MODELING LONG TERM DYNAMICS OF MODE CHOICE FOR SOCIAL TRIPS

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ABSTRACT

In the field of transportation, several studies have researched commute mode choice and its dynamics in the short and long term. Relatively less is known about mode choice for discretionary and more flexible activities, such as social visits. These choices are also dynamic and depend on personal habits and preferences, reflected to some extent by the history of similar choices, in addition to other socio-demographic factors. Using a dataset collected in the Netherlands in 2011, a multinomial logit model of mode choice was developed. Results suggest that mode choices for social activities are path dependent, yet not entirely, there is also evidence of switching towards faster and more flexible modes after a life cycle event.

Keywords: Mode choice, Social travel, Long term dynamics, Path dependency

BACKGROUND

Social trips are unique because they are both discretionary and obligatory for people. There is flexibility in terms of mode choice, duration, location, time of the day, etc but at the same time people are obligated to make social visits. Some of these visits are regular, such as, periodical visit to children and parents and some are irregular in nature. In transportation research however this facet of travel behavior is rather under-investigated, despite the increasing number of social trips every year. In the Netherlands, for example, more than 15% of all trips and more than 20% of the total volume of passenger kilometres travelled are made for social visits.

In this study, we concentrate on mode choice for social trips. This choice potentially should reflect one's preference, awareness to environmental sustainability and economic and social status. We assume that people may wish to maximize their preference, comfort and flexibility during those trips and choose accordingly. Therefore, the findings would provide insights towards people's preference and habitual behaviour.

Scholars have documented several factors that affect mode choice for social and leisure trips. Van den Berg (et al 2012) found effects of socio demographic variables, location and distance on mode choice for social trips. Schwanen (et al 2001) studied leisure travel mode choice in the Netherlands for older people. They found that urbanization correlates with public transport facilities and in rural areas public transport is substituted by bicycle trips. They also conclude that a better public transport take people away from bicycles rather than making them switching from car. Schmöcker (et al 2008) found similar results for seniors' shopping trips in the UK. They report that age and disability interaction and marginal costs related to a particular mode influence mode choice. However, our knowledge about social travel mode choice is still limited.

Particularly, from a long term dynamics point of view, studies related to social travel mode choice is rare. We argue that like any other decision making analysis, mode choice for social trips should also be studied including the effect of history of choices. Furthermore, the modes individuals choose to commute to work every day may also influence the mode they choose for social purposes. By including these effects, we seek to find answers to an important research question:

> Are mode choices for social trips path dependent or do people switch their mode choice for social trips after a life cycle event? If they do, in which direction do they switch towards?

The findings would also indicate to what extent are people driven by their habit and inherent preferences in terms of mode choice for social trips, in the sense that if they keep on choosing the same mode before and after life cycle events and the same mode they choose to commute with.

To that end, the study presents analyses of mode choice dynamics in the long term. To capture the dynamics life-cycle events were considered as triggers to these changes. An event-based retrospective survey was carried out in late 2011 in the Netherlands. Detailed information on social network and activity dynamics was collected from among 703 respondents.

THEORETICAL FRAMEWORK

History matters in every aspect of decision making process of individuals. The process is termed to be path dependent if the decision goes in the same direction as it has before. Path dependency has been used as a central concept to analyze historical inference in decision making process of institutions (Greener, 2002; Mahoney, 2000; Martin and Sunley, 2006; Pierson, 2000). The notion is widely used in political and economic geography. It was first explained by Noble Laureate Douglas North is his seminal book on institutional change and economic performances (North, 1990). He noted that path dependency is a way to narrow down the choice sets and to link decision making over time. In other words, it is a process that constraints future choice sets.

