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The determinants of mode choice for family visits – evidence from Dutch panel data

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ABSTRACT

We use panel data to estimate multinomial logistic regressions for the effect of household composition, car ownership, distance between family members, and degree of urbanization on mode choice for family visits in the Netherlands. Based on Mundlak's formulation our model accounts for unobserved heterogeneity and differentiates within-individual from between-individual variation. With respect to household composition, we find that living with a partner and having a child under six years old is negatively associated with the likelihood of using public transport for family visits. Number of children is not associated linearly with mode choice. Walking and cycling is mainly associated with distance between family members: the shorter the distance the higher the likelihood of using slow-modes instead of a car. Those travelling between areas of high degree of urbanization have a higher likelihood of using public transport relative to using cars. Car ownership is negatively associated with all other modes. Using a car for commuting is also found to be negatively associated with other modes for family visits.

1. Introduction

With the growing role leisure and social activities play in modern life, non-work related travel has started increasingly receiving attention by scholars (Schlich et al., 2004; Ettema and Schwanen, 2012). However, to the best of our knowledge, only little attention has been paid to the specificities of family visits. Families continue to be an important institution for individuals in Western societies and researchers argue that due to ageing its importance will increase even more (Bengtson, 2001; Bucx, 2009; Connidis, 2010). People indeed invest time and effort into visiting other family members by travelling: in 2012, 13% of all journeys in the Netherlands were categorized as "visiting friends and family", which is comparable with home-work journeys that made up 18% of all journeys (Statistics Netherlands, 2012). In the Netherlands Kinship Panel Study (Dykstra et al., 2007) it was found that 79% of the respondents visited their parents more than once a month, while 76% visited a friend. In the data collected for this paper, 37.5% report visiting their parents at least once a week, and 23.8% visit their siblings at least once a month.

While a vast research on contact in the kinship network exists (e.g. Rossi and Rossi, 1990; Lawton et al., 1994; De Jong Gierveld and Fokkema, 1998; Grundy and Shelton, 2001), the way in which the geographical separation of family members is overcome has been rarely explicitly studied. Van Acker et al. (2011) looked at the association of lifestyle preferences with mode choice for various types of travel in Flanders, family visits being one of them. They found that life-style and the built environment were only moderately associated with mode choice, while car ownership and household life stage (student, young family, older family) had a stronger association (Van Acker et al., 2011). Unfortunately, only a limited cross-sectional sample was available to them. In general, travelling for family visits has been usually placed under a broader category of social travel (e.g. Spissu et al., 2009) or leisure travel (e.g. Schwanen et al., 2001; Dieleman et al., 2002; Limtanakool et al., 2006). Given the geographical separation between family members, it is important to address mobility within the family network. In addition, because negative externalities, such as air pollution and congestion are associated with car mobility (Bertolini and Le Clercq, 2003; Banister, 2005) the socio-demographic and spatial features of car use in this travel segment deserve attention.

To address this knowledge gap in this paper we examine the determinants of main mode choice when travelling to visit family in the Netherlands. Our research question is: to which extent are household characteristics, car ownership, distance between family members and degree of urbanization associated with mode choice for family visits, while taking unobserved heterogeneity into account? We use the Mobility in Social Networks module, a unique

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3-wave panel dataset covering the period 2009–2011 from the Netherlands, which was designed specifically for studying family visits. This module is part of the Longitudinal Internet Studies for the Social sciences (LISS) panel administered by CentERdata. We estimate multinomial logistic regression models to estimate mode choice for family visits. Section 2 details the background, Section 3 describes the data and methodology, Section 4 provides descriptive statistics, Section 5 details the estimation results and Section 6 concludes, discusses limitations and sketches potential further research.

2. Background

Face-to-face contact between family members serves multiple purposes. It reinforces feelings of affection (Lawton et al., 1994) and it helps in developing and maintaining solidarity within the family sphere (Bengtson and Roberts, 1991). During visits instrumental and emotional support is exchanged, like help in childcare, or the help provided by adult children to their ageing parents (Rossi and Rossi, 1990; Smith, 1998). Through maintaining contact with the family network individuals accumulate valuable social capital (Astone et al., 1999).

Travelling for family visits shares some commonalities with leisure and social travel. These are rather flexible types of travel in terms of schedule and may take place during weekdays but also during weekends. However, family visits are more rigid than leisure and social activities in terms of three dimensions: location – one has a choice of many tennis clubs or amusement parks but assisting ageing parents at their home is spatially constrained; frequency – social norms and feelings of obligation towards one's kin (Lee et al., 1994) may dictate a minimum number of visits; participants – friendship contacts may be discontinued, for example due to long distance, while for family relationships this is much less frequently the case. Furthermore, family visits are often a coordinated activity that involves (at least) two households. For example, this is the case when parents of young children serve as intermediates in the interaction between grandparents and grandchildren (Uhlenberg and Hammill, 1998). These dimensions make family visits a more constrained type of social travel and thus call for a separate analysis. We focus on household composition and spatial characteristics as explanatory factors which were shown to have a significant effect on mode choice decisions (e.g. Schwanen et al., 2001; Dieleman et al., 2002; Limtanakool et al., 2006; Van Acker et al., 2011).

Regarding household composition, single adults were found to be more likely to use public transport (PT) than couples (Schwanen et al., 2001). The presence of children in the household was found to be associated with more car use and less PT use (Schwanen et al., 2001; Dieleman et al., 2002) while the effect on slow-modes is mixed. However, Limtanakool et al. (2006) found that specifically for long distance leisure trips, families with children travel more by train and less by car than single-person households. Families with young children are more car-dependent than other families (Ryley, 2006). At an early age children may not be able to walk or cycle a long distance and for the parents the use of PT in combination with young children may be cumbersome (Zwerts et al., 2010).

