al. (2012) advocate more emphasis on "the territorial embeddedness of institutional arrangements" (p. 973), Dewald and Truffer (2011) suggest more emphasis on the role of user related aspects of a new technology or service, after all, user characteristics do not only differ along the innovation process from early adopters to late majority but also per region.

According to Truffer (2008) and Truffer and Coenen (2012) regarding regional differences, innovation scholars can learn from insights from economical geography studies to reach a spatial perspective in analysing transitions. Therefore they plead for combining an economical geography perspective with insights from social studies of technologies. Dewald and Truffer (2011; 2012) build further on this idea in their study of the regional growth differentials in the German photovoltaic markets. Drawing on the idea that markets are "social arenas where firms, suppliers, customers, workers, and government interact" (Fligstein and Dauter, 2007, p. 107), Dewald and Truffer (2012) emphasize the importance of specific regional sub-processes that influence the development of an innovation.

Applied to car sharing in The Netherlands, the above mentioned studies demonstrate the importance of region and user specific characteristics in explaining regional adoption differentials. Hansen and Coenen (2013) however, recognize that the question how geography matters remains still unanswered. They state that "When asking the 'bigger' question why transitions unfold unevenly across space, it becomes obvious that further empirical and theoretical research is needed."(p. 17). That is exactly what this research about car sharing in The Netherlands aims to do.

2.3 Car sharing

"Successful innovations often depend on specific local preconditions" (Dewald and Truffer, 2012, p. 403). With these specific local preconditions Dewald and Truffer (2012) refer to the resources within one and the same region, which determine the dynamics of the development of an innovation. For this study of car sharing in The Netherlands, these resources are translated to the regional factors that foster the adoption of car sharing. According to the literature (Ball, 2005; Burkhardt and Millard-Ball, 2006; Efthymiou e.a., 2013; Loose, 2010; Shaheen e.a., 2001; Shaheen, 2004) a typical car sharing location is located in a highly populated area, with a relatively high percentage of rental houses, a high density of facilities and a high parking pressure. Regarding end-user profiles, a typical car sharing user is between 25 and 45, highly educated, is likely to have no car and lives alone or together with a partner without children. He or she does not value a car as a status symbol and does not like the hassle associated with owning a car, drives less than 15,000 kilometres per year, is environmentally minded and is already a frequent user of public transport and (Table 1).

Table 1: Demographical and geographical characteristics, favouring the adoption of car sharing

Car sharing user:	**Car sharing location:**
Young (between 25 and 45)	High urbanity
A higher than average education	Relatively high percentage rental housing
Likely to have no car	High density of facilities
Small household	High parking pressure
Does not value a car as status symbol	
Does not like the hassle associated with car owning	
Drives less than 15,000 km per year	
Environmentally minded	
Frequent user of public transport	

Most of these demographic and geographic characteristics intuitively influence the likelihood of adoption of car sharing: because of practicality, in the case of a high parking pressure; because of finances, for example for people who drive less than 15,000 km per year; or because of ideology from environmentally minded people. Other characteristics, like age and education, are less obvious though. These characteristics are often associated with early adopters of new innovations (Moore, 2002). There also may be other factors that could explain adoption differentials, such as non-Western immigrants. The ownership of a car is becoming less important amongst Western youth. However, the opposite is true for non-Western youth (KpVV, 2013c). Therefore, a high density of non-Western immigrants might negatively influence the adoption rate of car sharing in such a region. Also income may have an influence on the adoption of car sharing. On the one hand, car sharing reduces costs, provided that the user drives less than 15,000 km per year. A typical car sharing user drives less than 15,000 km per year so car sharing could be an outcome for persons with a relatively low income. On the other hand, a typical car sharing user is said to be highly educated, which leads to a higher income, therefore one might expect that car sharing is a typical business for those with a relatively higher income. This 'other hand' is expected to be the decisive hand, therefore it is expected that a relatively high income positively effects the adoption of car sharing.

The focus of this study is whether or not these characteristics explain the regional adoption differentials in The Netherlands and how they influence the development of car sharing. Together these characteristics may form a niche for the phenomenon car sharing to grow and spread throughout time and space. The following sub-question will specify the research question.

- *To what extent do the different demographical and geographical characteristics influence the adoption rate of traditional and peer-to-peer car sharing in The Netherlands?*

The hypotheses for this part of the research are:
1. The individual characteristics in Table 1 have a positive influence on the adoption of car sharing;
2. A high income has a positive effect on the adoption of car sharing;
3. A high percentage of non-Western immigrants has a negative influence on the adoption of car sharing.

As these characteristics differ per region it is expected that they explain, at least partly, the diverse adoption rates in The Netherlands. In section 3: Methods, these characteristics will be translated to measurable indicators if possible.

2.4 Policy

Apart from individual characteristics, an innovation also benefits from political legitimacy and supportive policies. Dewald and Truffer (2012) recognize the importance of policies for the emerging of markets: "Formal institutional arrangements such as laws or subsidy schemes are often preconditions for markets to emerge" (p. 403). Because a combination of these conditions is necessary for a market to form, Dewald and Truffer (2012) expect a high regional diversity in the adoption rate of an innovation. In other words, the regional uneven distribution of the adoption of car sharing in The Netherlands is likely caused, or at least partly by the different mobility policies of the governments of the Dutch municipalities.

Cities benefit from car sharing. Especially for larger municipalities, where urbanization creates complex challenges which ask for innovative solutions, car sharing could play a significant role. Therefore car sharing is high on the sustainability and mobility agenda of many municipalities (KpVV, 2013a). Nevertheless, hitherto involvement is limited to the allocation of specific parking licenses and parking space for the traditional car sharing organizations. Cities with a high parking pressure however, tend to hesitate to allocate specific parking space for car sharing (AEF, 2014). This may hamper the growth of car sharing. After all, according to the KpVV (2014) especially policy regarding parking is a precondition for the success of car sharing. Other methods to stimulate car sharing are public awareness campaigns to draw positive attention to the facts and 'look and feel' of car sharing, and policies regarding the removal of fiscal barriers associated with car sharing (AEF, 2014).

Also, it is to be expected that regional factors have different effects on the two types of car sharing. Traditional car sharing for example, is likely to be more dependent on policy than peer-to-peer car sharing. After all, a company like Car2Go that placed 300 electric vehicles in the centre of Amsterdam is highly dependent on whether the municipal government is willing to provide special licences, parking space, etc. Peer-to-peer car sharing on the other hand, might not be dependent on policy because the shared vehicles are private. However, peer-to-peer car sharing might be influenced by personal characteristics all the more. There are fewer administrative burdens associated with peer-to-peer car sharing but there is also less marketing and less commercial interest to share ones car. Therefore, peer-to-peer car sharing might be more dependent on the ideology of its users. The composition of both demographical and geographical characteristics as well as policy regarding car sharing differs per region, therefore it is assumed that if the adoption rate of car sharing is influenced by these factors, they cause the regional adoption differentials in The Netherlands.

The following sub-question will specify the research question.

- *To what extent does local governmental policy influence the adoption rate of both types of car sharing in The Netherlands?*

The hypothesis for this part of the research is:
Policy regarding car sharing has a positive influence on the adoption of car sharing, especially on traditional car sharing.

As municipalities individually develop mobility and sustainability policies and these policies subsequently differ per region, it is expected that policy will explain, at least partly, the diverse adoption rates in The Netherlands.

