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Master Thesis [programme: Urban, Port and Transport Economics]

The effect of the student travel card on later travel behaviour.

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SUMMARY

Car pollution is a problem in the Netherlands, specifically, the Randstad area. The Randstad area is highly populated and important for the economy. Because of the air polluting effects of the car, the government promotes travelling by public transport. Therefore, it is important to know why people travel with public transport. One of the reasons could be the student travel card, because people get familiar with public transport and might use public transport more often later in life. The following research question will be investigated in this paper: Does the student travel card have an influence on later public transport use among alumni?

Previous research about public transport led to various factors that determines the use of public transport. These factors include the proximity of public transport, from home and the destination. Furthermore, waiting times, travel time and income have an influence. Where public transport is seen as an inferior good, meaning that when income increases, the use of public transport decreases. Finally, past behaviour has an influence on current use of public transport, because it enhances the habit.

Data for the analysis is collected via online surveys. The survey contains questions about the use of public transport during college, and nowadays. Respondents are alumni who did not own the student travel card and the alumni who did. With help of an ordered logistic regression, the effect of the student travel card on travel behaviour will be examined. The results show a positive significant effect of the student travel card on current travel behaviour. However, it also shows that having a car at the disposal has a stronger negative effect.

In conclusion, the student travel card has an influence on later travel behaviour with public transport. However, the car is still a dominant factor in the choice of transportation mode. Familiarity is not solely effective to increase the use of public transport. To promote public transport more, the cost of public transport must decrease, or the cost of car use must increase.

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CHAPTER 1 INTRODUCTION

Air pollution is a well-known problem. It does not only damage the physical environment, but it also damages human health. Although air pollution arises from different industries, the car industry and car use amongst people are a big part of the air pollution (EEA, 2017). Specifically to the Netherlands, the three biggest cities in the Randstad area are among the twelve worst-performing urban areas in the European Union in terms of air pollution. Furthermore, in terms of economic cost of traffic jams, the Netherlands is the second worst country in the European Union. These traffic jams are also the cause of a lot of air pollution (EEA, 2017).

Because of the damaging effect of car use on the environment, the Dutch government wants to promote travelling by public transport by making it more attractive (Rijksoverheid, 2018). Public transport reduces air pollution as it transports many passengers at the same time. More efficient train schedules, extra parking places and bicycle parking should help promote public transport. Furthermore, the vehicles used for public transport; busses, trams and metros, must also be clean to relieve the environment even more (Rijksoverheid, 2018).

It is possible, however, that these promoting policies will not work for everyone. As Steg and Stievers (2000) investigate, each individual has its own risk perception with regard to the environment of driving a car. Because of these different risk perceptions, individuals are more active or reluctant to reduce car use to stop polluting the environment. Individuals with less risk perception, depend more on the government and technological changes.

Looking at the car ownership of the last decade among people between the ages of 18 and 30, it has declined although the number of people in this age category has increased (CBS, 2017). Furthermore, car ownership among students has declined from 11.9 percent in 2010 to 10.5 in 2014 (CBS, 2016). This may be due to different factors like income, lifestyle and the living environment, but it is also possible due to the student travel card.

A student of the Netherlands has the right to travel free with public transport, during the week or the weekend and with a discounted fare otherwise. This is for students of higher education who receive student grants. Basically, this is applicable for all students who are 18 or older. Therefore, students are most likely to travel to school with public transport, but also to other places for leisure, work and others. To go to school, students use the train for half of the distance from home and use the bus, tram or metro for a quarter of the distance (CBS, 2016). With the student travel card, it is possible that students become more familiar with public transport and may find it more convenient than travelling by car in the future.

In the coalition agreement of 2012 from the Dutch government, it was stated that the student travel card must be removed by 2016 and be replaced with a discount card (KiM, 2015). Because of this agreement, research is done about the possible effects for transport choice amongst students, effects on the amount of public transport and the effects on the public transport companies. However, there is no research done about possible external effects of the student travel card, such as travel behaviour later in life. Although the student travel card is still in operation, it is useful and interesting to look at these possible external effects.

Travelling with public transport is important, as it reduces pollution that comes from travelling by car. Therefore, it is important to stimulate public transport use. With the student travel product, public transport is introduced by younger people, and this can have an influence on later car ownership or use. At a relatively young age, the convenience of public transport is experienced which can impact the mode of travel in later life.

This study investigates whether the student travel card has an influence on the use of public transport after graduation. It is important to show whether the student travel card has an impact on travel behaviour in later life, as it can show a positive influence on companies, and to introduce a similar travel card for their employees. The following question will therefore be researched:

Does the student travel card have an influence on later public transport use among alumni?

To analyse the effect of the student travel card, data must be collected. This is done with the help of internet surveys. After collection of the data, the data must be analysed. This is done with the help of some statistical tests and with a regression analysis. The regression used is an ordered logistic regression, as the dependent variable is of ordinal scale.

In the following section literature about behaviour and attitudes towards public transport will be discussed. Chapter 3 contains a summary of the data collected and explains the methodology further. Chapter 4 summarizes the results. Finally, chapter 5 contains the conclusions, discussions and some recommendations for future research.

CHAPTER 2 THEORETICAL FRAMEWORK

2.1 FACTORS DETERMINING THE USE OF PUBLIC TRANSPORT

The use of public transport can be explained by various determinants. Although this study is focused on the effects of the student travel card on the use of public transport, these other factors should be incorporated. Various studies have investigated which factors could influence the behaviour of people and their use of public transport.

Murray, Davis, Stimson and Ferreira (1998) did a study about the influence of access based on proximity, rather than cost of public transport, on the use of public transport. As there are several public transport modes, it is worth mentioning that they looked at bus, train and ferry stops at the origin. They evaluate the performance of public transport in the South East Queensland area. Although there is no empirical evidence, they come to the conclusion that if the proximity of public transport stops is decreased, the performance of the public transport system will be improved. Furthermore, the time to reach a stop has a great influence on the total travel time, which in turn influences the clientele of public transport (Murray, Davis, Stimson & Ferreira, 1998)

A study from Beirão and Cabral (2007) showed attitudes towards public transport from 24 in-depth interviews in the region of Porto. The interviews were held at the time where public transport in Porto mostly consisted of bus travel. Because of the design of the study it is not generalizable to the bigger public, however, it gives some interesting insights of attitudes towards the bus service in comparison with cars.