Several effects of household composition are plausible. The larger the household size, the more people may join visits to an out-of-household family member, thus making travelling by PT relatively more expensive and cumbersome. In addition, from a coordination perspective, a larger household may require higher flexibility in scheduling. Lastly, a larger household size may lead to an indirect time budget effect. The larger the number of children the more time may be allocated to routine household tasks and childcare and more effort is being put into trip chaining (Van Acker and Witlox, 2010). Car travel is associated with higher flexibility and with decreasing marginal costs per traveller. This leads us to expect that larger households (households with two adults with or without children) are associated with more car travel and less PT use. Slow-modes offer flexibility in terms of scheduling, but their use is physically demanding, especially for children and therefore household size should have a weaker positive association with slow-mode use. Additionally, we expect that having young children is associated with more car travel relative to alternative modes.

Beyond factors directly relating to family relationships and the household we follow the travel behaviour literature and consider the spatial characteristics of the location of family. While the direction of causality between land use structure and travel behaviour is still debated (see: Næss, 2006 and a review by Cao et al., 2009), some outcomes are consistently found in the literature. Higher built area densities are associated with higher levels of walking, cycling and PT use (Cervero, 2002; Schwanen et al., 2004; Van Acker et al., 2007). For Switzerland, Ohnmacht et al. (2009) found that residents of city centres used cars for leisure trips less frequently. For the Netherlands Limtanakool et al. (2006) found significant negative associations between living in a suburb or in areas with low degree of urbanization and the likelihood of travelling by train on long distance leisure trips. Following previous work by Cervero (2002) and Limtanakool et al. (2006), we consider the spatial characteristics at both the origin of the trip and at the destination. We expect that travelling from and to more urban areas is associated with more PT and slow-mode usage and with less car use.

Visiting family needs to be woven into the family schedule of work, school and maintenance activities. Therefore family visits may require high flexibility. It has been argued that car mobility offers access to more geographically disparate activities than other modes (Sheller and Urry, 2000; Schönfelder and Axhausen, 2003; Farber and Páez, 2009; Schwanen and Lucas, 2011). In cases where travel distances are short, slow-modes may provide this necessary flexibility and be preferred over other modes. For longer distances – we expect car travel to be preferred over PT. Additionally, we expect that households that own a car will be more likely to choose for it compared with households that do not own one (Van Acker and Witlox, 2010).

Previous research on mode choice suggested additional long term factors which may explain individual and household decisions on mode of travel. For example, Van Acker et al. (2011) looked at the influence of different lifestyles, which were characterized according to types of leisure activities conducted by individuals. Haustein et al. (2009) showed that socialization processes at younger ages relate to car use and travel behaviour of students. Considering travel mode decision as an outcome of habitual behaviour (see: Gärling and Axhausen, 2003), Schlich and Axhausen (2003) used travel diaries to investigate the repetitiveness of travel decisions and found that travel on work days is highly repetitive. While we do not have information on travel behaviour beyond the three years covered in our data, we do consider the relationship between usual mode for commuting and mode used for family visits. For employed persons, commuting to work is arguably repetitive travel. If habit is driving our results then we expect that the main mode used for commuting would be highly correlated with the main mode used for family visits.

3. Data and method

3.1. Panel data

Over the years considerable attention was dedicated to address unobserved heterogeneity in travel behaviour. The concern is that cross sectional data does not allow accounting for the influence of unobserved variables such as personal traits (e.g. sociability) and preferences (e.g. affinity with car driving) on the outcome variables, leading to potentially biased estimations (e.g. Dargay and Hanly, 2007; Nolan, 2010; Chatterjee, 2011). A notable advantage of using panel data is indeed the ability to account for these effects, which should lead to a more precise and efficient model estimation (Baltagi, 2005). Another main advantage of using panel data structure is the ability to assess the impact of variables by observing their changes for the same individual across time, while holding long-term personal characteristics constant (cf. Schwanen and Lucas, 2011).

Panel data based on multi-day diaries and on annual surveys were used to study the impact of transport policy measures (e.g. Bradley, 1997), car ownership (Kitamura and Bunch, 1992; Woldeamanuel et al., 2009; Nolan, 2010), trip generation (Golob, 1989; Meurs, 1990), and mode choice (Chatterjee, 2011), especially in relation to commuting (e.g. Srinivasan and Bhargavi, 2007) or to model several of these dimensions (e.g. Dargay and Hanly, 2007; Kitamura, 2009). Other forms of longitudinal data, such as retrospective data were used for similar purposes (e.g. Oakil et al., 2011). However, to our knowledge our study is the first to use panel data to look into family visits.

3.2. The LISS data

Our main dataset are the three waves of the Mobility in Social Networks module of the Longitudinal Internet Studies for the Social sciences (LISS) panel. The waves were collected annually during the period 2009–2011.The data were collected through an internet based survey among a sample of Dutch speaking residents of the Netherlands, aged 16 and above (for a detailed description see: Scherpenzeel and Das (2010)). Our analysis sample consists of those respondents who stated that they were the head of household or the head's partner and did not have missing information on the main variables as detailed below. Because only a few persons aged over 65 still had living parents and to avoid issues related with students who enjoy free usage of PT in the Netherlands, we selected those individuals belonging to the working age population: between the age of 25 and 65. We randomly selected one person from every household where more than one person was included in the data. In addition, each respondent reported their own residential location in 4-digit postal code, the location of their parents and of their siblings. We matched these data with a distance matrix derived from the National Accessibility Map (*Nationale Bereikbaarheidskaart*)[1] that enabled us to calculate road distance for every pair of addresses in the data. We have assumed that the individuals live in the geometric centre of the 4-digit postal code area.

Earlier research on family relationships indicated that there may be a substantial difference between the relationship individuals have with their parents and with their siblings (Blaauboer et al., 2012). Individuals might feel lower levels of obligation and closeness towards siblings relative to parents, which might have an effect on their travel behaviour. In our data respondents indicated to visit their parents more often than their siblings. Therefore we split the dataset along two types of dyadic relationships: ego-parent and ego-sibling.