A number of terminologies are associated with the notion of path dependency, primarily used in policy evaluation studies. It was explained by terms such as 'reactive sequences' that are 'temporally ordered' or 'causally connected' (Pierson, 2000). From human behaviour perspective the notions can be inferred as individuals react and respond towards a particular choice set which are associated with their choices at a preceding and/or similar incident. Economics and technology policy evaluation studies refer to the notion of increasing returns as the cost to revert from a path usually is very high (Pierson, 2000). Although cost might not always be the factor, habits and constrained choice sets may overtake decision making process. A classic example in this regard was reported by Greener (2002), is the use of QWERTY keyboards. Despite the fact that efficient alternatives exist and that the cost of a path divergence in this case can be recovered in just ten days by the increased efficiency achieved, the QWERTY still continues to be the standard version. This phenomenon was described as inheritance overtaking choice (Rose, 1991). Habits, familiarity, inheritance and sense on belongingness therefore are of prime importance and could better explain the decision making process.

However one should be careful in making assumptions or deriving too simplistic conclusions based on path dependency effects only, particularly when testing new technologies. In those scenarios it is also important to understand the common sense and reasoning behind them. In a related study (Chen et al., 2009) examine history deposition effects in choice of residential neighbourhoods. In explaining the underlying process, they note that history influences choice in two ways. Under adaptive human behaviour perspective either individual becomes more tolerant to the negative attributes or more appreciative to the positive attributes associated with the choice that similar attributive features are chosen at a next stage. Under alternative hypothesis, one may become fatigued with a welcoming attribute or become rigid to an unwelcoming one. As a result of which soothing with a different or opposite set of attributes is chosen in the subsequent stage. They have found evidence towards the first hypothesis towards adaptive human behaviour.

In this study however without making any prior assumptions we are investigating social mode choice considering effects of history and habitual dependencies. The underlying motivation is explained here and the aspiration is that by incorporating path dependency effects we can better predict the choice of a particular travel mode for social travel purposes.

DATA, METHODOLOGY AND DESCRIPTIVES

Information about socio-demographics, social network and ego-alter tie characteristics, and social interaction dynamics were collected using an event-based questionnaire survey. Respondents were asked to choose one recent event from the event list provided at the beginning of the survey. Recent events were defined as events that took place within the past two years. The web-based and paper-based surveys were administered in September 2011 in the Netherlands. To cope with respondent and memory bias and reduce respondent-burden, respondents were asked questions about one (the most recent) life-cycle event. Respondents were asked to pick one event from a list provided that was the most recent one.

The survey was divided into four parts seeking information about socio-demographics of the respondent, the present social network, changes and new contacts (if any) in the personal social network and in activity-travel behaviour in response to the life-cycle event in question. The survey did not aim for all events, collected detailed information on the effects of one particular recent event. The first part collected socio-demographic details of the respondent including an estimate of the size of their present social network according to type of relationships.

In the second part, respondents were asked whether any change in the social network occurred as a result of the event. If yes, they were forwarded to a table where they had to list existing ties that involved a change and new ties that were formed. Furthermore, for each listed tie they had to fill out the type of change (geographical distance, frequency of contact per mode both before and after the event), the socio-demographics of the alter, information about the tie (strength, length known) for each of the alter where a change occurred. They also reported new ties and lost ties here. If there were no changes with a tie, they were not asked these details. The third part asked details about their close ties. Close ties were defined as those individuals with whom important information is shared, personal problems are discussed, help during emergency or daily necessities is asked and with whom regular contact exist. Respondents could mention up to 25 ties. Details include socio-demographics of the alter, geographical distance, frequency of interaction, relationship strength (on a five point scale) and length (in years). The ties already mentioned is part two were not repeated here. The fourth part of the survey asked about changes in activity-travel schedules before and after the event.

Majority of the respondents were recruited by a survey organization having a dedicated panel, representative of the Dutch population. In addition, a number of University students were sent out invitations, using the list of newly admitted students at the Eindhoven University of Technology. Respondents were selected based on the question whether any of the stated events had occurred in recent years in their life. Only if the answer was affirmative, the respondent could proceed with the questionnaire. The life-cycle events were

1. Residential relocation: change of residence
2. Getting married/divorced/cohabitation: change in civil status
3. Children starting school: any of the children of the household started school, who was not going to school before.
4. Starting new job: the respondent started a new job that involves a change in the workplace.
5. Starting University: respondents who have joined the University for higher education

A simple multinomial logit model of mode choice for social trips was developed. The dependent variable was calculated as the primary mode choice for social trips. The unit of measurement was social trips per week. Social trips are defined as visiting someone in individual's social network. Therefore they can safely be assumed as home-based trips. The data did not provide information on activity episodes, therefore if someone used multiple modes for social trips the mode he/she used most often was taken as the chosen mode. The unit of dependent variable therefore is the primary mode choice for social trips in a typical working week (including weekends). Each respondent has one record of their primary mode choice for social trips. After data imputation and cleaning 450 valid cases were selected for the analysis.

