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Disentangling the factors affecting leisure joint destination choice

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MEET ME HALFWAY - DISENTANGLING THE FACTORS AFFECTING LEISURE JOINT DESTINATION CHOICE

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ABSTRACT
How far are you literally willing to go to meet your friends and loved ones? Our study breaks down the different factors that influence leisure destination choice between pairs of socially connected people - friends, family, acquaintances. Using a novel dataset of self-reported frequently visited leisure destinations in Zurich, Switzerland, we estimate two joint destination choice models that in addition to joint travel impedance and zonal attractiveness, explicitly consider relationship attributes, such as relationship length, relationship strength or gender homophily. Results suggest that the impact of travel distances on utility differ considerably for home visits and out-of-home leisure, with the marginal disutility of travel being more than three times larger for out-of-home leisure for some pairs. At the same time, we show that the disutility of travel is mitigated by stronger and longer relationships, suggesting a higher willingness to travel further to meet with strong social ties. These results provide new insights on the behavioral mechanism behind joint activities, a subject that has been gaining attention in recent years. Such behavioral insights are not only important to improve the behavioral realism of activity-based models but have the potential of being incorporated in agent-based representations of such models.

Keywords: destination choice; social networks; leisure travel; joint destination choice;

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INTRODUCTION

We conduct leisure travel to be with friends and family, making it an inherently social activity. For example, social interaction is the main purpose for 50% of leisure trips in Germany Schlich et al. (2004); and more than 80%, 66% and 59% of eating out, sports and other leisure activities are conducted with others in Japan Qian et al. (2019). Although these statistics are rather intuitive, the analysis of travel behavior has focused mainly on individual-level activities, disregarding the social aspects of travel Axhausen (2005). In the last decades, research on social networks and travel have gained momentum, but until very recently the focus was mainly on understanding network characteristics, contact frequency patterns Frei and Axhausen (2007), Carrasco et al. (2008), Van den Berg et al. (2009), Kowald and Axhausen (2012), Calastri et al. (2020), Parady et al. (2021) and social effects on decisions such as travel mode choice or mobility tools ownership Kim et al. (2018), but research incorporating social network characteristics in travel dimensions such as destination choice is still very rare. However, due to the high share of joint leisure activities, incorporating social networks is a key factor to improve the behavioral realism and consequently the predictive ability of travel behavior models.

Although several studies have shown the essential influence of social networks on leisure travel Parady et al. (2019), Baburajan (2019), Gramsch-Calvo and Axhausen (2024), studies on destination choice remain scarce, largely due to data limitations. (Arentze, 2015) used data from an experimental stated preference survey using simulated group settings to estimate a model that accounts for the influence of the negotiation process on the spatial choices of groups, and found that group spatial choices are influenced by the negotiation process and that fairness was a non-ignorable factor determining individual preferences for joint activities, especially related to costs. The first study that explicitly incorporated group-level impedances in destination choice models using revealed preference data was conducted by (Han et al., 2023), who showed that models incorporating centrality measures of group impedance generally outperform models that consider individuals independently. In a similar line of research, using a novel dataset that collects data on all members of a clique and their decision-making processes Parady et al. (2023), (Gramsch-Calvo et al., 2024) estimated the willingness to travel (WTT) to meet with others in the context of eating-out activities in Tokyo, Japan, clearly illustrating the trade-offs made by cliques to participate in a joint activity.

From a microsimulation perspective, (Arentze and Timmermans, 2008) proposed a framework for modeling activity patterns within social networks that explicitly considers the formation of networks, the generation of activity, and social influences between members. More recently (Ji et al., 2024a) proposed a method to simulate social networks and incorporate socially motivated travel into an agent-based travel demand forecasting suite. This model was used to model the spread of the epidemic explicitly accounting for the social component of the spread phenomenon.In general, there is a lack of integration of social network effects in large-scale complete travel forecasting model frameworks.

Against this background and with the aim of contributing to the scarce research in this area, this study evaluates the sociodemographic and relationship characteristics that influence the destination choice for leisure activities in Zurich, Switzerland. To the best of our knowledge, this is the first of such studies in the European context. We conduct this study with an eye towards improving activity-based demand models, as coordinated leisure trips are not currently considered in the literature though they are an important share of total leisure trips. Incorporating such trips can improve the prediction of these models and the behavioral realism of transport simulations.