3. Methods

3.1 Data collection

In this study a quantitative as well as a qualitative method of research is used. The qualitative part consists of collecting and analysing governmental policies for all municipalities in The Netherlands (415), which will be translated to quantitative data for a regression analysis. The quantitative part consists of collecting and analysing demographical and geographical data per four digit postal code in The Netherlands (3873).

Policy

The first part of the data collection was qualitative in nature. Policies regarding car sharing on municipality level were collected for all Dutch municipalities, by means of searching for the term *autodelen* or *autodate* (most common Dutch terms for car sharing) on municipal websites, paper database LexisNexis® and Google Search. To search for the Dutch terms on the municipal websites the query "*insite:'municipality name'.nl autodelen OR autodate"* was typed into the Google search bar. The hits then were investigated for possible policies. Next LexisNexis® was used to investigate for any news on policies regarding car sharing, by searching for *'autodelen OR autodate'* in all Dutch news. Subsequently the *'search within results'* option was used to search for the municipality name of concern. Lastly, the Google search bar was used again with the query '*"municipality name" AND autodelen OR autodate'.* The collection of policies was done between May and July 2014. As is usual with qualitative research, the findings then were categorized to make a distinction between the different kinds of policies. On the basis of literature about policies regarding car sharing, whether or not from The Netherlands (AEF, 2014; KpVV 2013; 2014; Shaheen e.a., 2004; Shaheen e.a., 2006; Shaheen e.a., 2009) the following concepts were used to formulate categories: policy regarding car sharing organizations or car sharing users, policy regarding parking, taxes, subsidies, city development, information or public awareness campaigns. Each policy was given a present or non-present per municipality and eventually the amount of policies were incorporated as a number into the dataset with four digit postal code regions to be statistically analysed. Also the individual policies were incorporated into the dataset to see which kind of policies had the greatest positive influence on car sharing. The individual policies were given a present or non-present and as variables they are therefore nominal in nature.

Adoption rate: amount of shared cars

The adoption rate of car sharing in The Netherlands is measured per four digit postal code region, by means of figures of traditional and peer-to-peer car sharing organizations. These organizations are Car2Go, Greenwheels, CareCar, ConnectCar, Drive, StudentCar, WeGo, MyWheels and SnappCar, from which the latter two are peer-to-peer car sharing organizations. The collection of these figures was done between March and May 2014. The same way a user of car sharing can find out for each organization where to pick up a car, for this study the locations of each car have been identified. The website of Greenwheels for example shows a map with all of their locations where one can pick up a car provided that it's available, indicated by a green or red symbol (figure 3). For this study however, availability is not necessary so all locations are taken into account. Once compared with a map showing the four digit postal code regions, the amount of cars per region was identified. For the organization Car2Go the data collection was a snapshot because Car2Go doesn't work with fixed parking lots and customers can drop the car anywhere they want, therefore only available cars are shown on their website. Car2Go however only operates in the centre of Amsterdam and though the

cars may travel between different regions on different times, the pick-up spots are always in the centre of Amsterdam, consisting out of eight different four digit postal code regions. The moment of collecting figures from Car2Go was at night to make sure that as many as possible cars were available. In doing so the actual collected number of cars was 178 out of 300. The peer-to-peer car sharing organization Snappcar cooperated with this study by sharing the locations of shared cars of their members. Other organizations provide a list of car sharing locations on their website, some without the actual postal codes. In the case of a list without the actual postal codes, geographical software was used to assign the correct postal codes to the correct locations. Eventually the total amount of shared cars as well as the amount of traditional and peer-to-peer shared cars per region was identified and the adoption rate per region could be compared.

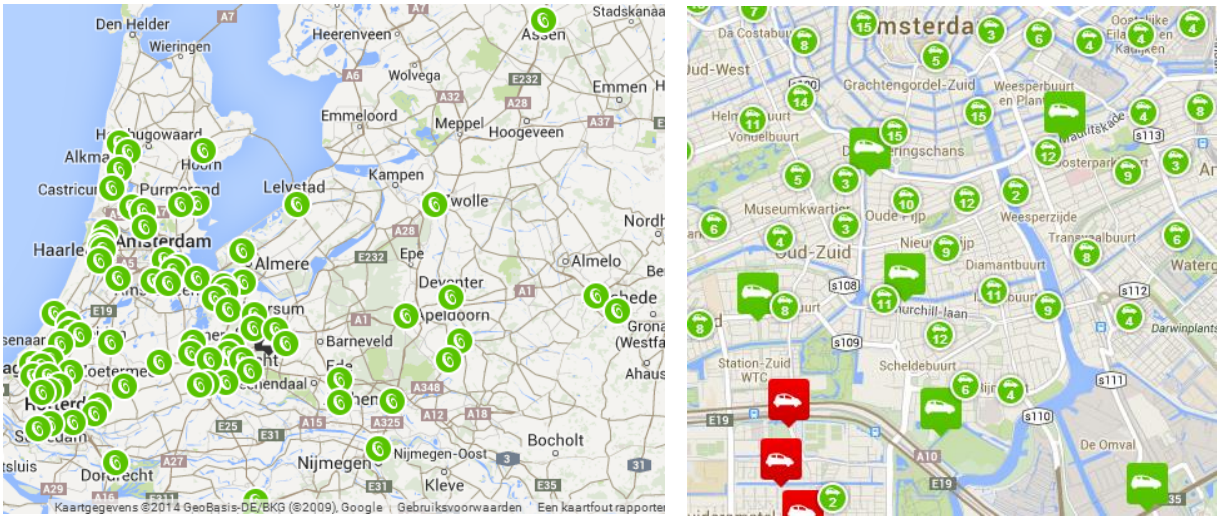


Figure 3: Map of cars Greenwheels, Left: The Netherlands, Right: Amsterdam

Demographic and geographic characteristics

After the collection of the amount of shared vehicles, demographic and geographic characteristics per four digit postal code region have been collected (Table 2). The source for this data is the website from the Dutch Bureau of Statistics (in Dutch: CBS). The CBS collects key figures per neighbourhood, from which there are about 16,000 in The Netherlands, and places them in their digital database *Statline*. For each neighbourhood the CBS also collects the most common four digit postal code. For about 90% of all neighbourhoods the most common postal code covered more than 90% of the neighbourhood. For the other 10% of the neighbourhoods the most common postal code covered between 41% and 90% of the neighbourhood. Because the adoption rate of car sharing is measured per four digit postal code region, the neighbourhoods with the same most common postal codes were joined and the average was taken from the variables with data in percentages and averages, and the sum from variables with actual amounts, like population (for an example, see appendix I).

With the literature as guideline Table 2 shows the indicators for the characteristics of a typical car sharing user and location as found in the database of the CBS:

Table 2: Indicators for demo- and geographical characteristics

- Population
- Urbanity: average amount of addresses in a radius of 1 kilometre per address
- Population density: average amount of habitants per km^2
- Density of facilities: average distance to nearest day care, school (primary, secondary-middle, and -higher), supermarket and train station
- Age: percentage of people with an age between 15 and 25, 25 and 45, 45 and 65 and 65+
- Education: percentage of people with a grade in lower, medium or higher education
- Car ownership: average amount of cars per household or per km^2
- Household size: percentage of 1-person households, multiple-person households with or without children and average household size
- House owning: percentage of privately owned houses or rental houses
- Percentage of non-Western immigrants
- Average income per person

According to the literature parking pressure highly correlates with urbanity so urbanity will serve also as indicator for parking pressure (Van de Coevering e.a., 2008). For personal characteristics like "drives less than 15,000 km per year", "environmentally minded", "does not like the hassle associated with car owning" and "frequent user of public transport" no indicators could be found, so whether or not these have any influence on the adoption of car sharing shall not be tested in this research. All demographic and geographic data is from 2013 except for average household size, percentage private owned houses and rental houses, education and distance to facilities, which are from 2012, while average income per person is from 2011. This is because data from later years was not yet available.