3.2.1. Ego-parents

Included were individuals who have at least one parent alive, do not live with any of their parents, and reported to have visited a parent at least once in the past year. The unbalanced sample consists of 1826 adult ego-parent dyads, of which 896 are represented in all waves, 492 in two waves and 438 in a single wave.

3.2.2. Ego-sibling

Included were individuals who have at least one sibling, live with neither their parents nor their siblings, and reported to have visited a sibling at least once in the past year. Respondents provided information for up to three out-of-home living siblings. We randomly selected one sibling for every respondent. The unbalanced sample consists of 2348 adult ego-sibling dyads, of which 1030 are represented in all waves, 679 in two waves and 639 in a single wave.

3.2.3. Dependent variable

The dependent variable is main mode of travel. Respondents were asked to name the main mode they generally use to travel to their parent's and the main mode used to travel to their sibling's home during the past year. The data include only information on in-home meetings, thus we ignore meetings that potentially took place elsewhere. The options for travel mode were walking, cycling, car, bus/tram/metro, train, and other. Due to small frequencies in certain categories we combined these answers into three categories: car (or other), slow-modes (walking, cycling) and PT (train, bus or tram). The dataset does not allow us to distinguish between driving a car and riding one as a passenger. Unfortunately, the dataset does not include information on usual day of the week, time of day, duration of visit or reason for the visit.

3.2.4. Independent variables

To account for household composition four dummy variables were used. One represents whether the respondent lived with a partner, two dummy variables represent the number of children in the household (no children as reference, one child and at least two), and one dummy indicating if there is a child younger than six in the household. While the latter variable was somewhat correlated with number of children in the household, including both did not cause a problem of multicollinearity. Additionally, we also controlled for whether the respondent is female, age and age squared.

We matched postal code data with data from Statistics Netherlands on the degrees of urbanization, distinguishing three categories: high (more than 1500 addresses per km^2), medium (500–1500 addresses per km^2) and low (fewer than 500 addresses per km^2). To measure the effect of degree of urbanization on mode choice in our model we included three dummy variables for the degree of urbanization at the respondent's postal code (reference: low) and three for the degree of urbanization at the parent's or sibling's postal code (reference: low). In addition we controlled for the road distance between the postal code area of the respondents and of their alter using the distance matrix derived from the National Accessibility Map. The distance between persons living in the same postal code was coded as zero. Due to data limitation continuous distance and travel time could not be matched to other socio-demographic variables. Therefore distance was measured using the following categories: same postal code (reference), 1–5 km, 6–10 km, 11–20 km, 21–50 km, 51–100 km and more than 100 km. Car ownership is controlled by a dummy variable for having a car in the household or not (reference: no).

As no reliable income data were available, we used three variables to account for socio-economic status Level of completed education was measured in three levels: low (completed primary school or intermediate secondary school, reference category), medium (completed higher secondary education or intermediate vocational education) and high (completed high vocational education or university). Employment status was coded using a dummy

[1] These data were produced by Goudappel Coffeng-http://www.bereikbaarheidskaart.nl/.

variable for being employed. Home ownership was coded using a dummy variable indicating whether the house was owner occupied.

3.3. Econometric model

We assume the standard multinomial logistic model, where, given the above mentioned dependent and independent variables, the baseline pooled model is the following:

$$\ln(P(\text{mode}_{\text{it}})/P(\text{car})) = x_i'\beta + z_{it}'\gamma + c_i + \varepsilon_{it} \quad (1)$$

For every individual i visiting family member at period t, mode choice (slow-mode or PT, relative to car) is dependent on two types of variables: time-constant variables x (gender and completed education), and time-varying variables z (such as age, car ownership, distance). Errors in the model are included as a composite random term of both time-specific and individual-specific errors which are allowed to be correlated between observations of individual i. We also assume variable c_i which represents a time-constant individual-specific effect.

An assumption underlying panel data random effects estimation is that unobserved heterogeneity is uncorrelated with the observed independent variables. In the case of mode choice this assumption is likely to be violated (e.g. Mokhtarian and Cao, 2008). An example of such correlation is when individual characteristics and place of residence are correlated with unobserved preference for a mode of travel. Someone with a strong preference for cycling might choose to live in an area with ample cycling opportunities (e.g. cycling paths and amenities within cycling distance). We address unobserved heterogeneity by using a variation on a panel data model suggested by Mundlak (1978; see: Wooldridge, 2002; Baltagi, 2005). The Mundlak estimation procedure was previously implemented in travel behaviour research for estimating the determinants of car ownership in Ireland (Nolan, 2010), for estimating frequency of bus travelling in England (Chatterjee, 2011) and to test the bias due to unobserved heterogeneity in trip generation models (Meurs, 1990).

Mundlak (1978) specified unobserved heterogeneity as a process dependent on the individual specific mean values of all observed variables (Eq. (2)):

$$c_i = \overline{z_i}'\rho + \sigma_i \quad (2)$$

Plugging Eqs. (2) into (1) adds for every time-variant z variable its within-individual mean. To remove all correlation between the mean value and its level we replaced the time-varying variables with their demeaned version (see Bartels (2008) and Bell and Jones (2014)):

$$\ln(P(\text{mode}_{\text{it}})/P(car)) = x_i'\beta + (z_{it} - \overline{z_i})'\lambda + \overline{z_i}'\rho + \sigma_i + \varepsilon_{it} \quad (3)$$

The model controls for the correlation between the unobserved time-constant characteristics and the z type (time-varying) variables (Baltagi, 2005; Wooldridge, 2002). In addition this formulation also provides a straight-forward test for whether such correlation actually exists: An F-test of whether the ρ vector coefficients are jointly equal to zero. The practical advantage of Mundlak's specification is that it accounts for unobserved heterogeneity while still allowing for the estimation of the effect of time-constant variables such as gender and of variables that are relatively persistent, like residential location and car ownership (Bell and Jones, 2014). The coefficients in Eq. (3) can be conveniently interpreted as a "within-effect" (λ) and a "between-effect" (ρ). For example, for car ownership (at least) three groups are distinguishable: persons that owned a car during all waves, those who did not own a car at all, and those who changed between the two states during the panel time period. The between-effect measures the effect of belonging to a certain group relative to other groups. The within-effect indicates the effect of deviating from the mean state of the individual – it compares the different states longitudinally (i.e. for the same individual). For a person who did not own a car at period 1 and did own one at period 2 and 3, the within estimator measures the effect of this "increase" in car ownership on mode choice.

