DO CARE TRIPS MATTER?

Exploring time use for the Mobility of Care using

Multiple Discrete Continuous Extreme Value modeling

Advanced Discrete Choice Modeling

Winter Quarter 2024

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Transportation Technology and Policy

Executive Summary

Traditionally, transportation planning has revolved around commute trips and tends to under-emphasize the importance of essential care trips. As care trips are predominantly done by women, especially low-income women, and are related to the presence of children, examining factors affecting time used traveling for care trips in people's daily travel is a potential way to advance women's unique travel behavior. This study utilizes the 2022 American Time Use Survey and applies the Multiple Discrete-Continuous Extreme Values to analyze the individuals and their households' characteristics affecting their time use traveling for care in comparison with traveling related to work and leisure activities. The findings show that the model shows a better fit when there are fewer alternatives which makes fewer parameters, and also when the demographic effect is taken into account. More time needed to satisfy the travel needs to pursue personal care, child care, and adult care activities may indicate poor accessibility to destinations related to these activities compared to accessibility to the workplace. However, there may be an endogeneity of residential self-selection where people choose to reside near their workplace with a trade-off of being farther from other amenities, such as hospitals and clinics. Nevertheless, people spend more time traveling for care in aggregation compared to commute travel. Furthermore, consistent with previous studies, women travel more for care activities than men. Interestingly, the presence of a spouse/partner is associated with less time traveling for care due to the possibility when the care travel being done by the spouse/partner. However, those who travel with the child for child care significantly spend more time traveling for child care than those who do not. The opposite occurs for elder care, people who take care of an elderly person are likely to make fewer trips for adult care.

This modest exploratory study shows that care trips are significant to people's daily travel and household structure affecting how people travel for care. This finding calls for the attention of policy-makers and transportation planners to take into consideration the trip generation of care trips in terms of planning accessibility and travel demand modeling. However, this study may be improved better when exploring other variables interactions and taking into account the availability of each type trips for each decision-makers.

Background

Traditionally, transportation planning has revolved around commute trips and tends to under-emphasize the importance of other types of trips. However, as travel is a derived demand from space-distributed activities, people also travel to pursue care and leisure activities besides working (Axhausen & Gärling, 1992). Care trips are essential as work trips but are not discretionary (i.e. free of obligation) as leisure trips (Freysinger, 2013; Tronto, 1993). Therefore, based on the notion of responding to existing needs that should be met, care trips can be defined as all travel made to take care of the household, the household's members, and also the individual's well-being (Petty & Trussell, 2021; Tronto, 1993). This includes grocery shopping, chauffeuring household children or adults, running errands, and exercising (i.e. self-care). In transportation research, care trips have been discussed under various labels, such as non-work trips, non-mandatory trips, household-serving trips, and the mobility of care (Boarnet & Hsu, 2015; Mauch & Taylor, 1997; Sánchez de Madariaga, 2016). Findings are consistent that it is predominantly done by women (especially low-income women), related to the presence of children, oftentimes done by walking or driving, and conducted as a part of a trip chain (Boarnet & Hsu, 2015; De Madariaga & Zucchini, 2019; Gómez-Varo et al., 2023; Mauch & Taylor, 1997; Murillo-Munar et al., 2023; Ravensbergen et al., 2023). Moreover, the share of care trips among adult workers is close to that of work trips (De Madariaga & Zucchini, 2019; Gómez-Varo et al., 2023). However, trip counts may fail to highlight the significance of care trips in people's daily lives. Meanwhile, a trip-duration-wise approach provides a better sense of how important care trips are in people's daily activities: **How significant is traveling for care in people's daily lives?** Using NHTS 2022, this study aims to see how much time each day people spend traveling for care compared to work trips and leisure trips. The results of this study are expected to inform policymakers and transportation planners to take care trips into account, thus benefitting women with their unique travel needs in the transportation landscape.

Literature Review

As defined by Sanchez de Madariaga (2016), mobility of care is an umbrella term for all travel made to take care of household members and household needs. Traveling for care purposes is opposed to commuting since care activities are unpaid, unlike paid work. It includes, but is

not limited to, escorting household members, shopping for groceries, running errands, and visiting sick relatives (De Madariaga & Zucchini, 2019; Sánchez de Madariaga, 2016). Compared to the share of work trips in adults' daily mobility, care trips can be higher or lower than work trips depending on how the study takes place and defines trip purposes of the mobility of care. For instance, holding the same definition of care trips, the share of care trips in Madrid, Spain, is close to Madrid's work trips share (De Madariaga & Zucchini, 2019). Meanwhile in Montreal, Canada, although the share of its care trips is similar to what is in Madrid (28% in Montreal and 29% in Madrid), the share of work trips in Montreal is greater than in Madrid (48% in Montreal and 33% in Madrid) (De Madariaga & Zucchini, 2019; Ravensbergen et al., 2023). Thus, the gap between care trips and work trips in Montreal is greater than in Madrid.