From their interviews it became clear that the travel time (short waiting times) and reliability is a big determinant of the travel mode decision. Furthermore, there were no complaints of the costs of bus travel and some respondents answered that bus travel is even cheaper than car travel. This can imply that the cost of public transport is not a large factor in determining the mode of transport. Finally, information (e.g. time tables) is important as it can act as a threshold to use public transport (Beirão & Cabral, 2007).

Bresson, Dargay, Madre and Pirotte (2003) compared the demand of public transport in England and France. This was done over a nine-year period, 1988 till 1996 for England and 1987 till 1995 for France. Furthermore, whereas all public transport is investigated in France, only bus-service are considered for England. There must be taking care of comparing the fare, service and income elasticities of the two countries, due to differences in the data definition and the scope. However, they do find any real difference with the income elasticity, meaning that in France public transport is seen less of an inferior good than in England. Overall, their conclusion states that demand is relatively sensitive to fare changes, and that the service of public transport is at least as important as the fare (Bresson, Dargay, Madre & Pirotte, 2003).

2.2 Behavioural factors determining the use of public transport

The demand for public transport is not solely determined by monetary value or quality of the service, it is also determined by behaviour and habits. When the same action is repeated over time, it eventually becomes a habit. This means that little cognitive action is needed to achieve a certain goal (Samson, 2017). To put into the context of this paper, when an individual repeatedly uses public transport to work, school or any other activity, it becomes a habit to use public transport instead of another mode of transport.

Bamberg, Azjen and Schmidt (2003) examined whether past behaviour has an influence on later bus use. Their first explanation of the role of past behaviour is that its frequency enhances the habit. Secondly, if there is a strong relation between past behaviour and later behaviour, there is no reason to change behaviour (e.g. if all factors determining the demand for bus use remain stable over time, there will be no behavioural change). Furthermore, they suggest that new information could influence an individual' s choice, so that the habit becomes less explanatory (Bamberg, Azjen & Schmidt, 2003).

To test their theory, they conducted a field study, with an introduction of a pre-paid bus ticket for students. Surveys were taken before and after the introduction. From their results it becomes clear that a considerable proportion of the students who drove to campus

by car, changed their behaviour and instead use the bus to go to campus. They conclude that relevant new information can change behavioural decisions and that past behaviour is only a good predictor for later behaviour if the circumstances remain relatively stable (Bamberg, Azjen & Schmidt, 2003).

A similar study was conducted by Heath and Gifford (2002). In their study they investigate the effect of '*The U-pass program'*, which is a buss pass for students to use freely in the region at a considerably lower fee than usual. The analysis from the questionnaires showed that students used the bus significantly more after the implementation of the program. Furthermore, their attitudes and beliefs about the bus and car as transportation modes changed. More specifically, the students thought that bus use was more desirable than car use after the implementation of the program, despite the fact that the students evaluated the same factors in choosing a transportation mode equally important before and after the U-pass program (Heath & Gifford, 2002).

Looking again at past behaviour of travelling with public transport, Beirão and Cabral (2007) found a result in their study. Respondents tend to rely more on their worst experience of bus travel, rather than the average performance. This can explain why people who have not used the bus in recent years, do not travel with the bus anymore and have a negative image of public transport, especially the bus.

Another study by Bamberg, Hunecke and Blöbaum (2007) examined whether personal and social norms have explanatory power on the travel mode choice. Their model shows that the personal norms (e.g. the obligation an individual feel to use public transport) have an effect, however, its effect is mediated by the variable *intention to use public transport*. The personal norm is affected by feeling of guilt because of the polluting effect of driving a car. This leads to the use of environmentally friendly transportation. However, in most cases the awareness of the polluting effects of car use is not sufficient to change the choice of transportation mode (Beirão & Cabral 2007). Social norms have merely, but strong, relations with personal norms and attitudes and functions more as an easily accessible information source (Bamberg, Hunecke & Blöbaum, 2007).

2.3 Perception of public transport

The demand for public transport can also be determined by the perception of it. For example, you have studied for five years and used mostly public transport and eventually made the association of public transport to be a 'student transportation mode'. Then after graduation, because you do not want to be associated with students, you buy a car and use it as your dominant transport mode.

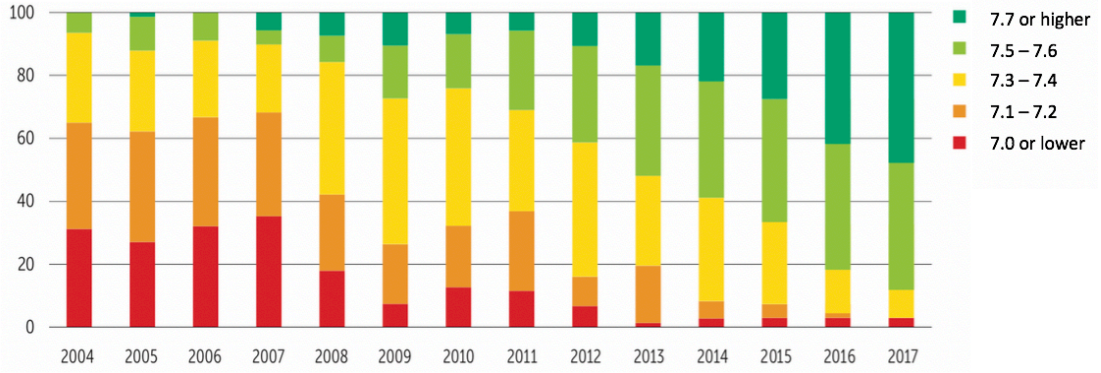
Another perception of public transport can be the one of an inferior good. As mentioned before (section 2.1), Bresson, Dargay, Madre and Pirotte (2003) find that the income elasticity for public transport is negative. This means that when income increases, the demand and use of public transport decreases. This can lead to an increase of, for example, car use. However, in a later study with a larger panel data set (1975 – 1995) and more available variables of France, Bresson, Dargay, Madre and Pirotte (2004) find that public transport is perceived as a normal good when car ownership is considered in the regression analysis, rather than solely income. This different result is due to increasing car ownership over the years, which in turn is due to economic growth.

2.4 Public transport use in the Netherlands

Public transport in the Netherlands consists of different vehicles, these are the train, metro, tram, bus and ferry. An institute in the Netherlands which examines the quality of public transport is CROW-KpVV. Every year, since 2001, the CROW-KpVV survey travellers of public transport and analyses these questionnaires. In their latest report (CROW-KpVV, 2017) public transport got on average a grade of 7.6 on a 1 to 10 scale. The aspect with the lowest score was the price of public transport, which got a 5.5.