Because observations of the same individual are not independent between the panel waves, in both the pooled (Eq. (1)) and the within-between (Eq. (3)) models standard errors were adjusted for clustering of observations within individuals (see: Wooldridge, 2002).

A cause for bias in our estimates is that some of our independent variables are not strictly exogenous (Cameron and Trivedi, 2005). The strict exogeneity assumption could be violated if for example the distance between a person and their family member is not independent of the person's previous mode choice decisions. As we cannot provide a solution for this limitation we refrain from interpreting the coefficients as causal and strictly present the results as associations.

3.4. Panel attrition

We address the potential attrition bias (non-random drop out of individuals from the panel), by adding three control variables (Verbeek and Nijman, 1992; Baltagi, 2005; for application in travel behavioural context see: Nolan, 2010): number of waves the individual participated in *(# waves)*, a dummy for whether the individual participated in all waves (*All waves*) and a dummy for wave t indicating whether the individual participated at wave $t + 1$ (*Next wave*). These controls indicate whether dropping out of the panel is systematically correlated with the outcome variables.

4. Descriptive statistics

Sample size and modal split for visiting family are presented in Table 1. In the pooled sample 70.5% reported usually taking the car to visit their parents, 24.7% walked or cycled and 4.8% used PT. This indicates slightly higher car use for family visits compared with other social travel. In the Netherlands in 2012 60% of journeys for social reasons were made by car compared with 23% by cycling, 14% walking and 3% by PT (Statistics Netherlands, 2012). The bottom row of Table 1 takes the longitudinal dimension into account: 75.6% reported using a car in at least one wave, 28% walked or cycled and 6.4% reported using PT, which suggests that some transition between the modes exists. For visiting siblings, car use is higher and slow-mode use is lower for all rows.

Transitions between modes occurred mainly from slow-modes and PT to car. For ego-parents 14.5% of slow-mode users at wave t moved to car at wave $t + 1$, 23.4% of PT users changed to car while only 6.3% changed from using car in some period t to a different mode in period $t + 1$. For ego-sibling the corresponding figures are 19.5%, 25.2% and 4.7%.

Table 2 provides descriptive statistics for the pooled sample for all independent variables. Like was already identified in the literature (Mulder and Kalmijn, 2006), also in our sample adult children live closer to their parents than to their siblings. Respondents live more frequently within the same postal code as their parents (18.2%) than as their siblings (11%). Similarly, the distribution of distance by distance category and by type of relationship shows that distances between respondents and their parents tend to be shorter than to their siblings (Fig. 1). The sample mean distance to parents is 33 km while 44.5 km to siblings. Excluding respondents who live in the same postal code area as their alter the mean distances are 40.4 and 50.1 km respectively (not shown).

For all categories in Table 2, the frequency of car usage for visiting siblings is higher than for visiting parents. For slow-modes it

Table 1
Main mode used for visiting family by wave and by type of dyad (%).

	Ego-parents				Ego-sibling			
	N	Car	Slow-modes	PT	*N*	Car	Slow-modes	PT
Wave 1 2009	1735	70.7	24.4	4.9	2178	77.8	16.5	5.6
Wave 2 2010	1305	71.8	23.7	4.5	1577	78.5	17.1	4.4
Wave 3 2011	1070	68.6	26.5	5.0	1332	79.4	15.6	5.0
2009–2011 (pooled)	4110	70.5	24.7	4.8	5087	78.5	16.5	5.1
2009–2011 (longitudinal)		75.6	28.0	6.4		82.6	19.0	6.9

Table 2
Descriptive statistics for independent variables (%).

Variable		Ego-parents				Ego-sibling			
		All	Car	Slow-modes	PT	All	Car	Slow-modes	PT
Total		100.0	70.7	24.1	5.1	100	78.5	16.5	5.1
Gender	Male	40.0	72.3	21.8	5.9	40.7	78.5	16.4	5.2
	Female	60.0	69.3	26.6	4.1	59.3	78.4	16.5	5.0
Living with partner	No	24.3	65.4	23.2	11.4	24.9	71.2	16.4	12.4
	Yes	75.7	72.2	25.2	2.7	75.1	80.9	16.5	2.7
Children in household	0	46.7	70.0	20.9	8.2	54.4	78.0	14.8	7.3
	1	13.2	72.9	24.7	2.4	12.6	79.8	16.2	4.1
	2 or more	40.1	69.3	29.2	1.6	33.0	78.8	19.3	1.9
Has a child under age 6	No	83.0	69.5	25.0	5.5	87.1	77.6	16.7	5.7
	Yes	17.0	75.4	23.2	1.4	12.9	84.2	14.6	1.2
Car ownership	No	19.6	45.4	35.6	19.0	20.9	57.4	24.6	18.0
	Yes	80.4	76.6	22.0	1.3	79.1	84.0	14.3	1.7
Distance (km)	0	18.2	27.6	72.0	0.4	11.0	28.0	71.1	0.9
	1–5	24.1	60.7	38.2	1.1	16.6	58.8	39.9	1.3
	6–10	12.1	82.7	14.5	2.8	9.9	85.9	11.9	2.2
	11–20	9.5	93.4	4.1	2.6	11.9	94.7	2.7	2.7
	21–50	13.1	93.0	1.3	5.8	18.4	93.4	1.5	5.1
	51–100	12.2	87.5	0.8	11.7	16.9	88.5	1.2	10.4
	>100 km	10.8	84.4	0.0	13.6	15.3	89.6	0.2	10.1
Degree of urbanization (ego)	Low	35.0	71.3	27.2	1.5	35.9	81.6	17.2	1.3
	Medium	32.9	71.7	24.9	3.3	32.5	79.9	16.3	3.9
	High	32.1	68.4	21.7	9.9	31.6	73.5	15.8	10.7
Degree of urbanization (alter)	Low	38.8	73.0	23.5	3.5	38.4	81.2	16.5	2.3
	Medium	30.3	68.2	27.5	4.3	26.6	76.4	18.4	5.2
	High	30.8	69.7	23.4	7.0	35.1	77.0	14.9	8.1
Education	Low	24.7	66.3	30.3	3.5	30.5	76.0	19.9	4.1
	Medium	38.0	69.5	26.7	3.8	34.4	77.9	18.4	3.7
	High	37.4	74.3	19.0	6.7	35.1	81.1	11.6	7.3
Employed	No	21.1	62.1	29.8	8.1	29.4	76.4	17.2	6.4
	Yes	78.9	72.8	23.3	3.9	70.6	79.3	16.1	4.6
Owner occupied	No	21.8	60.1	27.5	12.4	22.3	68.6	18.8	12.6
	Yes	78.2	73.4	23.9	2.7	77.7	81.3	15.8	2.9
Mean age (years)		44.0				47.8			
Age standard deviation		9.7				10.8			