The concept itself is relatively new despite it has been partially studied under other labels, such as non-work trips, non-mandatory trips, and household-serving trips (Boarnet & Hsu, 2015; Mauch & Taylor, 1997). However, mobility of care has a different definition of those labels that precede it. *Mobility of care* excludes recreational and personal trips, unlike non-work and non-mandatory trips. Besides, it is contrary to the term of being non-mandatory (i.e. assuming that commuting is the only mandatory travel), since travel related to caring activities is an essential part of daily life (Sánchez de Madariaga, 2016). While it is similar to household-serving trips, it does not only consist of grocery shopping and chauffeuring children but also escorting other adult household members, visiting relatives for care purposes, and doing administrative errands (Mauch & Taylor, 1997; Sánchez de Madariaga, 2016). Nevertheless, types of care trips that significantly differ are shopping and escorting children (Gómez-Varo et al., 2023).

Mobility of care is predominantly done by women, regardless of race or ethnicity (De Madariaga & Zucchini, 2019; Gómez-Varo et al., 2023; Mauch & Taylor, 1997; Murillo-Munar et al., 2023; Ravensbergen et al., 2023; Shuman et al., 2023). According to the expectation of gendered labor division in households, it is more in effect when the woman has at least one child, is within the low-income level, and is unemployed (De Madariaga & Zucchini, 2019; Murillo-Munar et al., 2023). Furthermore, the lower the household income, the greater the gap between men and women in serving care trips (Ravensbergen et al., 2023). In terms of transportation mode, mobility of care is mostly done by walking or driving cars (De Madariaga & Zucchini, 2019; Gómez-Varo et al., 2023; Murillo-Munar et al., 2023; Ravensbergen et al.,

2023). However, it may be biased toward the urban context since all previous studies take place in compact and dense urban cities, making travel by walking easier than in other places. On the other hand, depending on automobiles to serve care trips is related to cars' function in chauffeuring children and loading cargo, which is applied in both urban cities and their outskirts (De Madariaga & Zucchini, 2019; Gómez-Varo et al., 2023; Ravensbergen et al., 2023). Care trips are characterized by being short in distance, short in time travel (i.e. less than 15 minutes), and part of a trip chaining (De Madariaga & Zucchini, 2019; Murillo-Munar et al., 2023; Ravensbergen et al., 2023). When being done by bus, care trips are concentrated at the morning peak hour more than the afternoon peak hour (Shuman et al., 2023). However, the time context of mobility of care in general hasn't been discussed yet.

Traditionally, analysis of the mobility of care depends on travel surveys because survey captures a lot of travel information about individuals and households. Moreover, it features sociodemographic information. Nevertheless, the pattern of mobility of care has been also seen through 'big data' despite its limited information. For instance, a study that looked at the WMATA (The Washington Metropolitan Area Transit Authority) smart card data has no gender information, resulting in gender inference by name (Shuman et al., 2023).

When defining what care trips are, some have fewer and some have more trip purposes accounted as care trips than what is specified by the original mobility of care by Sanchez de Madariaga (2013). For example, the Barcelona study includes trips for personal care (e.g. going to the gym, going for recreation) as care trips, and the Bogota study only looks at trips for taking care of people but not the households' needs (Gómez-Varo et al., 2023; Murillo-Munar et al., 2023). Other than trip purposes, variables of interest in mobility of care include travel distance, travel time, travel mode, and the possibility of being done as part of a tour. In terms of sociodemographics, gender implies many things in the mobility of care, as well as the individual age and employment. Besides, household income and household structure (e.g. minor presence, senior presence, number of adults) are taken into account as explanatory variables to the patterns of care trips (De Madariaga & Zucchini, 2019; Gómez-Varo et al., 2023; Murillo-Munar et al., 2023; Ravensbergen et al., 2023).

Choice problem

This study looks at how the U.S. population uses their 24 hours a day to travel or not to travel and, within time used for traveling, how much time they spend pursuing caring activities in

comparison to other types of trips (work trips and leisure trips). Therefore, the choice problem will be the trip purpose generalized categories (Fig. 1):

1. Work trips

Work trips are all travel related to the paid job people do. Mainly this is about the trip made from home to the workplace, and vice versa. Other trips related to paid work activities fall into this category. Given its mandatory nature, trips made to school also fall into this category.

2. Care trips

Care trips, the main focus of this study, are defined as all trips made to meet the needs of the household, the household's members, and the individual's well-being which is based on the theory of care by Tronto (1993). Trips for care include grocery shopping, taking care of the needs of household children or adults, and running errands. Rooting on the definition of care by sociologists, the way this study describes care trips is different from previous studies discussing care-purpose travel (Engster, 2005; Tronto, 1993). It includes grocery shopping and chauffeuring children as household-serving trips but does not include visiting trips like in the mobility of care. Also, it considers trips to buy meals as care trips for its "mandatory" nature to fulfill people's physical needs (Engster, 2005).