3.2 Data analysis

For the actual analysis, a negative binomial regression was performed with IBM SPSS Statistics version 22 software. A negative binomial regression is most appropriate for count data because of the large amount of zeroes which causes a highly skewed distribution (Cao e.a., 2006). A negative binomial regression accounts for this non-normal distribution. Before the actual regression analysis was performed some other assumptions had to be met. First it is very likely that many of the variables mentioned above correlate with each other which would cause multicollinearity and would bias the outcome. Therefore, a correlation analysis was performed, the correlating variables were removed and the variance inflation factor (VIF) was calculated to double check for multicollinearity.

Secondly the data was checked for the presence of autocorrelation or dependence of observations by means of the Durbin-Watson test[2]. It was expected that there was some autocorrelation because the observations are regions and there is a high probability that neighbouring regions show some similarity or dependence on each other. A Durbin-Watson value between 1 and 2 would normally be acceptable though.

Thirdly, the data was checked for heteroskedasticity. The likelihood of heteroskedasticity is high because of the negative binomial distribution of the dependent variable, which causes the

[2] The Durbin Watson statistic is actually meant for autocorrelation in time-series models and calculates how much an observation correlates with one observation earlier and one later. The present model is regional and most postal codes are neighbouring regions with the postal codes 'earlier' and 'later' in the dataset. However, one postal code region of course has more than two neighbouring regions, therefore the Durbin-Watson statistic has to be interpreted with caution.

standardized residuals to become higher as the standardized predicted values increase. This is partly solved by the regression model that is used, and in the case of heteroskedasticity the regression analysis will be done with robust covariance estimators.

Once all assumptions were met the actual regression was performed, with the amount of shared cars per region as the dependent variable and the demographic and geographic characteristics, and level of policy as independent or predictor variables. The model was checked for robustness by means of running the analysis without outliers with a standard deviation of 3 or more and without the largest municipality: Amsterdam. If the outcome did not significantly change, the model is considered to be robust.

Because a negative binomial regression analysis is performed, it is not usual to show the (pseudo) R, (pseudo) R square or adjusted (pseudo) R square (McCullagh and Nelder, 1989). Instead, to compare the goodness of fit of each model, the Deviance, Pearson Chi-Square and Bayesian Information Criterion values were used. The smaller these values are the more they explain. The variables were included in the model in clusters of geographic characteristics and demographic characteristics. In order to keep a large N as long as possible, variables with more than 10% missing cases were included penultimate and policy was included in the model as last variable. To see whether different variables influence different types of car sharing, the complete model was run for three different dependent variables: the total amount of shared cars per region, the amount of traditional shared cars per region and the amount of peer-to-peer shared cars per region. All models will also include the standardized B-coefficient *Beta* in order to compare the explanation power of each variable on the adoption of car sharing. The standardized B-coefficient Beta is calculated by subtracting the mean of the concerning variable of each case of that variable and dividing it by the standard deviation of that concerning variable (Cao e.a., 2006). This is done for all independent variables and for all cases. The Beta values are ideal for comparing between variables in one model while the B values are ideal for comparing between models.

4. Results

4.1 Qualitative research: Policy

Most policies were stated on the municipal website. Campaigns were mostly found on side-websites, and elaborations of policies and interesting details of campaigns could be found mostly in papers. Many earlier policy plans and election programmes with plans and promises to stimulate car sharing passed in review. These plans often did not end in actual policies, however. Zaanstad (municipality with 150,000 habitants) for example budgeted €30,000 to stimulate car sharing. It is however not clear where they spent it on because they only allocated one specific parking space for a shared car from Greenwheels. Enschede (160,000 habitants) states that all plans regarding car sharing were cancelled because of budget cuts, which is shown by their policies, namely no policy at all. The policies that were indicated are as follows:

- Allocating specific parking spaces for shared vehicles from car sharing organizations
- Allocating specific licences for shared vehicles from car sharing organizations and users
- Financial support for car sharing organizations
- Financial support for car sharing users
- Municipal specific information about car sharing on municipal website
- General information about car sharing on municipal website
- Public awareness campaigns to stimulate car sharing

From the 415 municipalities only one district, Amsterdam Centre, scored a 7, which means that all indicated policies were present. Amsterdam (800,000 habitants) as municipality scored 6, lacking financial support for users. The second best was Nijmegen (166,000 habitants) with 5 present policies, lacking policy regarding parking licence and financial support for users. Third was Utrecht (320,000 habitants) with 4 points, lacking financial support at all and municipal specific information on the website. Then 21 municipalities scored a 3, most of them with policies regarding parking space and information on website, 14 municipalities scored a 2 and 25 scored a 1. 352 of the 415 municipalities showed no policy regarding car sharing on their website, in papers or on internet whatsoever.

Allocating specific parking spaces for shared vehicles from car sharing suppliers

Traditional car sharing organizations like Car2Go and Greenwheels have hundreds of cars that need a location where customers can pick the car up. Greenwheels is now owned by the Dutch railways and has therefore enough parking spaces at their train stations. Not all of their cars can be find at train stations though. In several municipalities special parking spaces are reserved where only Greenwheels cars are allowed to stand. The municipality Alkmaar for example (95,000 habitants) has reserved eight parking lots for Greenwheels cars only.

Allocating specific licences for shared vehicles from car sharing organizations and users

Several municipalities have parking licenses specific for shared cars from an organization or peer-to-peer shared cars. This license is not always cheaper but such a policy indicates that the local government takes car sharing into account and sees car sharing as legitimate. To stimulate peer-to-peer car sharing, the municipality Amersfoort (150,000 habitants) for example has arranged special parking licences for people who share their car via the website Snappcar, MyWheels or otherwise.

Financial support for car sharing organizations

This is a rare policy and is found only in 2 of the analysed municipalities. Nevertheless, the municipality Nijmegen not only reserves parking lots for car sharing organizations, it also facilitates the necessities, like signs indicating the special parking lot, for the purpose of shared cars.[3] Likewise, Amsterdam facilitates the charging pols for the purpose of electric shared cars.[4]

Financial support for car sharing users

This policy can be found only in the city centre of Amsterdam. To stimulate car sharing, the local government gives away free car sharing vouchers to the value of €300 for each person that gives up a

[3] "Autodelen ook handig voor wie met de fiets gaat." *De Gelderlander.* 31 maart 2009 dinsdag . Date Accessed: 2014/07/23. www.lexisnexis.com/nl/business.

[4] "Deelauto's veroveren de weg." *NRC Handelsblad.* 21 december 2012 vrijdag . Date Accessed: 2014/07/23. www.lexisnexis.com/nl/business.

normal parking license in the centre of Amsterdam. In association with Snappcar, Rotterdam (616,000 habitants) has given away ten free electric cars with the idea that each person would share it with at least 120 other people. This is however a one-off campaign and will therefore not be counted as financial support for car sharing users.