In our study, we estimate two joint destination choice models using ego-reported regularly visited leisure venues. The first model focuses on the effect of relationship level variables on the preference for distance to leisure destinations. The second model explores in detail the effect of homophily on the ego-alter differences for traveled distance. Such relational attributes remain unexplored in the literature. Both models also account for choosing to visit each other's home versus out-of-home as leisure destinations. The rest of this paper is structured as follows: the data section details the survey data collection and the spatial data processing, along with descriptive statistics of both datasets; the methodology section describes the modeling approach taken to estimate the final models; this is followed by discussion of the final model results and their insights into pair joint leisure destination choice.

DATA

Survey collection method

We conducted a survey in Zurich, Switzerland, between November 2022 and January 2023, consisting of three separate stages. To recruit respondents, mail invitations were sent to 8,000 randomly drawn individuals from the official registry. These invitations included an explanation of the survey, a link, and a QR code for the first stage. After this stage was completed, an invitation to the second stage was sent via e-mail three days later. The link to the third stage was sent three days after completion of the second stage. A 15 CHF (about 17US$) incentive was offered to those who completed all three stages of the survey.

The first stage of the survey consisted of sociodemographic questions such as age, income, education, mobility tool ownership, and home location. In addition, it asked for the propensity for leisure activities, knowledge of the city, and other information on the urban environment. The second stage included the questions on regularly visited leisure venues. This stage was separated into two parts: in the first part, called *Place Generator*, the respondents are asked to name the venues they visit regularly for leisure in six categories: restaurants and cafes, bars and nightclubs, cultural centers, sport-centers or gyms, parks and forests, and other leisure activities. For each category there were three spaces to fill, totalling up to 18 leisure venues for each person.

The second stage, the *Place Interpreter*, asked a series of questions about each previously mentioned venue. These questions were related to the visit routine, such as the day and time visited, the regularity of visits, and the reason for visit. After processing and filtering out locations that could not be geocoded, the data had an average of 9.97 venues per person, with the most mentioned category as restaurants and cafes (27.7%), followed by parks and forests (20.8%) and cultural centers (17.5%).

The third stage of the survey was separated in two parts. It starts with a *Name Generator* that asked individuals (here known as egos) to mention the people with whom they discuss important problems, are in regular contact, or whom they can ask for help, with the option to name up to 20 people (known as alters). The survey then includes space for 10 more alters that are in contact with the respondent as a prompt to give a second thought on their social connections. After naming alters, the following *Name Interpreter* section asked individuals about their alters. The questions gathered sociodemographic characteristics of the alters, such as gender, age, nationality and location of alters' homes. The survey also gathered information on the characteristics of the relationship, such as the type of relationship, how long they have known each other, and how often they communicate via different communication channels. To create a link between the second and third stage, questions on regularity of face-to-face meeting and places of meeting were included for out-of-household alters. In this second question the available answers were respondent dependent and consisted of all the venues mentioned in the *Place Interpreter* of the second stage, plus an option for selecting each other's homes as potential destinations.

To finalize the survey, we included a *Resource Generator* that asked four questions on expressive resources. These are defined as practical assistance, tangible goods, or emotional support individuals can receive from their social network with the goal of improving physical and mental health, and life satisfaction Van Der Gaag and Snijders (2005). The questions were: to whom they would ask in case of need of large amounts of money; to whom they would ask for help in case of need someone to take care of them in case of mental or physical health problems; who would they ask for help in case of need of a place to stay for a week, and; who would they ask for help in case of need to get a new job. The possible answers for these questions were all the members mentioned in the *Name Generator*. For a more detailed description of the survey process, please refer to (Gramsch-Calvo and Axhausen, 2022).

Survey data description

For this particular study, we required data from the completion of all three stages of the survey. Altogether the three stages takes on average 55 minutes to complete. Furthermore, due to privacy concerns, respondents were not required to mention their own or their alter's home locations. Therefore, after filtering complete individuals, we had a total of 207 egos (individuals that answered the survey) that mentioned 704 alters and 2,210 choice situations. Table 1 shows the sociodemographic characteristics of the individuals studied. With respect to age, we see that there are more younger alters than egos. This is due to a higher propensity of older individuals to answer the survey. We also exclude persons for under 18 to answer the survey. So there are no egos under 18, but alters mentioned may be under 18. Therefore there is a higher proportion of older egos than alters. In terms of gender, male and female egos are proportionally well represented, skeweing slight towards female. There is a higher proportion of highly educated individuals, especially in terms of alters. In addition, Table 2 shows the variables of interest in terms of relationships, 42% of the pairs of ego-alter are friends, while 30% are immediate family. The low proportion of partners (0.1%) is due to the exclusion of intra-household relationships, therefore we are including only partners that do not co-habitate. Finally, in terms of resources individuals can get from their social network, so-called expressive social resources, individuals are more willing to ask their alters for a place to stay, followed by care in case of health problems, while the expressive resource to which individuals have less access is to ask for large amounts of money.