3. Leisure trips

Leisure trips are made to pursue free or discretionary activities in discretionary time (Freysinger, 2013). In other words, these trips are not mandatory or obligatory. Trip purposes under this category are trips to engage in vacation, recreation, social activities, volunteer activities, and leisure shopping.

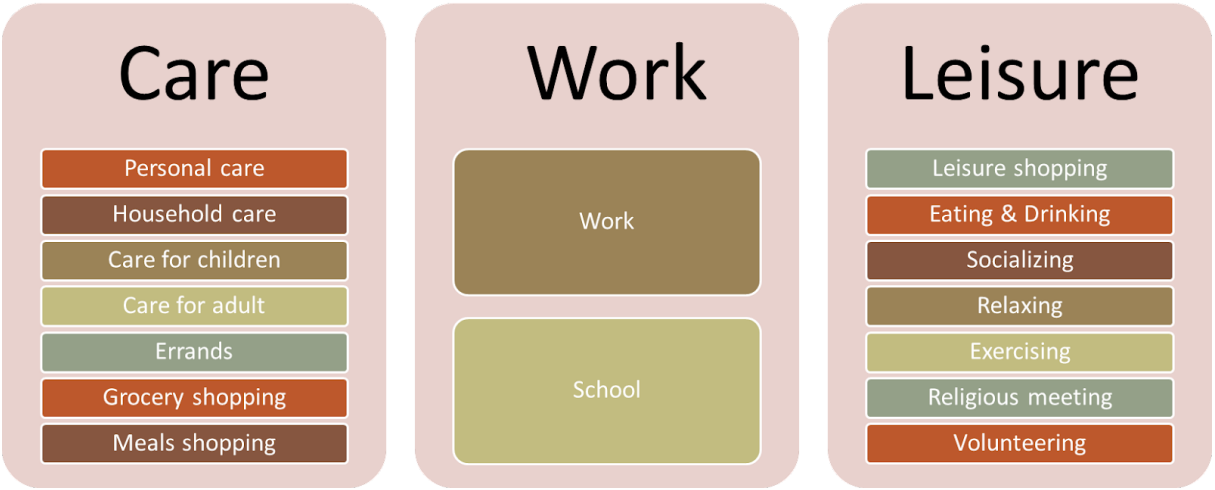

Figure 1. Trip purposes categories

Conceptual model

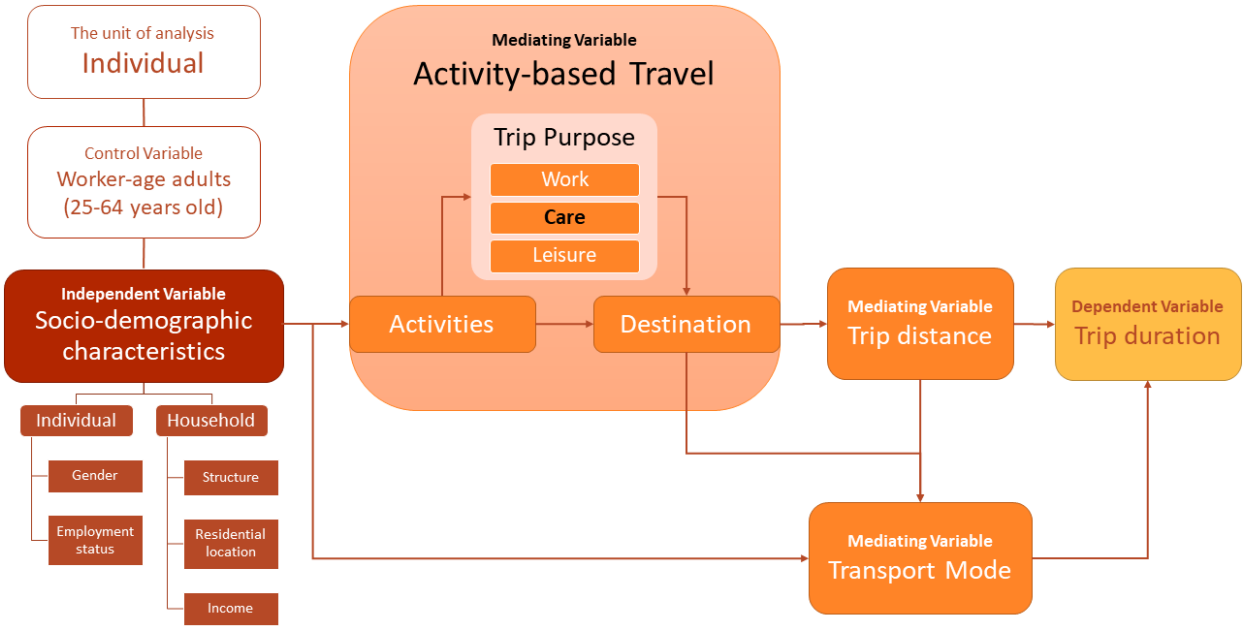

Figure 2. Conceptual Model

The independent variable in this study is the socio-demographic characteristics of individuals and the dependent variable is the duration of each trip category. This study is controlled by age and employment status, which makes 25 to 64-year-old worker-age adults the subjects (i.e. observations are not limited to employed people only). The dependent variable is the trip duration of traveling for caring purposes. Meanwhile, the mediating variables are the trip purpose (i.e. reflecting the activities the individuals aim to do), the trip distance, and the transportation mode they pick. This is based on the theory of travel being a derived demand from activities. Certain characteristics of people have activities they are engaged in which (some of them) require travel. With that certain activity in mind, they have a destination point thus knowing the trip distance from their point of origin. In the process of planning the trip, people may also think about what mode they pick to conduct that trip, and the mode availability depends on their socioeconomic status (the independent variable). Finally, trip duration is derived from the combination of the trip distance and the mode of transportation they use since different modes of transportation result in different travel times although go for the same distance.

Data sources

The data source for this study is the 2022 American Time Use Survey (2022 ATUS). It is a national representation estimate of how Americans spend their time in various activities, such as working, childcare, and volunteering. The 2022 ATUS has 8,136 samples, who are noninstitutional civilians aged 15 years old and older from a subset of households participating in the Current Population Survey (CPS). Table 1 features the descriptive statistics of the sample (unweighted) and of the American Community Survey (ACS) from the U.S. Census Bureau. The sample is randomly