Municipal specific information about car sharing on municipal website

Although this is not actually a policy, this municipality specific information is always associated with some other policy or general information on the municipal website. Most municipalities that allocated specific parking space for car sharing organizations, state on their website where these parking lots can be found. Other municipality specific information can be in the form of information about parking licences or about what this specific municipality does to stimulate car sharing.

General information about car sharing for car sharing users on municipal website

Most participating municipalities give some general information about car sharing on their website and perhaps some links to websites of car sharing organization. This differs from the previous policy in that the information could be applied to other municipalities as well instead of only to their own municipality. Hence, most general information from different municipalities is exactly the same, because it was drawn from the same source, e.g. institutions like the KpVV. This policy at least indicates that the government is familiar with the phenomenon and may be able to answer questions from potential users.

Campaigns to stimulate car sharing

Campaigns are used widely to stimulate car sharing. Most campaigns consist out of posters with inspiring slogans like ("Driving like a prince" or "Dare to Share" [freely translated from Dutch]) and information meetings. Some municipalities do more however, like the example of Rotterdam mentioned above, and like the municipality Wijk bij Duurstede, which decided as part of a campaign that all members of their local government should engage in car sharing.

4.2 Assumptions

Multicollinearity, heteroskedasticity and autocorrelation

Concerning multicollinearity it is recommended to prevent correlation between variables of ±0.7 or higher/lower (for an elaborate view on correlations, see appendix I). Variables that are excluded from the actual regression model due to high correlation are urbanity, lower education, cars per household and cars per km^2, household size and private and rental housing. Most of these variables are inherent to regions with a high population density, either positively or negatively. Therefore population density will serve as indicator for these variables. Lower education highly negatively correlates with higher education, while household size highly negatively correlates with one-person households. Age between 45 and 65 highly negatively correlates with age 25 and 45 and will therefore be removed, because the latter variable is the variable of concern. Multiple-person households with children highly negatively correlates with one-person households, therefore this variable will also be removed. To check whether the problem of multicollinearity is solved with the new selection of variables, the variance inflation factor (VIF) is calculated and as can be seen in Table 3, all variables stay nicely under the 10 which means there is no multicollinearity.

According to the Breusch-Pagan and Koenker test in Table 4, heteroskedasticity is present, therefore the regression analysis will be performed with robust covariance estimators. Table 4 also

shows the Durbin-Watson statistic which indicates the presence of an acceptable amount of autocorrelation. This value should be interpreted with caution because of earlier mentioned reasons (see footnote 2).

Model Robustness

To check for robustness the model has also been performed excluding outliers with a value of 3 or more standard deviations from the predicted value and excluding the largest municipality, Amsterdam. Compared with the original model all significance levels stay the same and regarding the Beta values the differences range from ±0.05 and ±0.001 which is negligible. Population density changes the most +0.05, which is expectable because Amsterdam is one of the most dens cities of The Netherlands. Altogether it can be said that the model is robust.

Descriptive Statistics

Table 3 also shows the means, standard deviations and number of cases for each selected variable. As can be seen, the variable 'Education high' misses many cases and will therefore be included penultimate in the model, just before policy is added. Table 5 shows the number and percentages of the presence or absence of the individual policies. As can be seen both financial compensation for the organisation and user have very few cases. This might bias the outcome and therefore has to be interpreted with caution. Table 6 shows a separate correlation matrix of the individual policies. As can be seen no particular high correlations exist.

Table 3 Variance Inflation Factor and descriptive statistics

Model	Collinearity Statistics		Descriptive statistics		
	Tolerance	VIF	Mean	Std. Deviation	N
Total amount shared cars			3.99	8.4	3873
Population	.673	1.487	6312.39	4173.39	3873
Population density	.331	3.024	3246.28	3338.56	3849
Age 15 25	.392	2.548	12.33	3.65	3785
Age 25 45	.198	5.046	24.08	5.98	3785
Age 65+	.187	5.344	17.27	6.03	3785
Education middle	.629	1.591	34.38	4.26	2895
Education high	.248	4.033	18.37	8.92	2585
One-person households	.150	6.654	31.81	12.42	3832
Multiple-person households no children	.272	3.681	31.47	5.94	3832
Income per person	.343	2.915	22.09	3.92	3651
Non-Western immigrants	.345	2.900	8.24	11.01	3785
Distance to facilities	.567	1.764	2.89	2.04	3849
Policy Total	.483	2.072	.81	1.43	3873

Table 4 Heteroskedasticity and Autocorrelation

Breusch-Pagan and Koenker test statistics and sig-values		
	LM	Sig
BP	7.948.124	0.00
Koenker	402.206	0.00

Null hypothesis: heteroskedasticity not present (homoskedasticity)
if sig-value less than 0.05, reject the null hypothesis

Durbin-Watson	1.080

Table 5 Categorical Variable Information

Factor	Presence	N	Percent
Allocation Parking space	No	3184	87.3%
	Yes	465	12.7%
	Total	3649	100%
Allocation Parking License	No	3341	91.6%
	Yes	308	8.4%
	Total	3649	100%
Financial compensation organisation	No	3566	97.7%
	Yes	83	2.3%
	Total	3649	100%
Financial compensation User	No	3641	99.8%
	Yes	8	0.2%
	Total	3649	100%
General info on municipal website	No	2942	80.6%
	Yes	707	19.4%
	Total	3649	100%
Specific info on municipal website	No	3299	90.4%
	Yes	350	9.6%
	Total	3649	100%
Public awareness campaign	No	3350	91.8%
	Yes	299	8.2%
	Total	3649	100%

Table 6 Correlations individual policies

		Allocation Parking space	Financial compensation organisation	Allocation Parking License	Financial compensation User	General info on municipal website	Specific info on municipal website	Public awareness campaign
Pearson Correlation	Parking space	1	.392	.393	.121	.545	.376	.434
	Compensation organisation	.392	1	.353	.307	.306	.462	.5
	Parking License	.393	.353	1	.153	.433	.336	.314
	Compensation User	.121	.307	.153	1	.094	.142	.154
	Info General	.545	.306	.433	.094	1	.661	.457
	Info Specific	.376	.462	.336	.142	.661	1	.235
	Campaign	.434	.5	.314	.154	.457	.235	1

4.3 Regression analysis

Table 7[5] shows the results of the negative binomial regression in 4 steps, with the total amount of shared cars as dependent variable. The first variables entered in the model (model 1) are the geographic characteristics. The influence of the density of facilities (indicated by the average distance to facilities) seems high in the first model but decreases rapidly in the models to come. The same accounts for population density while population itself, evidently stays relatively high. Population density highly negatively correlates with cars per household and positively with cars per km^2. Therefore it can be said that a relative high amount of cars per household, negatively effects the adoption of car sharing. Eventually it appears that the density of facilities is more important than the density of addresses in general (which is indicated by urbanity which highly correlates with population density). Distance to facilities is an indicator for the average distance to the nearest train station, supermarket, day care and primary and secondary schools. The negative coefficient indicates that the reachability of these specific facilities is important for persons to participate in car sharing. Apparently these facilities have to be reachable by bike or by foot, because for these daily activities a car sharing user might not make the effort to reserve and pick up a shared vehicle. If these daily facilities are too far away, the person in question might want to use an own car to reach these facilities.