Important to note is that users of public transport became more positive of public transport over the last decade. As can be seen in figure 1, the number of users of public transport that give a 7.7 or higher in general is increasing, whereas the users who give a 7.0 or lower is decreasing.

Figure 1: development satisfaction of public transport



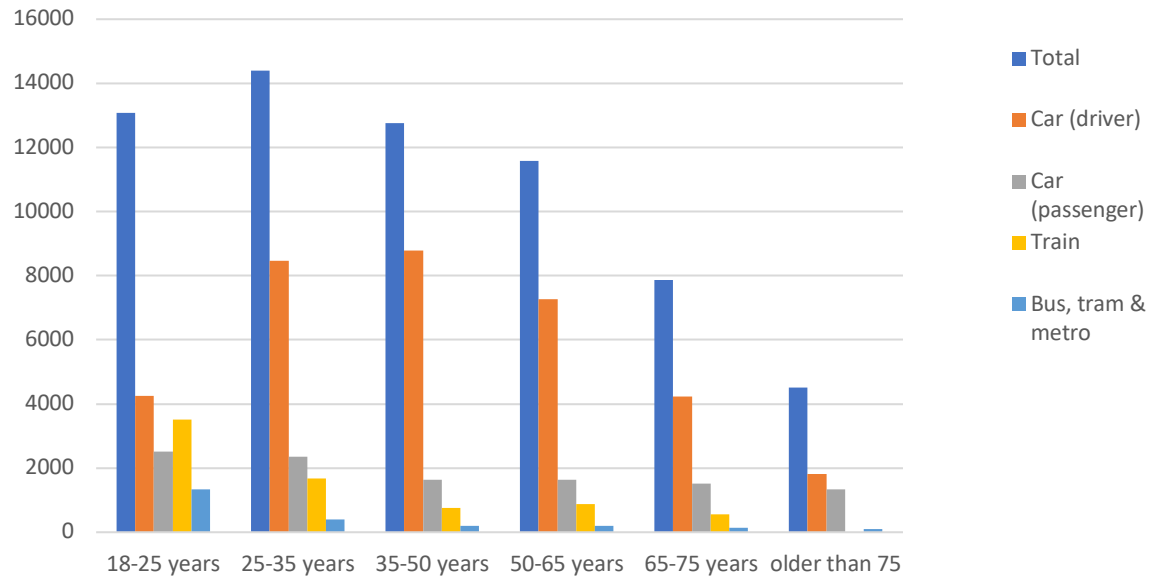
Source: CROW-KpVV, 2017

Figure 2 represents how people of different age categories are transporting. The data is collected by CBS and is based over the year 2016 (see appendix A). On total people in the age category of 25 till 35 years are moving the most per person in kilometres. Their most dominant mode is driving the car and public transport use is relatively low. The age category from 18 till 25 years has the second highest kilometre per person in a year. However, in this case public transport is a lot more dominant mode. Still, the car is used the most, but public transport is highest in this category.

This difference between public transport use in the age category in 18 till 25 years and the other categories can, perhaps, be linked to the student travel card. Going to higher education gives you the right, in the Netherland, to travel freely with public transport. This can make public transport use more convenient for students.

Car ownership amongst the age category 18 till 30 years has also declined over the last decade. Furthermore, these people are driving less kilometres by car in 2015 than a decade earlier (CBS, 2017). On top of that, people within the age category 30 till 50 years are also driving less kilometres by car. This means that, notwithstanding the fact they are the greatest group who drives a car, their car use is reduced (CBS, 2017).

Figure 2: car and public transport use across different age categories over 2016 in kilometres per person



Data source: CBS

Van der Loop, Bakker, Savelberg, Kouwenhoven and Helder (2018) analyses the growth in the use of trains between 2005 and 2016, which is 24 percent in this period. They found explanatory variables for this growth, however, two of them led to a decrease. These are the increasing costs of a train ticket and the ownership of a car. The increase of students, the population and the quality of service of the train have a relatively big explanatory power. The quality of service is determined by train frequencies, a bigger network and better transfer between trains. Growth of the economy (income and jobs) have relatively little explanatory power, which is due to, as explained by the authors, the travel motives. People travel more for leisure with public transport rather than work related motives. Furthermore, the leisure trips explain a relatively big part of the total growth in public transport (Van der Loop et al., 2018).

Kalter, Harm and Geurs (2015) analysed the preference, attitudes and behaviour for different transport modes among Dutch citizens. They categorized three kind of transport modes; the car, bike and public transport. Public transport is further categorized into train,

metro, tram and bus. The data is collected through surveys. Attitudes of different transport modes become more positive when people frequently travel with the same mode. People who travel frequently with public transport, have more positive attitudes towards it, however, they still have positive attitudes towards the car and bike. On the other hand, frequent car drivers and cyclists have more negative attitudes against public transport. Furthermore, attitudes towards the train are different to attitudes towards the bus, metro or tram (Kalter, Harm & Geurs, 2015).

Public transport is seen as the most save transport mode, however, it is lowest in comfort, travel time and flexibility compared to the car and bike (Kalter, Harm & Geurs, 2015). Furthermore, women, youngsters and elderly have a more positive attitude towards public transport. The main causes for shifting into a different transport mode were changes in attitudes towards transport modes, the composition of households, a new job or a new work address.

CHAPTER 3 DATA AND METHODOLOGY

3.1 DATA COLLECTION AND DESCRIPTION

To test whether the student travel card has an effect on future travel behaviour by public transport, data must be collected. This will be done with the help of surveys. The target group of the questionnaires are alumni who were in the possession of the student travel card during their studies and alumni who did not own the student travel card. The surveys contain questions about the use of public transport during college and the use of public transport present day.

The surveys will be taken anonymously and online which will be distributed through various websites. The data provided by the surveys will then be examined with the help of a regression analysis. The data will be compared if alumni travel more or less with public transport after graduation and whether there is a difference between the people who owned the student travel card and the people who did not.[1]

In total there are 227 complete surveys collected, 111 men, 107 women and 9 individuals who did not wanted to tell their gender. Also, there are 170 individuals who were in the possession of a student travel card, and 57 who did not own a student travel card during their studies. Furthermore, 222 respondents filled in their age in years, which ranges from 19 years old till 85. The age on average is 37.