Descriptive statistics (Table 1) show that almost half of the respondents use slow modes, 39% use car and 11% use public transport for social trips. From a survey in 2008 in Eindhoven, it was reported that car is the dominant mode choice for social trips (van den Berg, 2012). However, it is to note that the survey did not consider Public Transport as a mode choice and the sample was based in Eindhoven only and not the entire country. Comparing with commute mode choice (Table 1), we observe that primary mode for commute to work is car (34%). Approximately 28% use slow modes and on 9% use public transport to go to work. The remaining either do not work or work from home.

A comparative analysis (Figure 1) of before and after event show that modal share has increased for car and slow modes after event. Modal share to cars increased 4% and use of public transport has decreased by 5%.

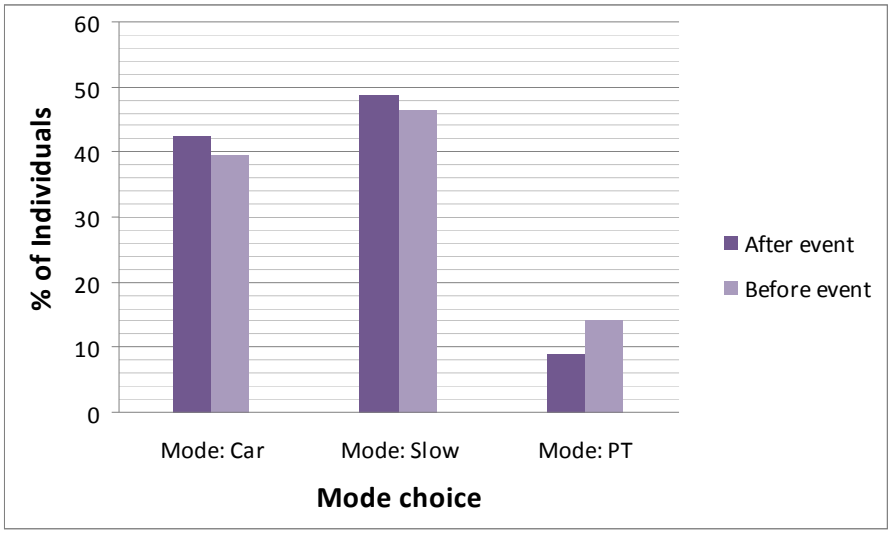

Figure 1: Mode choice for social trips before and after a life cycle event

Sample distribution suggests that it is slightly over-represented by young (age less than 30 years) respondents. Gender distribution is almost equal. Almost 40% of the respondents have a University degree. Note that education level is defined as the highest achieved education level. The sample in over-represented by highly educated people because many of the respondents are University students (as described in the sample selection part), who are

attending University and have not yet completed it. Therefore, they are coded in the second category.

Average number of children in the household is 1 and average household size in 3.39. The majority of the respondents have a paid job, while 25% are students. The average number of work hours per week is 22 (approximately). Most households have one car. 26% have two or more cars and 26% have no car.