selected, one individual from each household. The time-use information is collected over the phone by an interviewer using a Computer-Assisted Telephone Interview (CATI). It is then coded into 17 major activities, one of them being travel activity. The activity code consists of 6 digits: the first two represent the major activity, the next two digits represent the detail of the activity, and the last two digits represent more detail about the activity.

This study focuses on the travel activity and 8 out of 16 details about the travel which are categorized as care trips. Travel to work-related activities and educational activities are categorized as work trips, while the other 6 travel activities are accounted as leisure trips (Table 2). The variables of interest in this study include variables related to time-use and travel activities type as the outcome variables, demographics as the explanatory variables, and additional variables developed indicating the travel companion of the decision-maker in doing the travel activities (Figure 3).

Table 1. Descriptive statistics

	ATUS 2022 (unweighted)	**ACS 2022**
Age		
15 to 24	6.67%	16.15%
25 to 34	13.85%	16.51%
35 to 44	16.21%	16.08%
45 to 54	14.28%	14.78%
55 to 64	16.91%	15.38%
65 and older	32.07%	21.11%
Gender		
Male	45.55%	49.58%
Female	54.45%	50.42%
Employment		
Unemployed	41.19%	4.28%
Employed	58.81%	95.72%
HH Income		
Less than $25,000	14.00%	15.99%
$25,000 - $49,999	20.53%	17.91%
$50,000 - $74,999	18.23%	16.24%
$75,000 - $99,999	13.56%	12.82%
$100,000 - $149,999	15.90%	16.90%
Over $150,000	17.79%	20.14%

Figure 3. Variables of interest

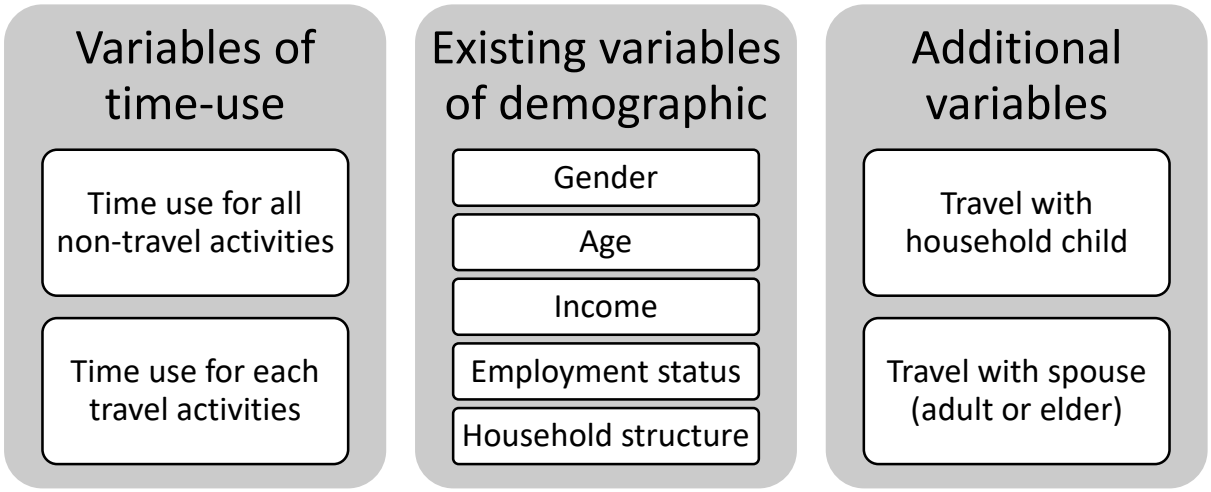

Table 2. Travel activities categorization

Travel category in ATUS	**Code in analysis**	**Category**
Personal care	Personal	Care
Household activities	Household	Care
Caring For & Helping Household Members	Carechild	Care
Caring For & Helping Non-Household Members	Careadult	Care
Work & Work-Related Activities	Work	Work
Education	School	Work
Consumer Purchases	Groceries	Care
	Buyfood	Care
	Shopping	Leisure
Professional & Personal Care Services	Errands	Care
Household Services		Care
Government Services & Civic Obligations		Care
Eating and Drinking	Eating	Leisure
Socializing, Relaxing, and Leisure	Social	Leisure
Sports, Exercise, and Recreation	Sports	Leisure
Religious and Spiritual Activities	Religious	Leisure
Volunteer Activities	Volunteer	Leisure