The survey is displayed in appendix B, however, a brief summary of the survey will be given. In total there are four blocks. Block 1 contains five questions about public transport use during respondent's college time. The questions are as follows; ownership of the student travel card, whether you had a car at the disposal, travel frequency, travel motive and an average grade (1 = worst 10 = best) of travelling with public transport. Block 2 contains five

[1] If in the paper 'travel' is stated without further explanation, it refers to travelling with public transport.

questions about public transport use nowadays. These questions are about the difference in travelling between now and college time, travel frequency, reason for the difference, whether the student travel card made the respondents aware of the use of public transport and whether they are aware of the polluting effects of the car.

Block 3 and 4 consists of some general questions about public transport and the individuals itself. They were asked to grade (1 = worst 5 = best) the cost, waiting times, information and accessibility from their home and destination of public transport. After these questions, there are questions about if there is any positive change implemented in the above-mentioned factors, whether the respondents would use public transport more often. Furthermore, respondents were asked if they associate public transport with students, safety, environmentally friendly and/or a mode of transport for people with lesser income. At last they were asked to grade (1 = worst 10 = best) current public transport and whether they have a car at their disposal. All the variables that are obtained from the surveys are summarized in appendix B table 1.

Looking further into the surveys, 96 people used public transport during college because of the costs of public transport. Furthermore, 48 people used public transport due to the ease of use of public transport. Only 21 individuals did not travel during college with public transport. The average grade the respondents gave to public transport during their college time is a 6.7. However, there is a difference between the people who had the student travel card and the people who did not. The people who did, gave public transport in the past a 6.9, while the people who did not own the student travel card gave public transport a 6.2.

Nowadays, public transport is used less by the respondents. 100 individuals reported that they never travel with public transport. Furthermore, the average grade public transport gets is a 6.4. It is still a sufficient, however, it is lower than the average grade people gave public transport during college. Again, there is a difference between the two groups of alumni, however, the absolute difference became smaller compared to the college time. On average the people who were in the possession of the student travel card gave public transport a 6.5 and the people who did not, gave public transport a 6.1.

3.2 METHODOLOGY

To test the effect of the student travel card on later travel behaviour an ordered logistic regression is generated. This is due to the dependent variable. The dependent variable will be how many times per week the respondents travel with public transport nowadays. Because this variable is categorized in four groups of ordinal scale (5-7 days, 3-4 days, 1-2 days and never) the ordered logistic regression is appropriate to use. With this type of regression, a categorized variable of ordinal scale can be tested, with several independent variables that are continuous, ordinal or categorical. Furthermore, some statistical test will be made to see whether the respondents, categorized into groups, significantly differ from each other. This is done by the Kruskal-Wallis test. The Kruskal-Wallis test is chosen instead of one-way ANOVA, because it cannot be assumed that the variables are of a normal distribution. Furthermore, because of ties in the data set, the chi-squared with ties is used to see whether the tests are significant.

To obtain the correct regression and tests, the data has to be altered. First, respondents who incorrectly reported their age are marked as missing. These observations will be dropped from the regression analysis. Furthermore, the variable cost is categorized into three groups; bad, neutral and good. People who graded the cost of public transport with a 1 or 2 are into the group ‘bad’. Respondents who graded a 3 are in the group ‘neutral’, and the respondents who graded the cost a 4 or 5 are grouped together in ‘good’. This is done due to the fact only five respondents graded the cost of public transport a 5. Not grouping this variable together will lead to a violation of the proportional odds assumption of the ordinal logit regression.

Finally, some variables will be included as dummy variable. These are the student travel card, travel mode for students, less fortunate and the environment, male, and having a car at the disposal. The variables that will be included as categorical variables are travel college time, accessibility from home and destination, cost of public transport, information and the household. Age is included as a continuous variable.

The robustness checks include a VIF test and a brant test. The VIF test, tests whether there is multicollinearity in the regression. However, this test can only be done after an OLS regression. Since the data is being analysed with an ordered logistic regression the VIF test cannot be generated. Therefore, the optimal model will be run as an OLS regression. This will chance the coefficients, however, collinearity will be the same in the OLS regression as in the ordered logistic regression. Multicollinearity only affects the independent variables and not the dependent variable. Hence, whether an OLS regression or ordered logistic regression is used, does not affect the collinearity in the model.

CHAPTER 4 RESULTS

Before starting the regression analysis, it is interesting to see whether there is any significant difference between the alumni who were in possession of the student travel card and the alumni who did not. Therefore, a Kruskal-Wallis test is generated.

First is to see whether there was a statistical difference between the alumni with and without the student travel card and their travel behaviour during college and nowadays. The results are shown in table 1. Both tests are significant and thus show that there is a difference between the people who owned the student travel card and not. To see which group travelled more during college and travels more nowadays, averages of the two groups are determined. These are also listed in table 1.

The travel variables are sorted as follows; 1 means 5 to 7 days of travel per week, 2 means 3 to 4 days of travel per week, 3 means 1 to 2 days travel per week and 4 means never. So, the lower the average, the more people have travelled or travels multiple times per week. As can been seen, the averages for the group of people with the student card are lower than the group of people without the student travel card. This means that people with the student travel card significantly differ from people without the student travel card, and that they travelled more during college and travel more nowadays.

Table 1: Kruskal-Wallis test results and averages

	Travel with public transport during college	**Travel with public transport present day**
Probability	0.0001	0.0232
Average student travel card	1.6	2.8
Average no student travel card	2.7	3.3

Secondly, the difference between travelling during college with public transport and travelling nowadays with public transport is being analysed. In total 144 respondents stated to travel less with public transport nowadays and thirty respondents travel more. 53 respondents indicated that their travel habits with public transport remained the same and 30 people stated that their travel habits have increased. It is important to see why they travelled during college and why there is a difference between then and now.

During college, most of the respondents travelled five to seven days per week with public transport, namely 114. Another 45 respondents travelled three to four days, 47 travelled 1 to 2 days and only 21 respondents never travelled with public transport. Furthermore, only sixty respondents were in the disposal of a car. Nowadays, the biggest group of people is those who never travel with public transport, namely 100. Second biggest is the group who travel 1 to 2 days per week, 56 respondents. 33 respondents travel 3 to 4 days and 38 respondents travel 5 to 7 days with public transport. Furthermore, there is a shift in having a car available nowadays. 176 respondents have a car at their disposal.