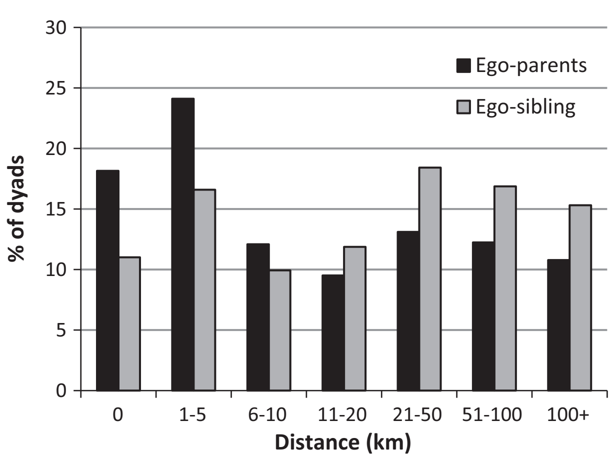

Fig. 1. Distribution of dyads by distance category and dyad type.

is the opposite and for PT it is mixed. For visiting parents, the highest rates of car usage (>75%) is observed when there is a child under six years old in the household, when the household owns a car and for distances of more than six kilometres. High rates of slow-mode usage (>29%) are found for respondents with at least two children, for less educated, unemployed, for households without a car and for distances up to five kilometres. High rates of PT usage (>10%) are found when the respondent is single, does not live in an owner occupied house and when the household does not own a car. Among the different residential areas, PT use is the highest in areas of high degree of urbanization. Similar results are found for visiting siblings.

Because the data is based on an internet and computer survey some bias in the data was to be expected. Relative to the general population in the Netherlands our sample has over representation of women, car owners, highly educated, and of low degree of urbanization, while under representation of single-person households and high degree of urbanization. Additional comparison is available upon request.

5. Multinomial logistic regression

For comparison purposes we present the results from the pooled model (Eq. (1)) for the two types of dyads: ego-parents (Table 3 – Model 1) and ego-sibling (Table 5 – Model 3). The regression results for the within-between model (Eq. (3)) are presented in Table 3 (Model 2) and in Table 5 (Model 4). The pooled model reflects a weighted average of the within and between coefficients, because it fits the cross-sectional and the longitudinal dimensions into a single parameter (Bell and Jones, 2014).

5.1. General findings

For both the ego-parents model and the ego-sibling model the coefficients of the individual specific means (the ρ parameters in Eq. (3) – the between-effect coefficients) are jointly significant ($p < 0.001$). This suggests that under our assumption the coefficients in Eq. (1) are correlated with the unobserved heterogeneity and the standard random effects estimation would not have been appropriate in this case. However, in terms of model fit the within-between model does not perform significantly better than the pooled model, which may have to do with the limited number of waves available: the demeaned (z) variables have lower variation than they would have had with additional waves. Comparing the ego-parents model and the ego-sibling model we find no conflict in sign between significant coefficients, while the significance level varies. Common to both models is the effect of car ownership. The between-effect compares the two categories – those with and without car. Being a car owner is as expected negatively associated with the likelihood of using slow-modes and PT. The within-effect compares the two states of car ownership while taking into account that it is the same person who moves between the two states. This association is insignificant for slow-modes, but negative for PT (Model 2: −1.138, $p < 0.01$), suggesting that in the short term, owning a car leads to the replacement of PT with car.

The control variables for socio-economic status show the following associations: highly-educated are more likely to use slow-modes (Model 2: 0.548, $p < 0.01$) and home ownership is associated negatively with the likelihood of using slow-modes and PT (Model 2: −0.729, $p < 0.01$). Home ownership in the Netherlands is negatively correlated with living in highly urbanized areas (Mulder and Wagner, 1998) where PT is more available, which may explain this negative relation. Employment status has the weakest association with mode choice – only one significant between-effect on slow-mode use (Model 4: 0.358, $p < 0.1$) which suggests that employed persons are more likely to use slow modes relative to car.

5.2. Ego-parents

As expected, having a partner is negatively associated with PT use (−0.918, $p < 0.01$). This might be due to an income effect of a second earner in the household that makes car use more likely, declining marginal costs for travelling by car compared with PT or the influence of a more complex time schedule than that of singles. With respect to number of children, the change from zero to one child (within-effect) is negatively associated with slow-modes (−0.773, $p < 0.05$). Unexpectedly, this association does not hold for more than one child and for PT, which implies a non-linear association of household size and mode choice. The change from not having a child under six to having one (within-effect) is as expected negatively associated with PT (−1.267, $p < 0.1$) – compared to other states, when respondents have a young child in the household, they are less likely to use PT relative to car. This is according to our expectation that travelling with young children is more cumbersome using PT. These within-effects indicate that these changes in household composition have a positive short term effect on car-usage.