In the second model the demographic characteristics are added except education. The influence of age decreases as more variables are added and the group of people between 25 and 45 loses its influence on the adoption of car sharing altogether. The presence of age 15 to 25 and 65+

[5] Because the analysis is a negative binomial regression, the B-coefficient value is the natural logarithm of the change in expected counts of the dependent variable when the concerning independent variable increases with one unit, given the other predictor variables in the model are held constant. For the B value of 1E-04 for population in the model 4 this means for example an increase of exp(1E-04) = 1.0001, which indicates an increase in expected counts of shared vehicles of 0.01% for every person added to the population.

seems to be more important, albeit negatively. Age 45 to 65 highly negatively correlates with age 25 to 45 and will therefore have the opposite effect on the adoption of car sharing.

Concerning household types, one-person households have a large positive influence on car sharing, while multiple-person households with no children have no significant influence. Multiple-person households in general will have a negative influence on car sharing because multiple person households with children highly negatively correlates with one-person households. Apparently for a person from a one-person household it is most convenient to participate in car sharing, while in contrast with earlier findings from other studies, for a person from a two-person household (as indicated by multiple-person households without children) car sharing is not particularly interesting. In general it can be said that the smaller the household, the less inconvenient car sharing and therefore the higher the probability of participating in car sharing. Hence, it can be said that also the percentage of rental houses positively influences the adoption of car sharing, as this highly positively correlates with percentage of one-person households. This is in line with earlier findings from other studies.

The percentage of non-Western immigrants has no influence on car sharing, while the average income per person has a significant positive influence on car sharing. This indicates that car sharing is attracted by people with a higher than average income. Thus indicating that motives to join the car sharing movement are most likely not of financial nature.

When education is added (model 3), the explanation power of most other variables decrease. This is most likely not caused by the low number of cases of the variable education but by the high explanation power of the percentage of people with a high or academic education, as indicated also by the goodness of fit values, which dramatically decrease. It seems that car sharing is a typical activity for highly educated people, which is in line with earlier studies and which is usual with sustainable innovations (Moore, 2002).

When policy is added (model 4[6]), there is no significant change noticeable in the values of other variables and in the goodness of fit values, though policy itself has a significant positive influence on car sharing. It seems that only the allocation of parking space and general information on the municipal website have a significant positive influence on the adoption of car sharing. The allocation of specific parking licenses and public awareness campaigns have no significant influence on car sharing, while compensation for car sharing users and municipal specific information on the website, in this model, have a significant negative influence on car sharing. This seems strange and has possibly to do with the low number of cases of the policies as indicated by Table 5.

For the total amount of shared vehicles per region, all hypotheses regarding geo- and demographical characteristics are accepted, except for influence of age and the percentage of non-Western immigrants. Concerning policy only the allocation of parking space and general information on the municipal website have a positive influence on car sharing.

[6] For the nominal variables no standardized value could be calculated, therefore only the significance levels and the B coefficients are shown.

Table 7 Negative binomial regression with total amount of shared cars

	Model 1			Model 2			Model 3		
Parameter	Beta	(B)	Standard error	Beta	(B)	Standard error	Beta	(B)	Standard error
Population	.66**	2E-4**	8E-6	.72**	2E-4**	7E-6	.58**	1E-4**	6E-6
Population density	.34**	1E-4**	1E-5	.09**	3E-5**	1E-5	.07*	2E-5*	8E-6
Distance to facilities	-.72**	-.3**	.023	-.41**	-.17**	.021	-.07**	-.10**	.018
Percentage persons									
age 15 to 25				-9E-3	-2E-3	.01	-.07*	-.02*	.008
age 25 to 45				.09*	.02*	.008	-.01	-2E-3	.008
age 65 plus				-.13*	-.02*	.01	-.16**	-.03**	.008
Middle education							-.06*	-.01*	.006
High education							.37**	.04**	.005
Percentage Households									
One-person				.37**	.03**	.006	.30**	.02**	.004
Multiple-person no children				-.05	-.01	.011	-.01	-.01	.007
Percentage Non-Western immigrants				-9E-3	-9E-4	.003	.05	5E-3	.003
Average									
Income per person x 1000				.39**	.10**	.007	.11**	.03**	.01
Policy									
Allocation of									
Parking lot									
Parking license									
Compensation for									
organization									
user									
information									
general									
municipality specific									
Campaign									
Number of observations	3819			3621			2526		
Goodness of fit[a]									
Deviance	3401.790			2772.010			1856.706		
Pearson Chi-square	5511.429			3918.238			1872.310		
Bayesian Information Criterion	11930.004			11283.154			9952.603		

* = significant on the 0.05 level
** = significant on the 0.01 level
[a] Information criteria are in smaller-is-better form

Table 7 Negative binomial regression with total amount of shared cars (Continued)

	Model 4a			Model 4b		
Parameter	Beta	(B)	Standard error	Beta	(B)	Standard error
Population	.56**	1E-4**	6E-6	.57**	1E-4**	6E-6
Population density	.06*	2E-5*	8E-8	.07**	2E-5**	8E-6
Distance to facilities	-.20**	-.10**	.018	-.17**	-.09**	.018
Percentage persons						
age 15 to 25	-.07*	-.02*	.008	-.08**	-.02**	.008
age 25 to 45	-5E-3	-8E-4	.007	-.02	-3E-3	.007
age 65 plus	-.14**	-.02**	.008	-.15**	-.02**	.007
Middle education	-.05*	-.01*	.006	-.05	-.01	.006
High education	.34**	.04**	.005	.34**	.04**	.005
Percentage Households						
One-person	.27**	.02**	.004	.30**	.02**	.004
Multiple-person no children	-6E-3	-7E-3	.007	-.01	-.01	.008
Percentage Non-Western immigrants	.02	2E-3	.003	.05	3E-3	.003
Average						
Income per person x 1000	.11**	.03**	.01	.12**	.03**	.01
Policy	.10**	.07**	.016			
Allocation of						
Parking lot				**	.31**	.052
Parking license					-.04	.059
Compensation for						
organization					.11	.121
user				**	-.48**	.18
information						
general				*	.19*	.075
municipality specific				**	-.28**	.077
Campaign					.02	.076
Number of observations	2526			2526		
Goodness of fit[a]						
Deviance	1846.144			1818.873		
Pearson Chi-square	1853.961			1831.023		
Bayesian Information Criterion	9949.876			9969.611		

* = significant on the 0.05 level
** = significant on the 0.01 level
[a] Information criteria are in smaller-is-better form

Traditional and peer-to-peer car sharing

To see whether geo- and demographic factors or different policies influence the two kinds of car sharing differently, the complete models have been run with the amount of traditional shared vehicles and peer-to-peer shared vehicles separately as dependent variables (Table 8). The first thing that strikes is the difference in goodness of fit values. It seems that regional factors have more influence on traditional car sharing than on peer-to-peer car sharing. Which indicates that regional factors explain the uneven distribution of the adoption of traditional car sharing to a much higher degree than the uneven distribution of peer-to-peer car sharing. Only population and population density seem to have more influence on peer-to-peer car sharing than on traditional car sharing, which makes sense because peer-to-peer car sharing is much more dependent on the actual population than traditional car sharing which is much more dependent on car sharing companies.