Looking at the reason why people travelled with public transport during college, it is mainly due to the fact that they travelled with public transport because of the costs. Furthermore, the ease of use of public transport is an important factor why the travelled with public transport. Another big reason why they travelled with public transport is the distance and not having a car available.

In the survey respondents were asked what the reason was for the difference between travelling during college and nowadays. The results for all options are summarized in table 2. Respondents could choose more than one answer, so the total reasons do not add up to the total number of respondents. There are three main reasons for the difference in travelling with public transport. These are the cost of public transport, the travel time and having new activities (like a new job). The distance from their home address is also a relatively big factor. Furthermore, 22 of the 49 respondents who answered other, noted that the difference was mainly due to the fact that they now have a car.

Table 2: reason for difference of travel behaviour between college time and nowadays

Reason for difference	**number of respondents**
1= costs of public transport	79
2= travel time of public transport	75
3= improvement of public transport	14
4= decline of public transport	12
5= other activities	74
6= distance to public transport (from home address)	53
7= change in income	30
8= change in household	21
9= public transport is better for the environment	17
10= public transport is worse for the environment	0
11= Other	49
12= No difference	24

Finally, the results for the questions about the positive change of some aspects of public transport is being analysed. The respondents were asked when some aspects of public transport are improved, whether they would travel more with public transport or not. These aspects refer to the cost, waiting times, information and accessibility to public transport from home and destination. The results are shown in table 3 As can be seen, most respondents would increase their public transport use for all aspects except for the improvement of information.

Table 3: change of travel behaviour with improvements of public transport.

Aspect of improvement	Yes	No	I do not know	Percentage
Reduction in costs	131	59	37	53%
Reduction in waiting times	116	76	35	51%
Improvement of information	61	121	45	27%
Improvement of accessibility from home address	102	97	28	45%
Improvement of accessibility from destination	134	67	26	59%

After these tests and analysis, it is important to see whether the student travel card has a significant direct effect on travelling with public transport after graduation. The dependent variable of the regression is how many times the respondents travel with public transport per week nowadays. The independent variable is whether the respondents had a student travel card or not. Several control variables are based on the former literature about factors that influence the use of public transport and the above analysis. Therefore, the proximity of public transport from home and destination, cost of public transport, past behaviour, information and perception in terms of income, student travel mode and the environment are included into the model. The results are shown in table 4.

In total there are four models generated. All with the same dependent variable, travel behaviour by public transport, and the same independent variable, the student travel card. Model 1 and 3 are the full model, the only difference is that in model 3 the travel behaviour during college is included. Model 2 excludes the perceptions of public transport, because only the perception for an inferior good is based on theory. Model 4 excludes the perceptions but includes the past travel behaviour.

Because the student travel card can have an influence on past travel behaviour, the correlation between the two must be checked, to prevent the model to be subjected to multicollinearity. A correlation of eighty percent is alarming. The correlation between past

behaviour and the student travel card is 64 percent. Although the correlation is under eighty percent, the student travel card and past behaviour still have a high correlation with each other.

To see whether the model is still correct a VIF test is made to show whether there is multicollinearity or not (based on model 3). A level of 4 in the VIF test needs further investigation, and a level of 10 or higher indicates serious multicollinearity and thus a correction has to be made for the variable in question. The student travel card has a value of 2.29 and past behaviour, 3 to 4 days per week, 1 to 2 days per week and never have respectively values of 1.26, 1.46 and 1.45. This means that past behaviour can be included into the model together with the student travel card.

To choose between the models, the Bayesian information criterion is conducted. The preference of the Bayesian information criterion over the Akaike information criterion, is that it penalizes an extra parameter more. The outcome is shown in table 4. The results suggest that model 2 is the preferred model, without past behaviour and without the perceptions. Henceforth, the results from model 2 will be discussed. Worth mentioning is that the perception of public transport in both model 1 and 3 were not significant, and thus have no explanatory power of travel behaviour with public transport.

The results show five significant variables; three at the five percent level and two at the ten percent level. The variable of interest, student travel card, has a negative significant effect on the dependent variable, travel behaviour. Because the dependent variable is ordered with value 1 as being the most travelling by public transport (5 to 7 days per week) and value 4 being the least (never), this result suggest that people who owned the student travel card travel more with public transport nowadays than people who did not own the student travel card. The log-odds for being in a higher category for people who owned the student travel card is 0.8788 less than people who did not own the student travel card c.p. The marginal effects from the coefficients will be discussed later in this section.

Table 4: results regression analysis with present travel behaviour as dependent and BIC

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Student travel card	(0.8232) *	(0.8788) *	(0.6371)	(0.7099)
Travel college time				
2			0.8461**	0.7913**
3			0.9254**	0.8381*
4			0.6354	0.8437
Accessibility from home				
2	0.291	0.2172	0.4635	0.3644
3	(0.357)	(0.4112)	(0.3236)	(0.3495)
4	(0.6572)	(0.7217)	(0.7851)	(0.8453)
5	(0.5498)	(0.6071)	(0.5319)	(0.58)
Accessibility from destination				
2	(0.4313)	(0.4111)	(0.4363)	(0.3706)
3	(1.712) **	(1.7797) **	(2.0559) **	(2.0519) **
4	(2.651) **	(2.6894) **	(2.8167) **	(2.7805) **
5	(3.215) **	(3.3621) **	(3.3224) **	(3.3957) **
Cost of public transport				
Neutral	0.19	0.1886	0.2797	0.2624
Good	(0.468)	(0.4023)	(0.5958)	(0.5)
Information				
2	0.5552	0.6673	0.7236	0.834
3	0.1837	0.2096	0.3404	0.3747
4	0.5213	0.5564	0.7056	0.7448
5	0.25	0.2775	0.2732	0.2849

Travel mode for students	0.3283		0.3591	
Travel mode for less fortunate	0.4114		0.4291	
Travel mode for the environment	(0.4376)		(0.5591)	
Male	(1.2119) **	(1.159) **	(1.1768) **	(1.1184) **
Age	0.0042	(0.0009)	(0.0005)	(0.0061)
Household				
2	(0.6749) *	(0.6167) *	(0.7214) *	(0.6596) *
3	0.5639	0.6245	0.7299	0.7635*
Car at the disposal	2.1932**	2.1491**	2.2574**	2.2196**
BIC	561.811	550.307	571.260	560.453

*/** is significant at 10/5 percent level

The accessibility of public transport from the destination has a negative significant effect for the categories 3, 4 and 5. These represents the grades respondents gave to accessibility with 1 being the worst and 5 being the best. The log odds for being in a higher category for people who graded accessibility with a 3 is 1.7797 less than for people who graded a 1 c.p. The log odds for being in a higher category for people who graded accessibility with a 4 is 2.6894 less than for people who graded a 1 c.p. The log odds for being in a higher category for people who graded accessibility with a 5 is 3.3621 less than for people who graded a 1 c.p. This means that people who graded accessibility of public transport from the destination a 3 or higher travels significantly more with public transport, than the respondents who graded a 1.