As expected, distance is negatively associated with the likelihood of using slow-modes for travel, relative to cars. This is the case for both the within and the between-effect: persons living closer to their parents use slow-modes more frequently relative to cars (between-effect), and so do respondents who moved closer during the panel period (within-effect).

The separation of within and between-effects allowed us to identify two different associations of distance with PT. Comparing short and long distances, for distances longer that 50 km we find a positive association with PT (the between-effect), similar to what has been found for long distance leisure travel by Limtanakool et al. (2006). Looking at the within variation we find a negative association with PT for distances longer than 11 km. Within-effects relate to the short-term effect of changes in distance and this association could be the impact of adjustments due to relocation to longer distances (of either the respondent or the parent) – after relocation the higher flexibility of a car might be necessary. With respect to degree of urbanization, higher degree of urbanization is associated with more PT, for both origin and destination, reflecting the wider availability of PT in urban areas (between-effect). Only one within-effect was found for slow-modes in medium density which is negatively associated (relative to low density) with slow-modes (−1.697, $p < 0.05$), possibly reflecting that individuals who relocated into suburban areas may have to travel longer distances in the short term.

Table 4 presents a cross tabulation of modes used for commuting and for visiting parents. For all three types of commuters car is the most frequently used mode for visiting parents: 80.6% of car commuters, 55.2% of slow-mode commuters and 61.8% of PT commuters travel by car when visiting their parents. Hence, the majority of slow-mode and PT commuters uses a different mode for commuting than for family visits. Additionally we have repeated estimating the ego-parents model, this time controlling for main commute mode by using a dummy variable indicating whether it is a car or other. The results show that while car commuting is indeed negatively associated with other modes, the other coefficients did not change substantially when car commuting was included. To the extent in which commuting mode represents habit, we find that including it does not modify the significant associations of household composition and other variables in the model. These results are available upon request.

5.3. Ego-sibling

The findings for the impact of partnership status, distance and degree of urbanization are similar to those found in the ego-parents sub-sample. For the ego-sibling sub-sample we find a negative association of age with slow-mode usage: all else equal, older people have a lower probability of choosing slow-modes over cars (−0.220, $p < 0.01$). Comparing households with one child with households with no children we find a positive association with slow-mode usage (0.464, $p < 0.05$). The effect of two or more children is similar (0.494, $p < 0.05$). A possible explanation is that in the Netherlands having children in the household is correlated with living closer to other family members (Mulder and Kalmijn, 2006; Michielin et al., 2008) and therefore an increased opportunity to walk or cycle exists. The negative association between having children under six and PT appears here as a between-effect (−1.003, $p < 0.1$), compared with a within-effect for visiting parents. Both findings suggest that using PT is more cumbersome when travelling with young children.

Table 3
Multinomial regression results for mode choice for ego-parents (base: car).

Model	1		2			
Variables	Pooled		Within (λ)		Between (ρ)	
	Slow-modes	PT	Slow-modes	PT	Slow-modes	PT
Female	0.128	−0.389	TC	TC	0.108	−0.416
	(0.152)	(0.264)			(0.156)	(0.268)
Age	0.116*	−0.083	−0.021	−0.444	0.114	−0.081
	(0.068)	(0.093)	(0.236)	(0.463)	(0.070)	(0.100)
Age sq.	−0.001	0.001	−0.001	0.004	−0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.004)	(0.070)	(0.100)
Household composition						
Has partner	0.173	−0.926***	0.143	0.767	0.167	−0.918***
	(0.184)	(0.282)	(0.414)	(0.466)	(0.195)	(0.303)
Num. children in HH (ref: 0)						
1	−0.101	−0.571	−0.773**	0.775	−0.096	−0.691
	(0.221)	(0.519)	(0.391)	(0.684)	(0.247)	(0.567)
At least 2	0.187	−0.514	−0.648	1.429	0.191	−0.591
	(0.180)	(0.382)	(0.422)	(0.924)	(0.191)	(0.427)
Has child under 6	−0.148	−0.932**	−0.259	−1.267*	−0.116	−0.839
	(0.205)	(0.463)	(0.269)	(0.699)	(0.235)	(0.539)
Car owner	−1.397***	−3.053***	−0.063	−1.138***	−1.656***	−3.526***
	(0.188)	(0.264)	(0.224)	(0.412)	(0.222)	(0.312)
Distance (ref: same postal code)						
1–5 km	−1.665***	−0.697	−1.578***	−0.100	−1.668***	−0.801
	(0.174)	(0.730)	(0.525)	(0.625)	(0.185)	(0.805)
6–10 km	−3.074***	−0.429	−2.850***	2.972*	−3.121***	−0.561
	(0.239)	(0.769)	(0.812)	(1.543)	(0.251)	(0.829)
11–20 km	−4.365***	0.020	−1.356	−2.192*	−4.465***	0.182
	(0.359)	(0.916)	(1.241)	(1.142)	(0.379)	(1.036)
21–50 km	−5.707***	0.668	−3.237**	−1.262**	−5.820***	0.598
	(0.569)	(0.719)	(1.485)	(0.588)	(0.578)	(0.781)
51–100 km	−6.125***	1.378*	−5.911***	−1.407**	−6.153***	1.430*
	(0.545)	(0.704)	(1.739)	(0.570)	(0.552)	(0.763)
>100 km	−20.236***	1.986***	−16.771***	−1.281*	−19.971	2.120***
	(0.201)	(0.720)	(1.731)	(0.656)	(0.237)	(0.783)
Degree of urbanization (ref: Low)						
Respondent						
Medium	−0.066	0.795*	−1.697**	−0.563	−0.051	0.835*
	(0.203)	(0.419)	(0.678)	(0.618)	(0.212)	(0.453)
High	0.070	1.024***	−0.644	0.051	0.060	1.021**
	(0.229)	(0.384)	(0.688)	(0.519)	(0.239)	(0.424)
Parents						
Medium	0.351*	0.214	0.820	−0.167	0.333	0.176
	(0.202)	(0.317)	(0.792)	(0.296)	(0.210)	(0.329)
High	0.169	0.883***	−0.262	−0.007	0.154	0.906***
	(0.225)	(0.284)	(0.848)	(0.250)	(0.231)	(0.305)
Socio–economic status						
Education (Ref.: Low)						
Medium	0.356**	0.087	TC	TC	0.378**	0.045
	(0.168)	(0.380)			(0.171)	(0.402)
High	0.716***	0.507	TC	TC	0.742***	0.501
	(0.190)	(0.380)			(0.194)	(0.398)
Employed	−0.106	−0.166	−0.210	−0.383	−0.056	−0.098
	(0.171)	(0.274)	(0.266)	(0.413)	(0.192)	(0.348)
Owner-occ.	−0.317*	−0.913***	0.141	−1.322	−0.314	−0.869***
	(0.180)	(0.251)	(0.423)	(0.850)	(0.191)	(0.277)
Control for panel attrition						
# Waves	0.211	−0.515			0.295	−0.344
	(0.206)	(0.344)			(0.216)	(0.384)
All waves	−0.225	0.750			−0.276	0.622
	(0.313)	(0.524)			(0.319)	(0.550)
Next wave	−0.020	0.063			−0.166	−0.072
	(0.066)	(0.140)			(0.124)	(0.285)
Constant	−1.681	0.628			−1.552	0.438
	(1.492)	(2.077)			(1.542)	(2.226)
N*T	4110				4110	
Pseudo R^2	0.43				0.44	
ll	−1732				−1698	
df_m	50				88	
chi2	28,310				27,620	