Spatial Data

To collect data from the spatial characteristics of Zurich, we used the OSM geocoding service OpenStreetMap contributors (2017) to collect information on leisure facilities and other points of interest available and the network distance between egos and alters homes, and destinations. There are a total of 11,722 venues, of which 62.8% are restaurants and other food venues, 11.8% are cafes, 10.9% are bars and 15.5% others including cinemas, parks, etc. After collecting the data on venues, to create the choice set for the estimation, we separated the city into equally sized spatial zones of 7 hectares and counted the number of leisure venues inside each zone. We tested different zone sizes and 7 hectares simplifies the estimation with similar results to smaller zones. In total there are 806 zones with the number of venues going from 1 to 173. Our zonal system is represented in Fig. 1.

TABLE 1 Sociodemographic characteristics of the studied individuals

	Ego total	Ego %	Alter total	Alter %
Under 18	-	-	3	0.4%
Less than 35 years of age	18	8.7%	105	14.8%
Between 35 and 44 years of age	17	8.2%	95	13.5%
Between 45 and 54 years of age	40	19.3%	169	24.0%
Between 55 and 64 years of age	95	45.9%	208	29.5%
More than 65 years of age	37	17.9%	124	17.6%
Male	98	47.3%	308	43.8%
Female	108	52.2%	387	55.0%
Other	1	0.5%	9	1.3%
High school or lower	26	12.6%	46	5%
Bachelor	95	45.9%	415	64%
Masters or PhD	86	41.5%	221	24%
I don't know	-	-	22	5%

TABLE 2 Relationship characteristics

Type of relationship		
	Total	%
Friends	405	57.5%
Immediate family	117	16.6%
Partner	8	0.1%
Acquaintances	113	16.1%
Other	61	8.7%
Expressive resources		
	Yes	No
Would ask for large amounts of money	14.3%	85.7%
Would ask for care in case of health problems	34.4%	65.6%
Would ask for a place to stay for a week	43.5%	56.5%
Would ask for help looking for a new job	29.8%	70.2%

Finally, we estimated the network distance from both the ego's and the alter's home to the center of the zones available. The network distance was estimated using walk mode. The data collected focused on regular destinations; therefore, the origin of the trip depends on the day and previously performed activity. For this reason, we used distance to home as a measure of travel impedance, considering that regardless of the origin, the distance to home is always a relevant location as the individual would eventually have to return to their place of residence. In terms of the estimated distance, the egos live a median of 4.1 km away from the chosen location while the alters are 5.4 km away. The maximum distance included in the estimation for the egos was 49 km, for the alter was 50 km, while the maximum total distance was 91.16 km. Figure 2 shows the relationship between total distance traveled and range. Total distance traveled is calculated as distance traveled by ego in addition to distance traveled by alter, and range is the absolute value of the difference in the distance traveled by both persons. The graph shows a conical shape bordered on both sides by when the range is zero and when it is at its maximum, which is the distance