Furthermore, the variable male has a negative significant effect. The log odds for being in a higher category for man is 1.159 less than for woman c.p. This means that man travel significantly more with public transport than woman. Also, the households without children has a significant negative effect on travel behaviour. The log odds for being in a higher category for household without children is 0.6167 less than for singles, meaning that these

households travel more with public transport than singles c.p. Finally, car has a positive significant effect on travel behaviour. The log odds for being in a higher category when having a car is 2.1491 more than people who do not have a car c.p. This means that people with a car at their disposal travel less with public transport than people who do not have a car.

To put these numbers into meaning, the marginal effects has to be generated. To compute the marginal effects the mean of all the variables is taken. This is chosen rather than to compute all the marginal effects and take the average from these outcomes. Because of this choice, the marginal effects of a so-called 'representative agent' is computed. The effects show how this agent behaves, which is the average person. On the other hand, average marginal effects show the average effect of the population. As this study focusses on the relationship between the student travel card and later travel behaviour, it is more interesting to look at the average person, rather than the whole population. However, the average marginal effects are also generated and placed in the appendix (see appendix C, table 1). The marginal effects at the mean are shown in table 5.

As can be seen, the student travel card has a significant effect on 5 to 7 days at the 5 percent level and at the 10 percent level for 3 to 4 days and never travelling with public transport. There is no significant effect on travelling 1 to 2 days. So, owning a student travel card in the past gives a 5.2 percent higher chance to travel nowadays 5 to 7 days with public transport than for people who did not own a student travel card, a 7.4 percent higher chance to travel 3 to 4 days and 21.5 percent less chance to never travel with public transport.

The marginal effects on travelling 5 to 7 days are as follows; individuals who graded the accessibility as 3 have 5.7 percent more chance than people who graded accessibility as 1, individuals who graded the accessibility as 4 have 14.4 percent more chance than people who graded accessibility as 1 and individuals who graded the accessibility as 5 have 25.4 percent more chance than people who graded accessibility as 1. Furthermore, being a man gives an 8.4 percent higher chance to travel with public transport and having a car reduces the chance to travel 5 to 7 days with 26.1 percent.

The marginal effects on travelling 3 to 4 days are as follows; individuals who graded the accessibility as 3 have 9.6 percent more chance than people who graded accessibility as 1, individuals who graded the accessibility as 4 have 18.8 percent more chance than people who graded accessibility as 1 and individuals who graded the accessibility as 5 have 24.3 percent more chance than people who graded accessibility as 1. Again, being a man gives a 10.7 percent higher chance to travel 3 to 4 days than women and having a car reduces the chance with 18.5 percent.

The marginal effects on travelling 1 to 2 days are as follows; individuals who graded the accessibility as 3 have 23.1 percent more chance than people who graded accessibility as 1, individuals who graded the accessibility as 4 have 25.1 percent more chance than people who graded accessibility as 1 and individuals who graded the accessibility as 5 have 18.6 percent more chance than people who graded accessibility as 1. The only other variable that has a significant effect on travelling 1 to 2 days is male. A man has 8.3 percent more chance to travel 1 to 2 days with public transport than women.

Finally, the marginal effects for never travelling with public transport are as follows; individuals who graded the accessibility as 3 have 38.4 percent less chance to never travel with public transport than people who graded accessibility as 1, individuals who graded the accessibility as 4 have 58.3 percent less chance than people who graded accessibility as 1 and individuals who graded the accessibility as 5 have 68.4 percent less chance than people who graded accessibility as 1. Male have 27.4 percent less chance to never travel than female, and households without children have 13.7 less chance to never travel with public transport than singles. Having a car at the disposal increases the chance to never travel with public transport with 41.1 percent.

Table 5: marginal effect at the mean, based on model 2. The significant variables only are displayed (including the non significant categories of that variable)

Variables	**Marginal effect on 5 to 7 days**	**Marginal effect on 3 to 4 days**	**Marginal effect on 1 to 2 days**	**Marginal effect on never**
Student travel card	0.0522**	0.0744*	0.0887	(0.2153) *
Accessibility from destination				
2	0.0062	0.0122	0.0499	(0.0683)
3	0.0571**	0.0962**	0.2311**	(0.3844) **
4	0.1442**	0.1882**	0.251**	(0.5833) **
5	0.2544**	0.2431**	0.1864*	(0.6839) **
Male	0.0844**	0.1065**	0.083**	(0.2739) **
Household				
2	0.0572	0.063	0.0168	(0.137) *
3	(0.0345)	(0.0511)	(0.0691)	0.1547
Car at the disposal	(0.2611) **	(0.1848) **	0.0354	0.4105**

To see whether the results are valid, some robustness checks are done. The model is checked whether there is no multicollinearity and if the assumption of proportional odds holds. The former influences how meaningful the results are and means that two independent variables cannot be highly correlated with each other, the latter means that the independent variables have an identical effect on the different groups of the dependent variable, in this case travel behaviour which is sorted into four groups.

For the assumption of proportional odds, a brant test is generated right after the ordered logistic regression. A significant test result shows a violation of the proportional odds assumption. The test showed a p-value of 0.2761, which is higher than the 10 percent significant level. This means that the model does not violate the proportional odds assumption.

To check for multicollinearity, a VIF test is done after the regression. As mentioned before, a value of 4 means further investigation and a value of 10 means serious multicollinearity. The average VIF value is 3, and there are four variables higher than 4, these are accessibility from home and destination, information and cost. To look whether these are correlated with another independent variable a polychoric correlation matrix is generated (see appendix C, table 2). The matrix shows no high correlation for any variables, thus assuming multicollinearity does not exist.