Clustered standard errors in parentheses.
* Significant at $p < 0.1$.
** Significant at $p < 0.05$.
*** Significant at $p < 0.01$; TC – time-constant.

Table 4
Commute mode vs. mode for visiting parents.

	Car	Slow-modes	PT	Total
Car	80.6	18.9	0.5	100.0
Slow-modes	55.2	38.6	6.2	100.0
PT	61.8	20.0	18.2	100.0

Rows represent main commute mode; columns represent main mode for visiting parents; based on a sub-sample including only those who were employed in every wave they participated in ($N = 2665$).

5.4. Tests for panel attrition

The test for non-random panel attrition (Verbeek and Nijman, 1992) shows that almost all parameters are insignificant. Two parameters (Next wave in model 3 and 4, for the outcome slow-modes and PT respectively) are marginally significant ($p < 0.1$). An F-test shows that in no model the parameters are jointly significant. Furthermore, the estimation results with and without these extra control variables were compared. The results show that all parameters were similar in sign, magnitude and significance levels.

Table 5
Multinomial regression results for mode choice for ego-sibling (base: car).

Model	3		4			
Variables	Pooled		Within (λ)		Between (ρ)	
	Slow-modes	PT	Slow-modes	PT	Slow-modes	PT
Female	0.086	−0.032	TC	TC	0.061	−0.033
	(0.151)	(0.218)			(0.155)	(0.225)
Age	−0.174***	−0.060	0.326	−0.932**	−0.220***	−0.059
	(0.067)	(0.076)	(0.232)	(0.390)	(0.072)	(0.079)
Age sq.	0.002***	0.001	−0.004*	0.006	0.003***	0.001
	(0.001)	(0.001)	(0.002)	(0.004)	(0.001)	(0.001)
Household composition						
Has partner	0.031	−1.138***	0.735	1.051	−0.018	−1.212***
	(0.179)	(0.240)	(0.456)	(0.660)	(0.190)	(0.254)
Num. children in HH (ref: 0)						
1	0.388*	−0.119	−0.156	−0.081	0.464**	−0.229
	(0.211)	(0.347)	(0.423)	(0.263)	(0.231)	(0.372)
At least 2	0.438**	−0.381	0.005	0.397	0.494**	−0.425
	(0.197)	(0.316)	(0.419)	(0.560)	(0.210)	(0.345)
Has child under 6	−0.288	−1.134**	−0.251	−1.186	−0.321	−1.003*
	(0.240)	(0.496)	(0.269)	(0.722)	(0.275)	(0.531)
Car owner	−1.180***	−2.718***	0.080	−1.658***	−1.427***	−2.935***
	(0.183)	(0.212)	(0.222)	(0.432)	(0.217)	(0.240)
Distance (ref: same postal code)						
1–5 km	−1.388***	−1.048	−1.136*	−0.749	−1.405***	−0.822
	(0.189)	(0.640)	(0.633)	(0.781)	(0.198)	(0.779)
6–10 km	−3.116***	−0.740	−0.613	0.227	−3.215***	−0.500
	(0.241)	(0.680)	(0.940)	(1.025)	(0.256)	(0.789)
11–20 km	−4.722***	−0.412	−3.149***	1.037	−4.800***	−0.224
	(0.362)	(0.604)	(0.876)	(1.323)	(0.374)	(0.727)
21–50 km	−5.347***	0.340	−2.097***	0.163	−5.505***	0.573
	(0.420)	(0.576)	(0.792)	(1.217)	(0.448)	(0.697)
51–100 km	−5.578***	0.768	−3.980***	−3.238***	−5.679***	1.106
	(0.352)	(0.565)	(1.281)	(1.071)	(0.348)	(0.688)
>100 km	−7.102***	1.238**	−3.970***	−1.126	−7.219***	1.559**
	(0.733)	(0.571)	(1.113)	(1.046)	(0.745)	(0.698)
Degree of urbanization (ref: Low)						
Respondent						
Medium	0.035	0.610*	0.248	−0.008	0.011	0.560*
	(0.205)	(0.315)	(0.505)	(0.648)	(0.213)	(0.329)
High	0.226	1.158***	1.067	1.082	0.199	1.101***
	(0.217)	(0.295)	(0.707)	(0.665)	(0.225)	(0.308)
Sibling						
Medium	0.052	0.787***	0.673	−0.060	0.030	0.775**
	(0.199)	(0.305)	(0.829)	(0.979)	(0.206)	(0.314)
High	−0.110	1.113***	−0.918	0.618	−0.097	1.101***
	(0.216)	(0.268)	(0.874)	(0.552)	(0.222)	(0.275)
Socio-economic status						
Education (Ref.: Low)						
Medium	0.278	−0.062	TC	TC	0.311*	−0.104
	(0.174)	(0.310)			(0.179)	(0.320)
High	0.512***	0.600**	TC	TC	0.548***	0.567*
	(0.192)	(0.291)			(0.196)	(0.299)
Employed	0.238	0.174	−0.280	−0.199	0.358*	0.279
	(0.175)	(0.242)	(0.225)	(0.361)	(0.200)	(0.286)
Owner-occ.	−0.211	−0.735***	0.203	−0.600	−0.215	−0.729***
	(0.175)	(0.224)	(0.502)	(0.673)	(0.185)	(0.235)