Table 1: Descriptive statistics (450 cases)

Variable names	Details	Type	Mean or %
Age<30	Age less than or equal to 30 years	Categorical	35.8
Age>50	Age more than or equal to 50 years	Categorical	32.2
Age 30-50	Age between 30 to 50 years	Reference category	32
Male	Individual is male	Categorical	49.6
Female	Individual is female	Reference category	50.4
High education: y	Education level: University or higher-yes	Categorical	39.8
High education: n	Education level: University or higher-no	Reference category	60.2
#child in HH	Number of child in household	Continuous	0.98
#HH member	Household size	Continuous	3.39
SN size	Social network size	Continuous	23.89
Student	Student, no work	Categorical	25.3
Working	Working (part or full time)	Categorical	63.3
Not working	Not working: retired, unemployed, looking for work	Reference category	11.4
#Work hr	Work hour per week	Continuous	21.89
One car	One car in the household	Categorical	47.3
Two + car	Two or more cars in the household	Categorical	26.7
No car	No car in the households	Reference category	26
High urban	>2500 addresses per km^2	Categorical	23.1
Mid urban	500-1500 addresses per km^2	Categorical	28.7
Rural	<500 addresses per km^2	Reference category	48.2
Event time	Time since the event under consideration (in months)	Continuous	20.1
Commute mode: car	Primary mode to/from work: car	Categorical	33.6
Commute mode: slow	Primary mode to/from work: walk, bicycle	Categorical	28.4
Commute mode: PT	Primary mode to/from work: bus, train	Categorical	8.7
Dependent variable: mode choice			
Mode: Car	Mode choice after event: car	Categorical	39.3
Mode: Slow	Mode choice after event: walk, bicycle	Categorical	49.8
Mode: PT	Mode choice after event: bus, train	Reference category	10.9
Choice history (to measure path dependency effects)			
Car before	Mode choice before event: car	Categorical	35.6
Slow before	Mode choice before event: walk, bicycle	Categorical	43.3
PT before	Mode choice before event: bus, train	Reference category	9.1

Most respondents live in a rural area (address density less than 500 per km²), 28% live in mid urban area and 23% live in highly urbanized areas. Average time since the concerned event (the event under consideration, with respect to which the respondent is reporting all the changes) is 20 months.

DISCUSSION OF FINDINGS

The logit model estimates parameters for car and slow modes, public transport was taken as reference category. Mode choice car includes both car as driver and passenger. Slow mode is defined by walking and bicycling. Public transport comprises bus, train, metro and tram.

The rho square value is high, indicating a high goodness of fit of the model. The constants are positive for the choice of car and slow modes indicating all else being equal people are more likely to drive, bike or walk for social trips than taking public transport.

The results show that older people are more likely to use car and bicycle compared to public transport. The finding is consistent with studies related to mode choice of elderly (Schmöcker et al., 2008; Schwanen et al., 2001). In particular, Schwanen (et al 2001) reported that in the Netherlands older people are more likely to use cars for leisure trips. Schmöcker et al. (2008) found evidence that older people have a preference for car and independent mobility and conclude that they are perhaps more sensitive to the marginal costs associated with each mode choice.

Male are more likely to use a car, which has also been reported in previous studies in several occasions (Golob and Hensher, 2007; Matthies et al., 2002; Schmöcker et al., 2008; van den Berg, 2012). Highly educated people are more likely to drive. This variable may also be considered as a proxy of income.

Household size has a positive effect for car use and negative effect for bicycle use for social trips. This is plausible since bigger household size would make car use more convenient and also economic compared to public transport. Remarkable though is that the size of social network and number of children in the household do not have a significant effect on mode choice.

Students are less likely to choose car for social trips. This is also a plausible finding since they likely have less mobility and financial resources. Number of work hours is negatively associated with car use for social trips.

In terms of mobility choices available in the households we tested the effect of number of cars. As assumed having one car in the household makes car use more likely and use of bicycle or walking is less likely for social trips. If there are two or more cars in the household, then the use of bicycle or walking to social activity destination becomes even less likely. Van den Berg (et al 2012) also found that number of cars in the household is negatively associated with walking and cycling.

We assumed that the choice of commute mode might also have an effect on the mode choice for social trips. Results show that people who walk or cycle to work are more likely to use the same mode for social trips, and people who use car to commute are more likely to drive to social activity destinations. This finding is indicative of the habitual and inherent preferences of people for a particular mode choice.