CHAPTER 5 CONCLUSIONS AND DISCUSSION

In this paper the effect of the student travel card on later travel behaviour with public transport is investigated. The motivation for this research are the polluting effects of car use, especially, in the Randstad area of the Netherlands. Earlier research about public transport showed that the proximity of public transport, waiting and travel times, income and past behaviour have an influence on the use of public transport. Data is collected via online surveys, which are in turn used to examine the effect of the student travel card with help of an ordered logistic regression.

The research question of this paper was:

Does the student travel card have an influence on later public transport use among alumni?

From the analysis, it became clear that the student travel card has an effect on later travel behaviour with public transport. This relationship is positive, which means that if an individual was in ownership of a student travel card, he or she travels nowadays more with public transport than an individual who did not owned a student travel card. However, important to note is that having a car at the disposal has a stronger effect on travel behaviour in comparison with the student travel card. This effect is negative, meaning that having a car available decreases the use of public transport. Furthermore, the negative effect of the car is bigger than the positive effect of public transport.

In summary, the student travel card has a positive effect on later public transport behaviour, however, having a car has a stronger negative effect on travel behaviour. This means that after graduation, when the option arises to having a car and want to have a car, in general people will not travel with public transport, even though they are more familiar with it through the student travel card. The car is still a dominant factor in determining how people travel to various places. To stimulate public transport, other policies are required besides getting familiar with public transport.

Policies to improve public transport has to involve economic incentives. Many respondents of the survey reported that the cost of public transport was one of the reasons why they do not travel as much with public transport as during their college time. Big public transport companies, like the NS, can start with offering lower rates to promote public transport. However, as the NS regulates transport with train, companies who regulate busses, tram and metro have to cooperate to lower the prices, as these transport modes are also used to get to a train station or other destinations.

On the other hand, instead of lowering fares of public transport, increasing the price of car use can push people to use public transport. The price of public transport can be easily retrieved, the fare. However, the price of car use is not that straight forward. The purchase, insurances, taxes, maintenance and fuel all have an influence on the price. Increasing the price of these factors can reduce the car use and increase the use of public transport. Furthermore, as many companies provide a car for their employees, workers are more reluctant to use public transport. If these companies invest in public transport for their employees instead of cars, the public transport use by these employees can increase.

The research was subjected to some limitations. First of all, the research is about public transport in general. Therefore, the analysis does not take care of the different types of public transport. As some respondents also noted, there are differences between the different types of public transport, bus, tram, metro and train. These differences are shown in various aspects, including the service of the type of mode. Categorizing the different type of transport modes could yield different outcomes in the analysis.

Second of all, for the simplicity of the research, transportation by bike and walking is not included. This is done to compare the car with public transport. However, there are people who walk or ride a bike to their destination. Finally, the home location of people could have changed during college, which could affect the number of times they travelled by public transport. The current location from home could also have an influence on the travel

frequency, as not all areas in the Netherlands are easily accessible by public transport. These two are not accounted for in the analysis, which can lead to an omitted variable bias.

For future research it is interesting to see whether the student travel card has different effects on the different types of public transport. As different modes have different travel experiences, the effect could also be diverse. Furthermore, it is important to see whether alumni travelled with one specific public transport mode during college. Frequency of use can turn into a habit. If alumni travelled with one specific mode of public transport, this can be preferred over the other modes of public transport.

Furthermore, to make the research even more accurate, transportation by bike or walking should be included, likewise for the current residence location, and the residence location during college. These factors can influence travel behaviour by public transport. With these factors included, the omitted variable bias could be prevented.

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APPENDIX A

Car, public transport and other modes use across different age categories over 2016 in kilometres per person

	Total	**18-25 years**	**25-35 years**	**35-50 years**	**50-65 years**	**65-75 years**	**older than 75**
Car (driver)	5291	4255	8464	8776	7262	4236	1815
Car (passenger)	2169	2507	2357	1631	1646	1515	1346
Train	980	3510	1683	756	873	555	.
Bus, tram & metro	317	1332	406	206	196	135	108
Total (incl. walking, bike moped and other transport modes)	10264	13081	14405	12768	11571	7861	4517

APPENDIX B

Hallo, en bedankt voor het deelnemen aan mijn enquête. Ik ben een student aan de Erasmus Universiteit Rotterdam. Voor mijn afstudeeronderzoek doe ik onderzoek naar het studentenreisproduct (voorheen OV-studentenkaart). De enquête zal ongeveer … minuten in beslag nemen en is geheel anoniem. Alvast bedankt voor het invullen.

Blok 1

De volgende vragen gaan over het gebruik van openbaar vervoer **tijdens uw studententijd**

1. Was u in het bezit van een studentenreisproduct (voorheen OV-studentenkaart)?
    - Ja
    - Nee

2. Had u een auto tot uw beschikking?
    - Ja
    - Nee

3. Over uw gehele studietijd bekeken, ging u gemiddeld regelmatig met het openbaar vervoer?
    - 5 tot 7 dagen per week
    - 3 tot 4 dagen per week
    - 1 tot 2 dagen per week
    - Nooit

4. In het algemeen, tijdens uw gehele studietijd, wat was de voornaamste reden om met het openbaar vervoer te reizen?
    - Reistijd
    - Reiskosten
    - Gebruiksgemak

- Sfeer
- Efficiëntie voor het milieu
- Anders, namelijk
- N.v.t.

5. Hoe ervaarde u het reizen met het openbaar vervoer tijdens de studententijd? (1 = slechtst en 10 = best)
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10

Blok 2

De volgende vragen gaan over het gebruik van openbaar vervoer **in het heden**

6. In vergelijking tot uw studententijd, tegenwoordig reist u meer, minder of (ongeveer) evenveel met het openbaar vervoer?
    - Minder
    - Ongeveer gelijk gebleven
    - Meer

7. Hoe vaak reist u tegenwoordig met het openbaar vervoer?
    - 5 tot 7 dagen per week
    - 3 tot 4 dagen per week
    - 1 tot 2 dagen per week
    - Nooit

8. Wat is de reden voor het verschil in reizen met het openbaar vervoer tussen nu en uw studententijd? Er zijn meerdere antwoorden mogelijk.
    - Kosten van het openbaar vervoer
    - Reistijd van het openbaar vervoer
    - Verbetering van het openbaar vervoer (veiligheid, schoon, efficiënter etc.)
    - Verslechtering van het openbaar vervoer (veiligheid, vies, minder efficiënt etc.)
    - Andere activiteiten (bijv. nieuwe baan)
    - Afstand tot het openbaar vervoer (vanaf uw thuisadres)
    - Verandering in inkomen
    - Verandering in huishouden
    - Openbaar vervoer is beter voor het milieu
    - Openbaar vervoer is slechter voor het milieu
    - Anders, namelijk
    - Geen verschil