Modeling approach and results

Model forms

This estimation analysis applies the Multiple Discrete Continuous Extreme Value (MDCEV) modeling with the outside good being considered (Bhat, 2008). The outside good in MDCEV is the product that is consumed by all desicion-makers in the sample. In this case, all non-travel activities are considered as the outside good because the sample show that all observations do non-travel activities.

The estimation is done with open-sourced R software with the help of R package of Apollo using the BGW algorithm (Bunch et al., 1993; Hess & Palma, 2019). The utility function used for this analysis is the alpha-gamma profile which is depicted as the third form in Eq. 2. with the probability of the alternative being chosen as depicted in Eq. 1. (Bhat, 2008)

$$P(x_1^*, x_2^*, x_3^*, \ldots, x_M^*, 0, 0, \ldots, 0) = \frac{1}{\sigma^{M-1}} \left[\prod_{i=1}^{M} f_i\right] \left[\sum_{i=1}^{M} \frac{p_i}{f_i}\right] \left[\frac{\prod_{i=1}^{M} e^{V_i/\sigma}}{\left(\sum_{k=1}^{K} e^{V_k/\sigma}\right)^M}\right] (M-1)!,$$

where $f_i = \left(\frac{1-\alpha_i}{x_i^*+\gamma_i}\right)$.[19]

Eq. 1.

$$\text{First form:} \quad V_k = \beta' z_k + (\alpha_k - 1)\ln(x_k^* + 1) - \ln p_k (k \geqslant 2); V_1 = (\alpha_1 - 1)\ln(x_1^*),$$

$$\text{Second form:} \quad V_k = \beta' z_k - \ln\left(\frac{x_k^*}{\gamma_k} + 1\right) - \ln p_k (k \geqslant 2); V_1 = (\alpha_1 - 1)\ln(x_1^*),$$

$$\text{Third form:} \quad V_k = \beta' z_k + (\alpha - 1)\ln\left(\frac{x_k^*}{\gamma_k} + 1\right) - \ln p_k (k \geqslant 2); V_1 = (\alpha - 1)\ln(x_1^*).$$

Eq. 2.

Model specifications

There are 6 models estimated in this analysis (Figure 4), namely model 1a, 2a, 3a, 1b, 2b, and 3b. All models coded with an “a” in the models name include only the constants in the estimation modeling, while all models coded with a “b” in the models name incorporate the effect of demographics in addition to the constants. Moreover, the difference between model 1, 2, and 3 is in the number of the choice sets. Model 1 has 3 alternatives: work, care, and leisure. Model 2 has 10 alternatives with the care travel being elaborated into 8 kinds of care trips. Meanwhile, model 3 has 15 alternatives with all trip categories are being

elaborated into details (i.e. 2 alternatives of the work trips, 8 alternatives of the care trips, and 5 alternatives of the leisure trips).