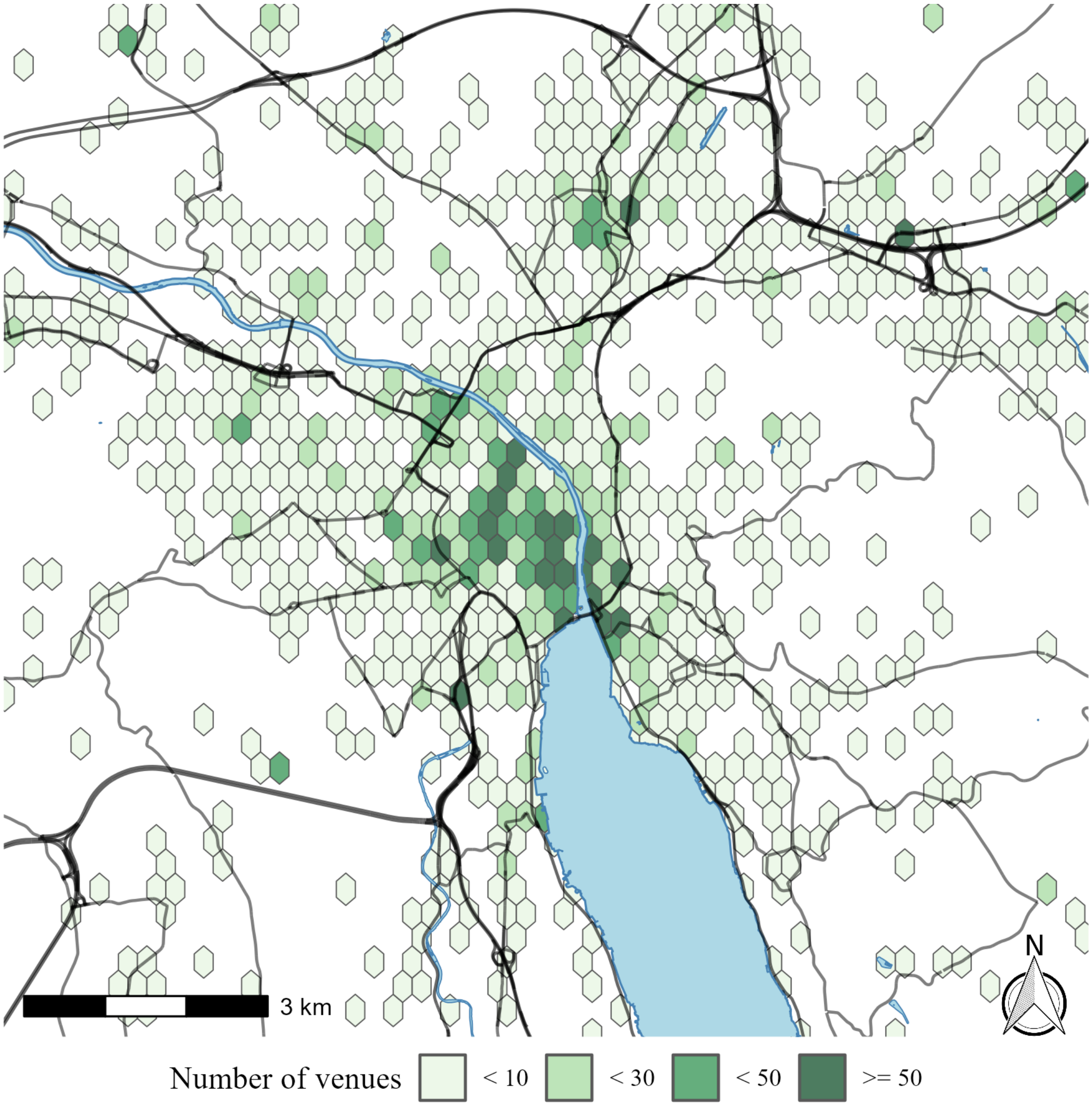

FIGURE 1 Zones (Zurich) used for estimation of the destination choice model

between egos' and alters' homes.

The survey data also indicated whether the ego's or alter's home location is chosen as a joint destination location. Therefore, ego's and alter's homes were also processed as potential destination locations and the network distances between ego and alter homes are estimated. There are 27% of destinations chosen as each other's homes. When egos visit alters' homes, they travel an average of 3.23 km. When alters visit egos' homes, they travel an average of 4.07 km. To show the proportion of destinations, Figure 3 visualizes the ratios of ego home distance to destination divided by alter home distance to destination and ratio of alter distance to destination divided by ego distance to destination. When these two ratios are less than 1, then the trip is closer to ego or alter respectively, If the ratio is near 1, then the ego and alters travel equidistant to the destination, meeting halfway, so-to-speak. The data shows that there is a tendency to choose destinations close to the ego or alter's homes, and also a slight bump at the halfway mark, showing people do, indeed,