Table 5 (*continued*)

Model	3		4			
Variables	Pooled		Within (λ)		Between (ρ)	
	Slow-modes	PT	Slow-modes	PT	Slow-modes	PT
Control for panel attrition						
# Waves	0.151	0.023			0.264	0.337
	(0.207)	(0.268)			(0.224)	(0.301)
All waves	−0.146	−0.431			−0.235	−0.680
	(0.314)	(0.423)			(0.325)	(0.450)
Next wave	0.130*	0.111			−0.003	−0.438*
	(0.076)	(0.125)			(0.152)	(0.236)
Constant	4.118***	−1.128			5.126***	−1.690
	(1.534)	(1.858)			(1.632)	(1.979)
N^*T	5087				5087	
Pseudo R^2	0.44				0.45	
ll	−1830				−1793	
df_m	50				88	
chi2	908.1				954.7	

Clustered standard errors in parentheses.
* Significant at $p < 0.1$.
** Significant at $p < 0.05$.
*** Significant at $p < 0.01$; TC – time-constant.

6. Conclusions and discussion

6.1. Main findings

In this paper we investigated the extent to which household characteristics and spatial variables associated with mode choice for family visits. We focused on four categories of variables: household composition, distance between family members, degree of urbanization and car ownership.

Distance between family members and car ownership have the strongest association with main travel mode. Car ownership was negatively associated with slow mode and PT usage, while distance was negatively associated mainly with slow-mode usage. As we hypothesized those travelling from and to areas of high degree of urbanization had a higher likelihood of using public transport relative to using cars. However contrary to expectations, a similar association was not found regarding slow-modes. Yet another unexpected finding is the non-linear effect of household-composition. While having a partner and having a child under six in the household showed the expected effect of higher probability for car use relative to PT, number of children appears to have only limited association with slow-modes. No model showed the expected linear relationship between number of children and car use.

In general, we found that car use for visiting siblings is higher than for visiting parents. This may have to do with the shorter distance individuals live from their parents and with the different nature of these relationships, for example the different role support provision plays in them. These differences may lead to different visit purposes and therefore to different choices regarding travel mode.

In our sample car use for family visits is higher than for commuting. This is in line with our theoretical assumption that family visits is more rigid and that car use offers flexibility over long distances. The residential location (and hence: the distance to other family members) of a household depends on an array of factors (see: Van Acker et al., 2010), while the need for face-to-face contact within the family network under varying circumstances remains. It is to be seen if this holds true when comparing family visits to other social travel.

Methodologically, separating within and between-effects provides additional insights into various processes that affect mode choice decisions and these in turn could have interesting policy implications. Variation in mode choice could be explained by within-individual changes (for example having children and relocating) or by differences between individuals (for example, owning a car vs. not). These effects are not separable when using a pooled model. Compared with the pooled model, the between-effects are in general similar in their significance level. However, two significant within-effects are insignificant in the pooled model: having one child and living in medium degree of urbanization, which indicates that changes in household composition and residential location are associated with mode change in the short term. Another example is the association between distance and PT use, which in the between-effect was positive, while in the within-effect was negative – two mechanisms that could not be identified in the pooled model.

6.2. Limitations and future research

The research presented here has several shortcomings which should be addressed in future research. The first limitation is the use of relatively few panel waves. First, the limited number of waves meant that the number of transitions that the respondents experienced (e.g. moving between states of car ownership) is rather small. This is probably one reason only few within-effects were found. Additional waves would have increased the number of transitions and our ability to measure their effect more precisely. Future research might discover additional variables that display different within and between variations and hence new mechanisms that drive mode choice decisions. Secondly, we did not have precise information on the reason for visiting. Visits of various types (e.g. helping with daily groceries and a holiday meal) were lumped under the same category. We expect that the reason for visit influences for example number of persons travelling, and time and day on which the visit takes place and therefore influences mode choice. Related to this, we did not have information on the usual number of persons travelling, and we assumed it to be correlated with the size of household. Finally, we only looked at visits occurring at home, which underestimates total number of visits neglecting potential meetings in restaurants, hotels, shops, hospitals and other.

Our findings suggest opportunities and challenges for policy makers who try to understand the role of transport modes in family visits. Whether to travel by slow-modes or by car depends mostly on specific family circumstances, i.e. the distance between the locations of the family members. These results may be specific for the Netherlands, where almost every residential area has sufficient cycling and walking infrastructure and facilities that allow individuals with different characteristics to easily use them, as long as distance is reasonable. In this context, spatial policy and the regulation of the housing market could increase opportunities for family members to locate closer to each other. However, other factors affecting residential choice might still hamper that. A greater room for intervention appears to be in the decision regarding PT. If PT would become more attractive to larger (two-adult) households and households with young children then households travelling for visiting family might indeed consider switching from car use to tram, bus or rail travel.

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