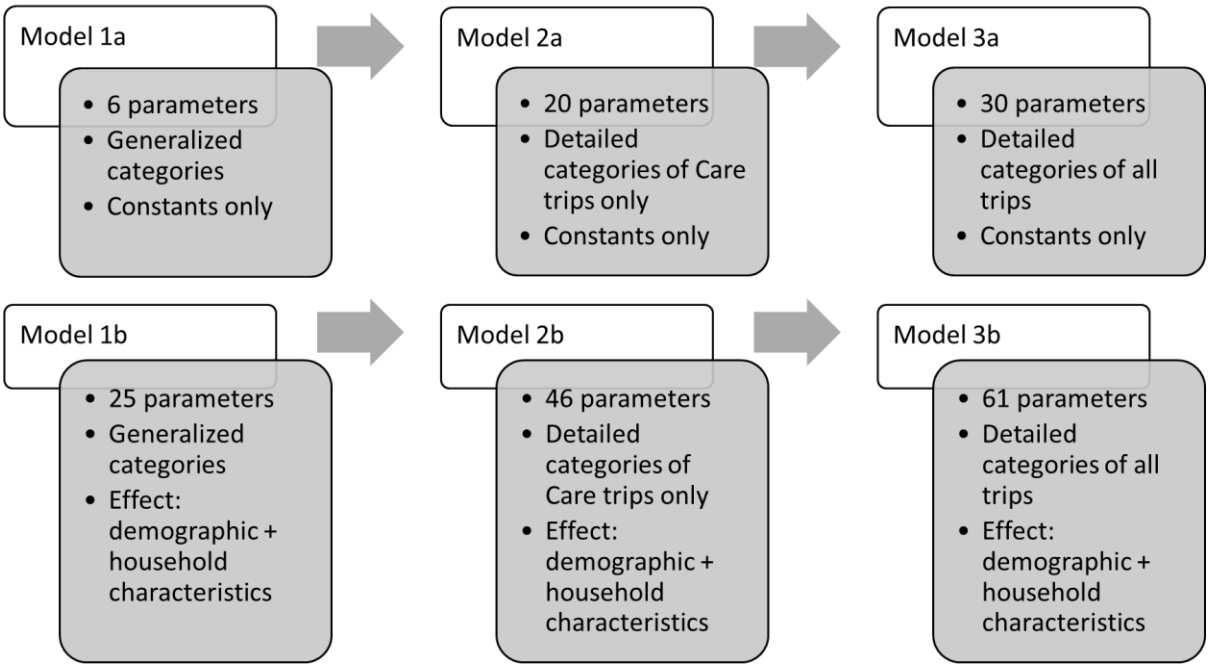

Figure 4. Model specification

Model estimation results and testing

The model estimation results are summarized in Table 3 to Table 8. In summary, a better goodness-of-fit is depicted when the model is simpler and when the effect of demographics is taken into account. When comparing Model 1a which has 3 alternatives, Model 2a which has 10 alternatives, and Model 3a which has 15 alternatives – Model 1a shows a better fit by smaller values of AIC and BIC, also by the final log-likelihood value that is closer to 0 among all models. However, when comparing all "a" models which do not include the demographics effects and all "b" models which incorporates demographics effects, the goodness-of-fit is better off when the demographics are taken into consideration. The "b" models have smaller values of AIC and BIC, also the final log-likelihood values that are closer to 0.

Table 3. Estimation results of constant-only models (1)

Model name	Model 1a		Model 2a		Model 3a	
Number of modelled outcomes	8136		8136		8136	
Estimated parameters	6		20		30	
LL(final)	-24966.88		-35502.27		-46264.18	
AIC	49945.75		71044.55		92588.36	
BIC	49987.78		71184.63		92798.49	
	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)
Scale parameter of Sigma	1	NA	1	NA	1	NA
alpha_base	-20	NA	-20	NA	-20	NA
Satiation parameter of Alpha	2.06E-09	NA	2.06E-09	NA	2.06E-09	NA
Satiation parameter of Gamma						
work	0.4724	46.79	0.4773	46.06	0.4806	46.12
care	0.3332	54.44	NA	NA	NA	NA
personal	NA	NA	0.4491	10.71	0.4489	10.72
household	NA	NA	0.3240	25.07	0.3242	25.06
care child	NA	NA	0.4877	30.38	0.4885	30.39
care adult	NA	NA	0.4446	22.92	0.4445	22.92
errand	NA	NA	0.3694	25.81	0.3699	25.80
groceries	NA	NA	0.3078	41.30	0.3085	41.26
buy food	NA	NA	0.2607	32.86	0.2612	32.80
school	NA	NA	0.5412	12.03	0.5412	12.03
leisure	0.3548	52.14	0.3569	52.38	0.3897	35.68
shopping	NA	NA	NA	NA	0.3554	39.69
eating	NA	NA	NA	NA	0.3174	36.00
social	NA	NA	NA	NA	0.3489	29.86
religious	NA	NA	NA	NA	0.3311	23.50
volunteer	NA	NA	NA	NA	0.3372	17.65

Table 4. Estimation results of constant-only models (2)

Baseline Marginal Utility						
work	-4.4133	-181.93	-4.4831	-181.50	-4.4890	-183.08
care	-3.4787	-167.19	NA	NA	NA	NA
personal	NA	NA	-7.1874	-83.51	-7.1867	-83.48
household	NA	NA	-5.6405	-135.99	-5.6406	-136.11
care child	NA	NA	-5.3476	-147.94	-5.3486	-148.21
care adult	NA	NA	-5.7565	-131.46	-5.7561	-131.50
errand	NA	NA	-5.7099	-133.84	-5.7109	-134.08
groceries	NA	NA	-4.7712	-167.48	-4.7734	-168.09
buy food	NA	NA	-5.1930	-150.90	-5.1947	-151.36
school	NA	NA	-7.3244	-80.07	-7.3241	-80.09
leisure	-3.3328	-163.92	-3.3400	-166.11	-4.6366	-170.52
shopping	NA	NA	NA	NA	-4.7918	-165.60
eating	NA	NA	NA	NA	-4.7681	-164.05
social	NA	NA	NA	NA	-5.1459	-153.80
religious	NA	NA	NA	NA	-6.0089	-124.08
volunteer	NA	NA	NA	NA	-6.6093	-102.04

Table 5. Estimation results of models with demographics effects (1)