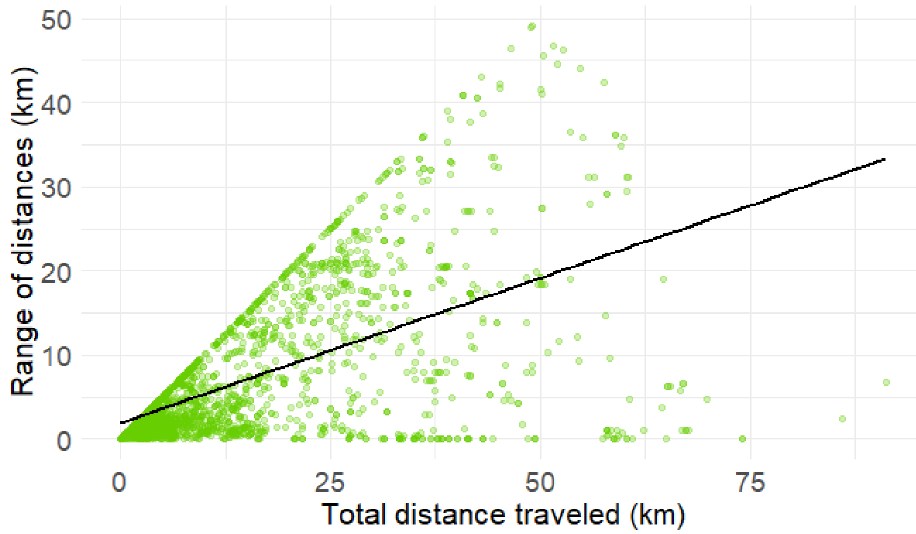

FIGURE 2 Total traveled distance of both persons versus range of distances

meet somewhat halfway.

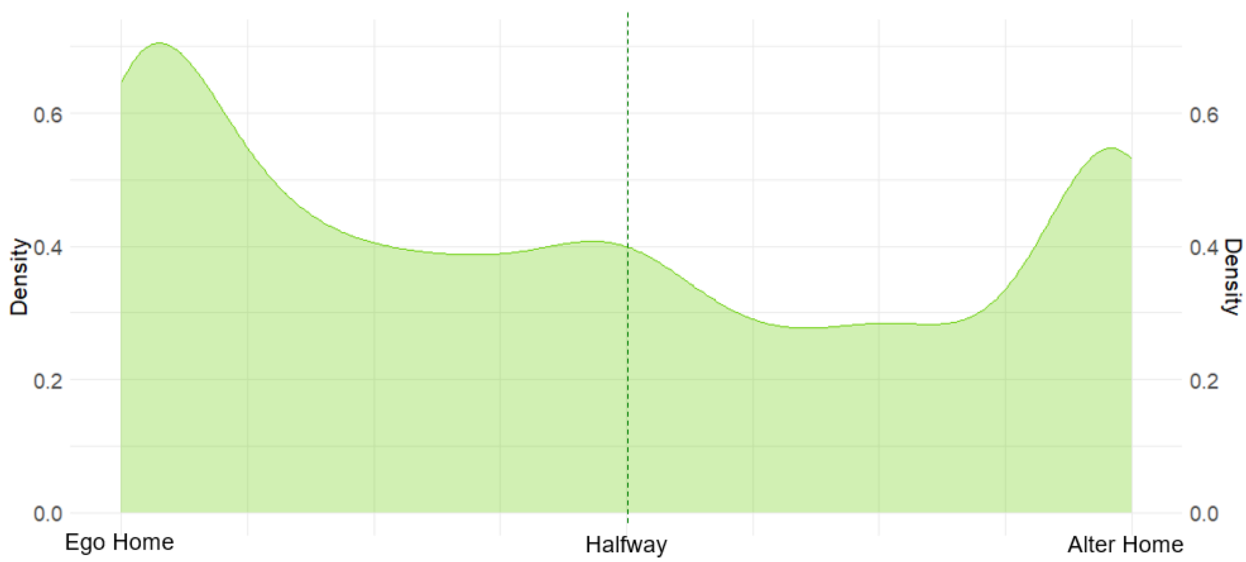

FIGURE 3 Density of destinations chosen from in relation to how relatively close they are to ego's and alter's homes

MODEL FRAMEWORK

To estimate the models, we used a choice model based on McFadden McFadden (1973) in which the probability that individual n visits zone i is given by:

$$P_{i,n} = \frac{e^{V_{i,n}}}{\sum_{j \in C_{i,n}} e^{V_{j,n}}} \tag{1}$$

In which $V_{i,n}$ is the systematic component of the utility of person n given by the alternative i. $C_{i,n}$ is the choice set that depends on the type of venue visited by the individual. The zones that belong to the choice set are all the zones that have at least one venue of the type of venue chosen by individual n. In our case, we estimate a joint destination choice model, which means the choice i is not only made by person n but also by person m. We have specified three utility functions, two utility functions for the first final model using combined impedance, consisting of one utility equation for in-home activities and one for out-of-home activities, and one equation for the model using separate impedance for each individual. $V_{i,n}$ is a representation of joint utility of both persons. For utility specifications, please refer to the Results section. The models are estimated using the R Apollo package Hess and Palma (2019). The models were estimated in an incremental additive process. The choice set consists of zones for which at least one of the type of venue chosen exist. For example, if the type of venue chosen is 'restaurant', then only zones in which at least one restaurant exists are considered as part of the potential destination choice set.