The density of facilities is more important for traditional car sharing than for peer-to-peer car sharing. Referring to what has been said before about the density of facilities, this may indicate that traditional car sharing users participate in car sharing as an alternative for owning a car, hence the importance of the density of these specific facilities. Peer-to-peer car sharing might be more of a replacement for a second car or a solution for special occasions. This is confirmed by the effect of the percentage of one-person households on both types of car sharing, which highly negatively correlates with the average amount of cars per household. Traditional car sharing is typical for one-person households and thus for households with relatively low amount of cars. In other words, a traditional car sharing user is more likely to have no car than a peer-to-peer car sharing user. One-person households are much less important for peer-to-peer car sharing, indicating that a low amount of cars per household is not that important either. Thus a peer-to-peer car sharing user is more likely to own a car than a traditional car sharing user.

Concerning age, the percentage of persons between 25 and 45 still does not seem to be that important, however the percentage of other age groups has a significant negative influence on both types of car sharing. The percentage of people with a higher education has a positive effect on both types of car sharing. Income has a slightly positive effect on both types of car sharing, while the percentage of non-Western immigrants seems to have a positive effect only on traditional car sharing. Although the percentage of non-Western immigrants correlates with population density, population density seems to have the opposite effect. Apparently non-Western immigrants do participate in car sharing albeit only in traditional car sharing.

Perhaps the most interesting finding of this comparison is the fact that policy has a large significant influence on traditional car sharing while to a much lesser extent, though significant on peer-to-peer car sharing. This was expected because car sharing organizations are much more dependent on the cooperation of the local governments than private car sharing operators. This also explains the finding that the allocation of parking licenses and compensation for car sharing organizations have a positive influence on traditional car sharing and not on peer-to-peer car sharing. The allocation of parking space and general information on the municipal website remain important for both types of car sharing. Municipal specific information about car sharing on the municipal website, financial compensation for the users and public awareness campaigns seem to have no or at least no positive effect on both types of car sharing in this model.

For the different types of car sharing it can be concluded that the hypothesis that policy has a larger influence on traditional car sharing than on peer-to-peer car sharing, is accepted.

Table 8 Negative binomial regression, Traditional and Peer-to-peer car sharing

	Traditional (a)			Traditional (b)			Peer-to-Peer (a)			Peer-to-Peer (b)		
Parameter	Beta	(B)	St. error	Beta	(B)	St. error	Beta	(B)	St. error	Beta	(B)	St. error
Population	.44**	1E-4**	1E-5	.46**	1E-4**	1E-5	.55**	1E-4**	6E-6	.57**	1E-4**	6E-6
Population density	-.02	-7E-6	2E-5	-.03	-6E-6	2E-5	.07*	2E-5*	9E-6	.08*	2E-5*	9E-6
Distance to facilities	-.78**	-.38**	.08	-.64**	-.30**	.084	-.21**	-.10**	.019	-.17**	-.09**	.018
Percentage persons												
age 15 to 25	-.17**	-.05**	.015	-.20**	-.06**	.015	-.06	-.02	.009	-.09**	-.02**	.009
age 25 to 45	-.13	-.02	.014	-.14*	-.03*	.015	-.01	-2E-3	.008	-.05	-.01	.008
age 65 plus	-.23**	-.04**	.015	-.25**	-.04**	.015	-.13**	-.02**	.008	-.16**	-.02**	.008
Middle education	.09	.02	.014	.08	.02	.014	-.07**	-.02**	.006	-.06*	-.02*	.006
High education	.54**	.06**	.010	.55**	.06**	.01	.32**	.04**	.005	.32**	.04**	.005
Percentage Households												
One-person	.59**	.05**	.008	.67**	.06**	.008	.23**	.02**	.004	.26**	.02**	.004
Percentage Non-Western immigrants	.18**	.02**	.006	.26**	.02**	.006	.01	.02	.003	.04	1E-3	.003
Average												
Income per person x 1000	.14*	.04*	.018	.16*	.04*	.017	.04*	.02*	.010	.02*	.02*	.010
Policy	.47**	.32**	.035				.03**	.02**	.017			
Allocation of												
Parking lot				**	.83**	.116				**	.27**	.054
Parking license				*	.24*	.133					-.02	.629
Compensation for												
organization				*	.48*	.222					-.22	.128
user				**	-.83**	.202				**	-.62**	.206
information												
general				**	.42**	.140				*	.17*	.078
municipality specific					-.16	.154				**	-.28**	.081
Campaign					.03	.152					-.03	.079
Number of observations	2526			2526			2526			2526		
Goodness of fit[a]												
Deviance	899.201			860.593			1889.789			1857.899		
Pearson Chi-square	1878.532			1795.519			1908.865			1885.485		
Bayesian Information Criterion	2942.812			2951.210			9628.875			9643.442		

* = significant on the 0.05 level
** = significant on the 0.01 level
[a] Information criteria are in smaller-is-better form

5. Conclusions and Discussion

5.1 Overview of the main findings

This study was able to statistically test findings from earlier studies about car sharing users and car sharing locations. Concerning geographical and demographical factors most findings are in line with earlier studies except for the importance of age. The results of the binomial regression analysis indicate that car sharing users are not necessarily between 25 and 45 years of age. On the other hand younger persons and individuals older than 65 are not likely to participate in car sharing. The results of this study indicate that the percentage of persons with a higher education and one-person households are most important for the adoption of car sharing. Subsequently the reachability of daily facilities like day-care, supermarkets, train stations and primary and secondary schools are crucial for the adoption of car sharing. Thereafter, income, municipal policy and population density seem to be decisive. Regarding policy, only the allocation of parking space and general information on the municipal website seem to have a positive influence on the adoption of car sharing.

There seems to be much difference in influencing factors between traditional and peer-to-peer car sharing. Overall, traditional car sharing is much more influenced by regional factors. Especially density of daily facilities and policy are crucial for traditional car sharing. The importance of density of daily facilities could indicate that traditional car sharing users are likely to have no car. The importance of policy for traditional car sharing is evident because organizations are much more dependent on local governments than private car sharing suppliers are. A higher education and one-person households seem to be the crucial factors for peer-to-peer car sharing which underwrites the importance of individual characteristics for peer-to-peer car sharing.

Like Coenen et al. (2012) discuss the advantage of Denmark over the US in wind energy, the same discussion can be hold for the case of car sharing in The Netherlands. Why does the city of Amsterdam has an advantage in car sharing over other cities or regions? Did other municipal governments just chose the wrong strategy or is a different development path just not possible for many municipalities or regions? On the basis of the results of this study the answer lies in the middle. The significant influence on car sharing of many geographical and demographical characteristics indicates that the regional adoption differentials can be explained by specific geographic and demographic characteristics. These characteristics cannot easily be changed and therefore would result in path dependency. On the other hand, the significant positive effect of policy on car sharing in The Netherlands, especially in the case of traditional car sharing, indicates that strategy in the form of policy is important to stimulate the adoption of car sharing. Especially the allocation of parking space and general information for car sharing users.

However, these findings account to a much higher extend for traditional car sharing than for peer-to-peer car sharing. Therefore, the uneven regional distribution of the adoption of peer-to-peer car sharing is only partly explained by the geographical and demographical characteristics and policies. Apparently there are more factors explaining the uneven distribution of peer-to-peer car sharing than analysed in this study.

5.2 Theoretical implications

This empirical study was able to demonstrate Coenen et al.'s (2012) conclusion that "A more explicit spatial perspective on sustainability transitions acknowledges and investigates diversity in transition processes, which follows from a 'natural' variety in institutional conditions, networks, actor strategies and resources across space".