Model name	Model 1b		Model 2b		Model 3b	
Number of modelled outcomes	8136		8136		8136	
Estimated parameters	25		46		61	
LL(final)	-23691.64		-32989.67		-43727.77	
AIC	47433.29		66071.34		87577.54	
BIC	47608.39		66393.53		88004.79	
	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)
Scale parameter of Sigma	1	NA	1	NA	1	NA
alpha_base	-20	NA	-20	NA	-20	NA
Satiation parameter of Alpha	2.06E-09		2.06E-09		2.06E-09	
Satiation parameter of Gamma						
CARE TRIPS						
care	0.2928	54.16	NA	NA	NA	NA
personal	NA	NA	0.4492	10.71	0.4490	10.71
household	NA	NA	0.3239	25.06	0.3241	25.04
care_child	NA	NA	0.2274	17.88	0.2280	17.99
care_adult	NA	NA	0.3865	21.3	0.3870	21.29
errand	NA	NA	0.3684	25.77	0.3691	25.76
groceries	NA	NA	0.3075	41.32	0.3083	41.28
buyfood	NA	NA	0.2616	32.88	0.2620	32.82
WORK TRIPS						
work	0.4089	43.94	0.4136	43.61	0.4200	43.84
school	NA	NA	0.4564	11.36	0.4596	11.38
LEISURE TRIPS						
leisure	0.3538	52.13	0.3563	52.39	0.3899	35.7
shopping	NA	NA	NA	NA	0.3541	39.48
eating	NA	NA	NA	NA	0.3177	36.01
social	NA	NA	NA	NA	0.3479	29.79
religious	NA	NA	NA	NA	0.3306	23.48
volunteer	NA	NA	NA	NA	0.337	17.64

Table 6. Estimation results of models with demographics effects (2)

Model name	Model 1b		Model 2b		Model 3b	
Number of modelled outcomes	8136		8136		8136	
Estimated parameters	25		46		61	
LL(final)	-23691.64		-32989.67		-43727.77	
AIC	47433.29		66071.34		87577.54	
BIC	47608.39		66393.53		88004.79	
	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)
Scale parameter of Sigma	1	NA	1	NA	1	NA
alpha_base	-20	NA	-20	NA	-20	NA
Satiation parameter of Alpha	2.06E-09		2.06E-09		2.06E-09	
Baseline Marginal Utility						
CARE TRIPS	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)
care	-3.6168	-91.80	NA	NA	NA	NA
personal	NA	NA	-7.0983	-58.14	-7.0978	-58.13
household	NA	NA	-5.7123	-89.86	-5.7127	-89.97
care_child	NA	NA	-6.3294	-60.47	-6.2776	-69.36
care_adult	NA	NA	-5.9633	-86.69	-5.9596	-86.74
errand	NA	NA	-5.8922	-85.35	-5.8928	-85.45
groceries	NA	NA	-4.8339	-112.37	-4.8364	-112.78
buyfood	NA	NA	-5.1864	-102.85	-5.1878	-103.12
WORK TRIPS						
work	-6.8175	-62.56	-8.1778	-34.31	-8.1672	-34.26
school	NA	NA	-9.1195	-39.72	-9.1184	-39.73
LEISURE TRIPS						
leisure	-3.3417	-116.74	-3.3500	-118.2	-4.5440	-118.13
shopping	NA	NA	NA	NA	-4.9405	-109.2
eating	NA	NA	NA	NA	-4.7184	-112.62
social	NA	NA	NA	NA	-5.3233	-99.6
religious	NA	NA	NA	NA	-6.1105	-80.98
volunteer	NA	NA	NA	NA	-6.7473	-65.62

Table 7. Estimation results of models with demographics effects (3)

DEMOGRAPHICS	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)
Being a woman in serving care trips						
care	0.0605	1.57	NA	NA	NA	NA
personal	NA	NA	-0.1711	-0.99	-0.1706	-0.99
household	NA	NA	0.1272	1.52	0.1278	1.53
care_child	NA	NA	0.2507	2.27	0.2382	2.86
care_adult	NA	NA	0.0963	1.09	0.0912	1.04
errand	NA	NA	0.3152	3.59	0.3139	3.58
groceries	NA	NA	0.1132	1.98	0.1135	1.99
buyfood	NA	NA	-0.0184	-0.27	-0.0183	-0.27
Being a woman in serving work trips						
work	-0.2596	-4.93	-0.2683	-5.03	-0.2652	-5.00
school	NA	NA	0.1300	0.59	0.1304	0.60
Being a woman in serving leisure trips						
leisure	0.0207	0.56	0.0212	0.58	-0.1779	-3.30
shopping	NA	NA	NA	NA	0.2610	4.45
eating	NA	NA	NA	NA	-0.0954	-1.65
social	NA	NA	NA	NA	0.3074	4.49
religious	NA	NA	NA	NA	0.1802	1.83
volunteer	NA	NA	NA	NA	0.2399	1.81
Serving childcare trips						
Having at least one child	-0.1762	-4.03	NA	NA	-0.234	-2.30
Being a mother	NA	NA	0.0087	0.10	NA	NA
Having a spouse/partner	-0.2016	-3.66	-0.1675	-1.17	-0.1677	-1.16
Having an employed spouse/partner	0.3452	6.06	0.4022	2.82	0.4425	3.16
Older age of the youngest child	0.0106	2.74	0.0284	4.69	0.0374	4.65
The more time spent in childcare activities	1.00E-04	1.52	-6.00E-04	-3.94	-5.00E-04	-3.04
Traveling with children in childcare activities	0.7418	20.57	1.5962	17.08	1.7106	18.13
Traveling with spouse in childcare activities	1.5793	8.77	3.7801	18.80	3.8229	17.97
Traveling with children and spouse in childcare activities	-0.6548	-7.63	-1.5076	-10.87	-1.5417	-10.50