RESULTS AND DISCUSSION

As mentioned above, two models were estimated; the first model considers the mean distance between the ego's home to the destination and the alter's home to the destination, while the second includes separate distance coefficients for the egos and alters.

Exploration of combined distance measure

The first model estimates the importance of mean ego-alter distance from home and is defined as:

$$
\begin{aligned}
V_{i,nm}^{non-home} = & \log(DNH_{i,avg_{nm}}) \cdot (\beta_{DNH_{avg}} + \beta_{rel} \cdot rel_{nm} + \beta_{res} \cdot res_{nm}) + \\
& \log(D_{i,range_{nm}}) \cdot (\beta_{D_{range}} + \beta_{h_{age}} \cdot h_{age_{nm}} + \beta_{h_{fem}} \cdot h_{fem_{nm}}) + \\
& \beta_{attr} \cdot \log(n_{venues_i})
\end{aligned} \tag{2}
$$

$$
\begin{aligned}
V_{i,nm}^{home} = & \log(DH_{i,avg_{nm}}) \cdot (\beta_{DH_{avg}} + \beta_{rel} \cdot rel_{nm} + \beta_{res} \cdot res_{nm}) + \\
& \beta_{attr} \cdot \log(n_{venues_i}) + ASC_{home} \cdot (1 + h_{fem_{nm}} \cdot \beta_{home,h_{fem}})
\end{aligned} \tag{3}
$$

Equation (2) is the utility function of non-home destinations in the destination zone i by the ego n and the alter m. Equation (3) is then the utility function of home destinations, meaning the destination is neither the ego's nor the alter's home. $DNH_{i,avg_{nm}}$ is the average network distance from both individuals' home to the zone i, for non-home activities. rel_{nm} is a dummy variable if the relationship between ego and alter has been longer than seven years. res_{nm} is a dummy equal to one when the ego can obtain three or four expressive resources from the alter as a measure of closeness of the pair. $D_{i,range_{nm}}$ is the difference in distance to the zone between ego and alter, calculated as $|D_{i,n} - D_{i,m}|$, equivalent to the standard deviation, and it is a measure of fairness in distance to home. $h_{age_{nm}}$ is a dummy if the ego and alter are in the same age bracket. $h_{fem_{nm}}$ is a dummy when both individuals are female. n_{venues_i} is the number of venues in the zone i, which is a proxy for the attractiveness of the zone. Note that the equation uses the log of distances, range and the number of venues, we use this specification because we assume that the preference for this variables does not have a linear impact on the utilities but a decreasing marginal utility. Equation (3) uses the same variables, with three exceptions: distance has a separate coefficient depending if it is a home activity or not, range is not included as there is always one individual with a distance equal to zero, and an alternative specific constant ASC_{home} for home activities, interacting with $h_{fem_{nm}}$. The results of the estimation are presented in Table 3. Note all p-values presented in estimation results are 1-sided.

TABLE 3 Model using combined average distance

Variables	Coefficients	Std. err.	p-value
ASC			
Home destination	2.11	0.10	0.00
Home destination * gender homophily - female	-0.62	0.12	0.00
Average distance			
Home destination average distance	-0.64	0.11	0.00
Non-home destination average distance	-2.16	0.10	0.00
Average distance * Long relationship	0.23	0.10	0.01
Average distance * High social capita	0.29	0.08	0.00
Range distance - Non-home destination only			
Non-home range distance	0.50	0.09	0.00
Non-home range distance * Age homophily	-0.22	0.08	0.00
Non-home range distance * Gender homophily - female	-0.07	0.05	0.11
Attractiveness			
Attractiveness	0.42	0.01	0.00
Number of observations			2210
ρ^2			0.23
AIC			20205
BIC			20262
LL Start			-13111
LL End			-10092

Various specifications of combined distance variables were tested - minimum, maximum, and average. Of these, the average distance was shown to have the best model performance. First, the alternative specific constant (ASC) was estimated for the home destinations to capture the unobserved variables that influence the choice of home over out-of-home destinations, showing there is a positive preference for visiting homes. The ASC has an additional term for female homophily - pairs who are both female have lower utility for home locations than pairs who are both male or are of different genders. In terms of distance from home, the coefficients for home and non-home destinations considerably differ, with the estimate for non-home activities being more negative. This means distance from home plays a bigger role in non-home activities compared to home activities. The interactions between distance and relationship strength (relationship length and expressive social resources) both have a positive sign, showing that distance to home has a lower effect when traveling to meet with stronger relationships. In comparison, relationships with high expressive social resources have a smaller disutility of distance than longer relationships. Figure 4 graphically demonstrates this in the change in utility as distance increases for different relationship length and social resources.