Table 2: Multinomial logit model of mode choice for social trips including path dependency effects

Mode choice: Car (as driver/passenger)			Mode Choice: slow modes (walk, bicycle)		
Explanatory variables	**β**	**p-value**	**Explanatory variables**	**β**	**p-value**
Constant	1.96	0.08	Const: slow mode	2.81	0.01
Age<30	0.0552	0.94	Age<30	0.315	0.59
Age>50	1.45	0.05	Age>50	1.47	0.01
Male	0.907	0.06	Male	0.31	0.48
High education	0.924	0.06	High education	0.833	0.08
#HH member	0.218	0.09	#HH member	-0.184	0.01
#child in HH	-0.0233	0.92	#child in HH	0.0753	0.60
SN size	-0.0024	0.81	SN size	0.011	0.29
Student	-1.29	0.07	Student	-0.195	0.76
Working	-0.445	0.60	Working	-0.546	0.51
#Work hr	-0.0527	0.03	#Work hr	-0.014	0.55
One car	1.19	0.05	One car	-0.966	0.06
Two +car	0.712	0.22	Two+ car	-1.18	0.02
Commute mode: car	1.24	0.00	Commute mode: slow	0.573	0.07
Event time	0.017	0.14	Event time	0.0146	0.21
High urban	-1.34	0.01	High urban	-0.111	0.82
Mid urban	-0.0687	0.90	Mid urban	0.574	0.27
Car before	1.92	0.00	Car before	-5.1	0.01
PT before	-4.09	0.00	PT before	-1.79	0.00
Slow before	0.917	0.08	Slow before	1.1	0.07

Reference category of dependent variable: public transport (bus, train)

Null log-likelihood: -943.708
Final log-likelihood: -302.468
Rho-square: 0.679
Adjusted rho-square: 0.637

The effect of land use was captured by the degree of urbanization. In high-urbanized areas people are less likely to choose car for social trips. The effects is perhaps due to the fact that urbanization degree is correlated with public transport facilities (Schwanen et al., 2001). Several studies have also reported similar results of urbanization level on general mode choice (Kemperman and Timmerman, 2009; Pucher and Renne, 2004; Rosenbloom, 2003)

Finally, we tested the path dependency effect social travel mode choice. Findings suggest that, those who use to walk or cycle to social activity destinations are likely to choose walking and cycling after the event. If individual was used to travel by car or public transit they are less likely to cycle or walk for social trips. Particularly if an individual had chosen the car before the event for social trips, it is much less likely that he/she will switch to walking or cycling. On the other hand, if they used to walk or cycle they are likely to switch to car use. A similar trend was found by studies in the Netherlands on long term commute

mode choice and switching decisions (Oakil et al., 2011). Choice of car for social trips before the event makes it more likely to choose the car after the event. If they used public transport they are much less likely to use car after the event.

CONCLUSIONS

This study has examined the determinants of mode choice for social trips. To the best of our knowledge, this is the first study looking at mode choice for social trips considering the effects of path dependency and life cycle events.

The study found support for the contention that mode choice for social trips is path dependent. People are driven by their habitual or inherent choice preference. Yet people also do change their travel modes for social purposes some times and when they do it is more towards car use. The likelihood of moving away from car is rather unlikely.

The findings provide important insight about inherent and habitual preferences of individuals, which is relevant in terms of environment sustainability, health and energy pricing policies.

One limitation of the study is that distance of travel could not be incorporated, which can be a major determinant of mode choice. Also the unit of measurement is not the episode but the most frequent mode choice for social trips. In terms of data, the event of childbirth was not included which may have important impact in terms of mode choice.

Further studies along these lines are crucial to enhance our understanding of social travel demand. One important facet to explore would be to link the effects of change of income or unemployment with change of mode choice. Moreover the effects of introduction of new technologies and availability of sustainable mobility options could be incorporated, particularly responding to the findings of modal shift towards car.

As stated in section two, it is also important to understand the underlying motivation towards a particular decision; a future direction would be to investigate the effects of each event type. Due to under-representation of type of events, this was not possible to investigate in this study.

Having social travel choices under represented in transportation research, we believe the study has circulated new insights in the field and announced emerging research possibilities. Furthermore it incorporated temporal effects under path dependency theory, allotting more merit to the findings.

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