Table 8. Estimation results of models with demographics effects (4)

DEMOGRAPHICS	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)	estimate	Rob.t-ratio(0)
Serving eldercare trips						
The more time spent in eldercare activities	6.00E-04	2.46	0.0019	6.52	0.0019	6.53
Engaging in eldercare and traveling with an elderly person	1.7432	16.22	3.5198	33.76	3.463	31.72
Traveling with an elderly person in eldercare activities	-4.00E-04	-0.60	-0.002	-4.40	-0.0018	-3.86
Being employed						
Having multiple jobs	0.3552	4.03	0.3407	3.87	0.3278	3.69
Working Full-Time	3.1144	27.87	4.4748	18.74	4.4432	18.61
Working Part-ime	2.7632	20.51	4.2232	17.16	4.1888	17.03
Going to school						
Going to school	0.4634	2.71	3.7914	10.39	3.7860	10.40
The older the age of people going to school (Age < 25)	0.8909	3.88	1.1428	4.16	1.1268	4.11

Findings and Interpretation

The modeling results show that a better goodness-of-fit are shown in the model that has fewer alternatives and the model that incorporate the effect of demographics. This is shown by the smaller value of AIC and BIC, also by the value of final log-likelihood that is closer to 0. The satiation paramater Alpha is close to 0, while the satiation parameter Gamma are varied. The smaller value of the satiation parameter Gamma means the quicker the satisfaction of doing the trips. In other words, it does not need too much time to travel for the activities. The values of the satiation parameter Gamma indicate that time use to travel for care is less easily satisfied than time use to travel for work, specifically for personal care (health visit is included in this care), child care, and adult care. This means that more time is needed to travel for personal care, child care, and adult care compared to commuting. This result may imply that destinations related to these activities (e.g. healthcare facilities, childcare, schools) are relatively farther from the decision-makers' origin (e.g their homes).

The values of the baseline marginal utility Delta show that when being aggregated, people spend more time traveling for care than commuting. However, when being broken down into details of types of care trips, people spend less time on each type of care trip. Interestingly, all time use to travel related to shopping activities (grocery shopping, buying foods, and leisure shopping) are greater than time use for commuting.

Regarding demographics, it is found that women generally spend more time traveling for care which is consistent with previous studies. Furthermore, women spend less time traveling for personal care (including health visits), buying foods, eating out, commuting, and leisure-related activities. When looking at the household structure, people who have at least one child in the household and/or a spouse/partner spend less time traveling for child care. However, those who travel with the child significantly travel more for child care. When a spouse/parter is present, the probability is the child care travel depends on the spouse/partner. Moreover, the younger the age of the youngest household child is also associated with less time traveling for child care. It is reasonable since parents with a very young child mostly stay at home due to the vulnerability of the baby. As for elder care, people who take care of an elderly person is likely to make fewer trips for adult care.

Summary and conclusion

To conclude, the model shows a better fit when there is fewer alternatives which makes fewer parameters, also when demographics effect is taken into account. More time needed to satisfy the travel needs to pursue personal care, child care, and adult care activities may indicate poor accessibility to destinations related to these activities compared to accessibility to workplace. However, there may be an endogeneity of residential self-selection where people choose to reside nearby their workplace with a trade-off of being farther from other amenities, such as hospitals and clinics. Nevertheless, people spend more time traveling for care in aggregation compare to commute travel. Furthermore, consistent with previous studies, women travel more for care activities than men. Interestingly, the presence of spouse/partner is associated with less time traveling for care due to possibility when the care travel is done by the spouse/partner. However, those who travel with the child for child care significantly spend more time traveling for child care than those who do not. The opposite occurs for elder care, people who take care of an elderly person is likely to make fewer trips for adult care.

This modest exploratory study shows that care trips are significant to people's daily travel and household structure affecting how people travel for care. This finding calls for the attention of policy-makers and transportation planners to take into consideration trip generation of care trips in terms of planning accessibility and travel demand modeling.

As the next steps, this study may be improved better when exploring other variables interactions and taking into account the availability of each type trips for each decision-makers. For example, for a 80-year-old retired person, educational trip, commute trip, and child care trip may not be available to them.

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