The variable range was found to be positive, which echoes the findings in Han et al. (2023) and Gramsch-Calvo et al. (2024) of a positive standard deviation coefficient. This means that one person tends to be closer to the destination than the other, suggesting that there is not always fairness in terms of the pair's traveled distance. In terms of homophily variables, the estimated coefficient is negative, indicating that when persons are closer in age, there is a higher fairness in distances to home. In terms of gender homophily, when both individuals are female, the impact on range is also negative, albeit less negative than for age homophily. Figure 5 shows the change in utility for different homophily combinations as range goes up, with utility increasing fastest for pairs of different ages and are not female-female.

To make a comparison between the utilities of travel for home activities and non-home activities, we have estimated the marginal rate of substitution ($MRS_{D^{home}_{i,avg_{nm}},D^{non-home}_{j,avg_{nm}}}$) between home and non-home distances, this is defined as:

$$MRS_{D^{home}_{i,avg_{nm}},D^{non-home}_{j,avg_{nm}}} = \frac{\frac{\partial V^{home}_{i,nm}}{\partial D_{i,avg_{nm}}}}{\frac{\partial V^{non-home}_{j,nm}}{\partial D_{j,avg_{nm}}}} = \frac{\beta_{DH_{avg}} + \beta_{rel}\cdot rel_{nm} + \beta_{res}\cdot res_{nm}}{\beta_{DNH_{avg}} + \beta_{rel}\cdot rel_{nm} + \beta_{res}\cdot res_{nm}} \cdot \frac{D^{non-home}_{j,avg_{nm}}}{D^{home}_{i,avg_{nm}}} = \frac{-0.64 + 0.23\cdot rel_{nm} + 0.29\cdot res_{nm}}{-2.16 + 0.23\cdot rel_{nm} + 0.29\cdot res_{nm}} \cdot \frac{D^{non-home}_{j,avg_{nm}}}{D^{home}_{i,avg_{nm}}} \tag{4}$$

When this value is equal to one, the ego-alter pair has the same level of disutility between traveling to a non-home activity j and traveling to a home i, if we consider a relationship with $rel_{nm} = res_{nm} = 0 \Rightarrow D^{home}_{i,avg_{nm}} = 0.3\cdot D^{non-home}_{j,avg_{nm}}$, so people are more willing to travel further if the destination is the other person's home compared to a non-home zone.

Exploration of separate distance measures

To look deeper into the effect of homophily on willingness to travel, we estimate a model with separate distance parameters for the two persons so as to differentiate the influence of age and gender characteristics. The estimated model is in Table 4. Equation (5) is the utility specification for non-home, using separate distances for egos and alters, we have excluded home destination from this model because for this type of trips there is always one individual with a travel distance equals to 0.

$$\begin{aligned} V^{non-home}_{i,nm} = {} & \log(D_{i,ego}) * (\beta_{D_{ego}} + \beta_{pt_{ego}} * n_{ptstops_{egohome}} + \beta_{older} * older + \\ & \beta_{female_{ff}} * female_{ff} + \beta_{female_{mf}} * female_{mf} + \beta_{male_{mf}} * male_{mf}) + \\ & \log(D_{i,alter}) + (\beta_{D_{alter}} + \beta_{pt_{alter}} * n_{ptstops_{alterhome}} + \beta_{older} * older + \\ & \beta_{female_{ff}} * female_{ff} + \beta_{female_{mf}} * female_{mf} + \beta_{male_{mf}} * male_{mf}) + \\ & \beta_{attr} * \log(n_{venues_i}) \end{aligned} \tag{5}$$

The non-home destination utility considers the ego's and alter's distances to the destination separately, as denoted by $D_{i,ego}$ and $D_{i,alter}$, respectively. As shown in the results, the ego distance and alter distance parameters are statistically different from each other, as we are estimating ego-alter pairs travel we would expect to see the same parameter for both individuals, to reduce the