9. Stelling: door het studentenreisproduct (voorheen OV-studentenkaart) ben ik bewust geworden in het gebruik van het openbaar vervoer (informatie verkrijgen over reistijden en perrons, reizen, vertragingen, huisregels etc.)
    - Juist
    - Onjuist

10. Bent u zich bewust van de milieuvervuilende effecten van de auto?
    - Ja, en probeer de auto zo min mogelijk te gebruiken
    - Ja, maar verander mijn autogebruik niet
    - Nee

Blok 3

De volgende vragen zijn **algemene vragen over het openbaar vervoer.**

In het algemeen, op een schaal van 1 tot 5 (1 het slechts, 5 het beste), wat vindt u van de;

11. Kosten van het openbaar vervoer
12. Wachttijden van het openbaar vervoer
13. Informatie gegeven m.b.t. wachttijden, reistijden en vertragingen
14. Bereikbaarheid vanuit uw huis tot het openbaar vervoer
15. Bereikbaarheid tot uw bestemming vanaf het openbaar vervoer

Mocht het volgende doorgevoerd worden zou u dan **meer** gebruik maken van het openbaar vervoer? (Ja/nee/weet ik niet)

16. Verlaging in de ticketprijzen
17. Minder lange wachttijden
18. Informatie beter aangegeven
19. Betere bereikbaarheid vanuit uw huis tot het openbaar vervoer
20. Betere bereikbaarheid tot uw bestemming vanaf het openbaar vervoer

Associeert u het openbaar vervoer als; (ja/nee)

21. Vervoersmiddel voor studenten
22. Veilig vervoersmiddel
23. Milieuvriendelijk vervoersmiddel
24. Vervoersmiddel voor minder welvarende mensen

25. Welk cijfer zou u het huidige openbaar vervoer geven? (1 = slechtst en 10 = best)
    - 1
    - 2
    - 3
    - 4

- 5
- 6
- 7
- 8
- 9
- 10

Blok 4

Algemene vragen

26. Wat is uw geslacht?
    - Man
    - Vrouw
    - Ik wil het niet zeggen

27. Wat is uw leeftijd in jaren?

28. Wat is uw huishouden?
    - Alleenstaand
    - Samenwonend, zonder kinderen
    - Samenwonend, met kinderen

29. Wat is uw viercijferige postcode?

30. Heeft u een auto tot uw beschikking?
    - Ja
    - Nee
    -

31. Opmerkingen

Table 1: variable description

Variables	**Description**
Current public transport travel behaviour	1= 5 to 7 days
	2= 3 to 4 days
	3= 1 to 2 days
	4= never
Student travel card	1= Yes 0= No
Car at the disposal during college	1= Yes 0= No
Travel college time	1= 5 to 7 days
	2= 3 to 4 days
	3= 1 to 2 days
	4= never
Reason for travel during college	1= Travel time
	2= Travel cost
	3= Ease of use
	4= Atmosphere
	5= Environmental friendly
	6= Other
	7= n.a.

Grade public transport during college	1 = worst 10 = best
Difference in travel after graduation	1= Less
	2= Same
	3= More
Reason for difference	See table …
Statement student travel card	1= True 0= False
Environmentally conscious	1= Yes, and less car use
	2= Yes, no change in car use
	3= No
Cost of public transport	1 = worst 5 = best
Waiting times of public transport	1 = worst 5 = best
Information	1 = worst 5 = best
Accessibility from home	1 = worst 5 = best
Accessibility from destination	1 = worst 5 = best
Positive change in cost	1= Yes 2= No 3= I do not know
Positive change in waiting times	1= Yes 2= No 3= I do not know

Positive change in information	1= Yes 2= No 3= I do not know
Positive change in accessibility from home	1= Yes 2= No 3= I do not know
Positive change in accessibility from destination	1= Yes 2= No 3= I do not know
Travel mode for students	1= Yes 0= No
Travel mode for safety	1= Yes 0= No
Travel mode for the environment	1= Yes 0= No
Travel mode for less fortunate	1= Yes 0= No
Grade public transport nowadays	1 = worst 10 = best
Male	1= Male 0= Female
Age	In years
Household	1= Single
	2= household without children
	3= household with children
Car at the disposal	1= Yes 0= No

APPENDIX C

Table 1: Average marginal effects based on model 2. The significant variables only are displayed (including the non-significant categories of that variable)

Variables	**Marginal effect on 5 to 7 days**	**Marginal effect on 3 to 4 days**	**Marginal effect on 1 to 2 days**	**Marginal effect on never**
Student travel card	0.076*	0.038*	0.0267	(0.1407) *
Accessibility from destination				
2	0.0134	0.0147	0.0292	(0.0573)
3	0.0948**	0.0763**	0.12**	(0.2912) **
4	0.1891**	0.1214**	0.1439**	(0.4544) **
5	0.2821**	0.1484**	0.1267**	(0.5572) **
Male	0.1103**	0.0478**	0.025**	(0.1831) **
Household				

2	0.0654*	0.0261	0.0062	(0.0976) *
3	(0.0510)	(0.0283)	(0.0232)	0.1026
Car at the disposal	(0.2719) **	(0.0873) **	0.026	0.3332**

Table 2: polychoric correlation matrix

	Travel behaviour	Student travel card	Accessibility from home	Accessibility from destination	Cost of public transport	Information	Male	Age	Household	Car at the disposal
Travel behaviour	1									
Student travel card	-.23876415	1								
Accessibility from home	-.26264792	.13862792	1							
Accessibility from destination	-.45893971	-.02212871	.48801197	1						
Cost of public transport	-.21692517	-.1813281	.12920271	.1943145	1					
Information	-.00338925	.16513212	.22347111	.09219395	.03543255	1				
Male	-.1850918	.03229547	-.28492924	-.32954479	.20128829	-.23608626	1			

Age	.19865997	-.77415126	-.0602543	.07250254	.20703745	-.16863346	-.0199622	1		
Household	.28782119	-.10738904	-.02127882	.03049841	-.10678975	.04575192	-.133256	.33404773	1	
Car at the disposal	.66818999	-.40448122	-.13277175	-.17309495	-.11692903	-.06378991	-.10697948	.43729111	.59211942	1