By studying the regional adoption differentials of car sharing in The Netherlands, this study tried to gain more insight into the spatial dynamics of the possible transition of the mobility regime in The Netherlands towards car sharing. Just like other expressions of the collaborative economy, car sharing has the potential to be disruptive and to overthrow the current mobility regime. Knowledge of the dynamics of this transition can give local governments and companies an advantage in developing policies or business strategies. Until recently however, studies of sustainable transitions have focussed mainly on the national level and on the development of such phenomena over time. Policy implications would be on national level and therefore be limited to policies regarding taxes and expensive national public awareness campaigns. Managerial advice would mainly focus on technology and target groups. Without sufficient focus on spatial aspects, research would neglect the fact that municipalities regulate their own mobility policies and the fact that regions, even much smaller than municipalities, range from being very supportive for car sharing to not interesting at all for car sharing and car sharing organizations. As Coenen et al. (2012) put it: " (…) what is gained in a historical treatment has come at the expense of a neglect of spatial dimensions." (p. 968-969).

This study was able to show that car sharing is a territorial embedded phenomenon and that sufficient focus on this territorial embeddedness is needed to gain a complete picture of the dynamics of the sustainable transition towards car sharing. This study has revealed the uneven distribution of car sharing in The Netherlands, which suggests that its development may not just take place anywhere. The exponential growth of shared vehicles in Amsterdam, indicates the presence of niches that might be crucial for the development of car sharing in the greater mobility regime. The interactions between the local government, car sharing organizations and users within these niches may be exemplary for other regions. This study however was not only able to reveal that "context and scale matter" (Hansen and Coenen, 2013) but it also revealed why it matters.

Without sufficient focus on regional factors, one would miss for example the fact that traditional car sharing has a different development process and dynamics than peer-to-peer car sharing. This knowledge is crucial for explication of effective policies regarding car sharing. Evidently, the stimulation of peer-to-peer car sharing requires a different approach than traditional car sharing does. Not only because policy has a much smaller effect on peer-to-peer car sharing, but most geographical and demographical factors have a much smaller influence on peer-to-peer car sharing. Furthermore, without actually analysing the type of use concerning car sharing and car owning, by taking a spatial perspective, this study was able to reveal that traditional car sharing users tend to use car sharing as replacement for an own car, while peer-to-peer car sharing users tend to use car sharing as a solution for special occasions.

5.3 Policy Implications

The low number of municipalities that actually showed policy regarding car sharing (63 of the 415) indicates that local governments do not keep up with the rapid development of car sharing. Those that do have policies mainly focus on giving general information on the municipality website and allocating parking space for shared vehicles from car sharing organizations. Consequently these policies are generally addressed to traditional car sharing. These findings are in line with recent reports of the AEF and KpVV which state that municipalities have trouble developing policies regarding car sharing and mainly focus on traditional car sharing (AEF, 2014; KpVV, 2014). These findings are quite disappointing because it is very likely that cities, especially highly populated areas, could benefit a lot from car sharing, regarding parking pressure and the environment. The actual effect of car sharing on the environment in The Netherlands is however still unknown and sufficient research has to be done to give a clear picture of to what extend cities could benefit (AEF, 2014).

Assuming that cities and the environment actually benefit sufficiently from car sharing, the results of this study show that policy in general has a positive influence on both forms of car sharing, although to a much lesser extent on peer-to-peer car sharing. This was expected at forehand because traditional car sharing organization are much more dependent on the cooperation of the local government. This is also shown by the results of analysis of the individual policies. Policies regarding parking have a greater positive influence on traditional car sharing than on peer-to-peer car sharing. The allocation of parking licenses even has a significant positive influence on traditional car sharing only. Traditional shared vehicles are dependent on available public parking space, while peer-to-peer shared vehicles generally can be picked up and dropped at the owners house, hence no need for available public parking space.

Effective policies regarding traditional car sharing thus have been exposed. Effective policies for peer-to-peer car sharing however remain unclear. The current policy regime is not sufficient to properly stimulate peer-to-peer car sharing, therefore new policies have to be developed to foster also this promising business model. For that it is perhaps best to look abroad for good examples regarding car sharing in general and specifically peer-to-peer car sharing. In the United States and Canada for example, car sharing is already taken into account at the early stages of development of urban areas. By downgrading the amount of required parking spaces, allocating parking space specifically for car sharing and allowing for more dense building on a site, governments aim to discourage the owning of a car and encourage the use of car sharing in general (Shaheen e.a., 2009). Also local governments replaced their car fleet with car sharing services to set an example, which is also an initiative of the Dutch municipality Wijk bij Duurstede. Furthermore, subsidies exist for specific locations and for the low income market to reduce the barriers to participate in car sharing activities (Shaheen e.a., 2006). Also local governments in the US and Canada are active in collaboration with car sharing organizations through risk sharing partnerships and start-up funds (Shaheen e.a., 2004; Shaheen e.a., 2006). The effects of these policies on different forms of car sharing in the US and Canada are not yet examined however.

Overall it can be said that the development of policies regarding car sharing is in its very early stages and that a more thoroughly qualitative study has to be performed to identify more effective policies regarding the different types of car sharing. For example a qualitative study to the effect of public awareness campaigns on the attitude towards car sharing, either traditional or peer-to-peer.

5.4 Limitations and suggestions for further research

For this study it is assumed that the amount of cars per region is a good indicator for adoption. Another indicator could be the amount of members per location, after all it are the members that adopt the idea of car sharing. Further research could focus on the members and their car sharing activity instead of vehicles to see whether or not the outcomes differ. This would at the same time reveal the average use of each available vehicle. Especially for peer-to-peer car sharing it is not clear how often cars are being used. Many vehicles could only be used once a year and in this study these cars have the same value as shared cars that are being used every day. The data and results of the individual policies seem to show ambiguous results. This has become clear by the appearing negative effects of some policies on car sharing that have most likely a positive effect in reality. A thoroughly qualitative research on these policies could indicate the real effect on car sharing. Although it is hard to find data per four digit postal code region, further research could also take more factors into account that might influence the adoption rate of car sharing even more, especially peer-to-peer car sharing as this type seems to be dependent on other factors than measured in this research.

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Appendix I

Statline Output

Neighbourhood	Municipality	Postal code	Coverage[a]	Population	% Age 15 25	% Age 25 45	% Age 45 65	% Age 65+
Binnenstad-Noord	Harderwijk	3841	1	1360	13	33	31	11
Binnenstad-Zuid	Harderwijk	3841	1	945	16	39	22	12
Zeebuurt-Oost	Harderwijk	3841	1	1375	11	24	31	17
Zeebuurt-west	Harderwijk	3841	1	860	7	22	33	24
Friesegracht-Noord	Harderwijk	3841	1	835	13	22	35	20
Friesegracht-Zuid	Harderwijk	3841	1	520	10	16	33	24
Stadsdennen-Noord	Harderwijk	3842	1	2030	10	31	22	16
Stadsdennen-Oost	Harderwijk	3842	1	975	14	31	20	16
Stadsdennen-Zuidwest	Harderwijk	3842	1	1150	12	30	24	13
Sypel-Oost	Harderwijk	3842	1	160	6	25	29	26
Sypel-West	Harderwijk	3842	1	485	11	24	36	10
Veldkamp	Harderwijk	3843	1	1235	10	21	33	17
Kranenburg	Harderwijk	3843	1	545	13	21	33	16
"De Sypel"	Harderwijk	3843	1	95	16	60	18	3
Tinnegieter	Harderwijk	3843	1	1170	13	27	28	17
De Wittenhagen-Noord	Harderwijk	3843	1	2005	12	30	24	11
De Wittenhagen-Zuid	Harderwijk	3843	1	1530	14	32	21	10
nachthok	Harderwijk	3844	1	100	9	17	36	23
Weiburg	Harderwijk	3844	1	125	6	10	36	40
Kruithuis	Harderwijk	3844	1	915	4	17	19	53
Hanzewaard	Harderwijk	3844	1	580	15	19	26	24
Scheepswaard	Harderwijk	3844	1	1045	10	23	27	17
Stedenwaard	Harderwijk	3844	1	1180	10	20	35	17
Vogelwaard	Harderwijk	3844	1	1240	13	25	33	8
Weidewaard	Harderwijk	3844	1	1625	15	29	29	4
Drift	Harderwijk	3844	1	510	10	31	13	32
Stromenwaard	Harderwijk	3844	1	845	9	43	22	4
Slingerbos-Noord	Harderwijk	3844	1	795	10	26	23	20
Slingerbos-Zuid	Harderwijk	3844	1	550	11	20	29	19
Muziekland I	Harderwijk	3845	1	1220	10	24	33	16
Muziekland II	Harderwijk	3845	1	625	13	16	41	12
Muziekland III	Harderwijk	3845	1	1140	11	33	25	5
Muziekland IV	Harderwijk	3845	1	1415	9	36	17	5
Drielanden-Centrum	Harderwijk	3845	1	1295	9	36	19	15
Harderhout I	Harderwijk	3845	1	1215	11	32	24	6
Harderhout II	Harderwijk	3845	1	2125	7	49	11	3
Groerne Zoom	Harderwijk	3845	1	85	12	22	24	15
Weisteeg	Harderwijk	3845	1	50	8	26	30	21
Strokel	Harderwijk	3847	1	235	8	14	35	33
Sonnevanck	Harderwijk	3847	1	210	9	4	30	49
Harderwijkerbos	Harderwijk	3847	2	200	68	7	12	7
Broekland	Harderwijk	3848	1	1220	14	26	33	8
De Akker	Harderwijk	3848	1	1240	12	18	36	17
Walstein	Harderwijk	3848	1	1630	10	30	23	14

Postal code	Population	% Age 15 25	% Age 25 45	% Age 45 65	% Age 65+
3841	5895	11,67	26	30,83	18
3842	6740	10,50	27,00	25,50	18,83
3843	6580	13,00	31,83	26,17	12,33
3844	9510	10,17	23,33	27,33	21,75
3845	9170	10,00	30,44	24,89	10,89
3847	645	28,33	8,33	25,67	29,67
3848	4090	12,00	24,67	30,67	13,00

[a] 1: postal code covers more than 90% of neighbourhood

2: postal code covers between 80% and 90%

3: postal code covers between 70% and 80%

4: postal code covers between 60% and 70%

5: postal code covers between 50% and 60%

6: postal code covers between 40% and 50%

All neighbourhoods with the same most common postal code (left table), indicated by 'postal code' are joined (right table). The sum is taken from the amounts (e.g. population) and the average is taken from averages and percentage (e.g. Age).
This is can done semi-automatically by means of a pivot table in MS Excel.

Appendix II

	SC_Total	*Population*	*Pop_density*	*Urbanity*	*Age_15_25*	*Age_25_45*	*Age_45_65*	*Age_65plus*	*Education_Low*	*Education_mid*	*Education_high*	*Cars_per_hh*	*Cars_per_km2*	*One_P_hh*	*Hh_no_child*	*Hh_child*	*Hh_size*	*Private_Houses*	*Rental_houses*	*Income_PP*	*Imm_nonWest*	*Dist_Facilities*	*PolicyTotal*
SC_Total	1,00																						
Population	0,45	1,00																					
Pop_density	0,59	0,50	1,00																				
Urbanity	0,67	0,47	0,91	1,00																			
Age_15_25	0,14	0,08	0,20	0,22	1,00																		
Age_25_45	0,48	0,32	0,63	0,65	0,21	1,00																	
Age_45_65	-0,32	-0,30	-0,51	-0,52	-0,33	-0,72	1,00																
Age_65plus	-0,20	-0,10	-0,24	-0,18	-0,41	-0,59	0,18	1,00															
Education_Low	-0,41	-0,04	-0,18	-0,28	-0,22	-0,11	0,06	-0,01	1,00														
Education_mid	-0,37	-0,23	-0,33	-0,35	0,10	-0,28	0,28	0,09	-0,09	1,00													
Education_high	0,56	0,15	0,33	0,43	0,15	0,24	-0,19	-0,04	-0,88	-0,40	1,00												
Cars_per_hh	-0,49	-0,41	-0,75	-0,78	-0,29	-0,62	0,60	0,08	0,22	0,28	-0,33	1,00											
Cars_per_km2	0,46	0,52	0,90	0,78	0,09	0,55	-0,44	-0,16	-0,17	-0,27	0,29	-0,68	1,00										
One_P_hh	0,48	0,30	0,63	0,73	0,38	0,54	-0,57	0,07	-0,35	-0,22	0,43	-0,85	0,53	1,00									
Hh_no_child	-0,43	-0,37	-0,63	-0,63	-0,44	-0,67	0,66	0,44	0,12	0,31	-0,26	0,67	-0,53	-0,66	1,00								
Hh_child	-0,36	-0,16	-0,42	-0,56	-0,21	-0,28	0,33	-0,36	0,38	0,09	-0,40	0,68	-0,36	-0,89	0,23	1,00							
Hh_size	-0,42	-0,26	-0,56	-0,67	-0,19	-0,43	0,40	-0,23	0,37	0,15	-0,41	0,79	-0,51	-0,92	0,41	0,94	1,00						
Private_Houses	-0,40	-0,39	-0,66	-0,70	-0,21	-0,53	0,56	-0,02	0,00	0,28	-0,14	0,80	-0,59	-0,77	0,62	0,62	0,73	1,00					
Rental_houses	0,39	0,39	0,66	0,69	0,20	0,53	-0,56	0,02	0,01	-0,27	0,13	-0,80	0,59	0,76	-0,61	-0,61	-0,72	-0,99	1,00				
Income_PP	0,22	0,01	-0,03	0,04	-0,24	-0,19	0,20	0,22	-0,60	-0,21	0,66	0,13	0,06	-0,03	0,20	-0,09	-0,06	0,22	-0,23	1,00			
Imm_nonWest	0,31	0,42	0,68	0,66	0,18	0,57	-0,51	-0,24	0,14	-0,36	0,05	-0,66	0,58	0,53	-0,62	-0,30	-0,46	-0,72	0,72	-0,24	1,00		
Dist_Facilities	-0,31	-0,44	-0,54	-0,56	-0,12	-0,38	0,41	0,02	0,25	0,27	-0,36	0,58	-0,58	-0,49	0,48	0,34	0,47	0,52	-0,52	-0,11	-0,44	1,00	
PolicyTotal	0,61	0,38	0,59	0,66	0,19	0,49	-0,39	-0,20	-0,27	-0,40	0,44	-0,58	0,48	0,54	-0,53	-0,38	-0,47	-0,53	0,53	0,10	0,54	-0,39	1,00