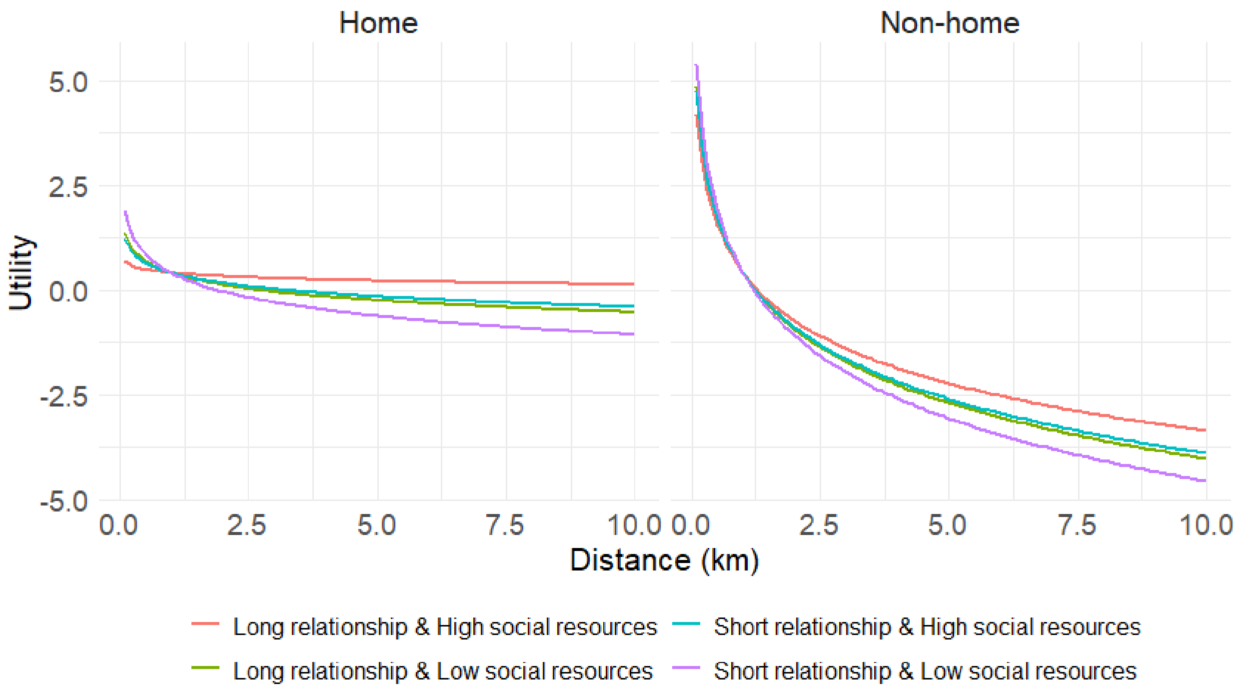

FIGURE 4 Relationship variables' effect on changes in utility

difference we included the number of public transit stops around ego's or alter's homes as a proxy of accessibility of their home locations, denoted by $n_{pt\,stops_{ego\,home}}$ and $n_{pt\,stops_{alter\,home}}$, this helped reducing the difference of the distance parameters between both individual but there is still an unobserved variable that could be confounding the effect, which we hypothesize is due to the ego-centric data collection method. Ego and alter's distances are interacted with the age variable, β_{older} is the coefficient for when the alter or ego is 20 or more years older than the other. The distances are also interacted with gender variables, $\beta_{female_{ff}}$ is the coefficient for the dummy variable of being a female in a female-female pair. Likewise, $\beta_{female_{mf}}$ and $\beta_{male_{mf}}$ are the coefficients for being female in a male-female pair or male in a male-female pair. The reference level here is being male in a male-male pair. Attractiveness is defined similarly as in the previous model, as the number of venues in the zone n_{venues}.

The coefficient β_{older} indicates that the older person, in a pair where one is at least 20 years older, has a lower distance sensitivity. In the data set 88% of these pairs are family members; therefore, the older generation of the family (i.e. parents, uncles/aunts, granparents) tends to take the travel burden in a joint activity. This is in line with the effect of age homophily in Table 3, which showed that pairs of similar age have a smaller range coefficient compared to pairs of different age. Figure 6 shows the change in utility if one person is much older than the other versus when they are within 20 years of age of each other. As distance goes up for ego and alter, utility for the pair with age difference decreases slower than for those similar in age.

In terms of gender effects, the model captures the differences depending on the gender composition of the pair, being female in a female-female pair shows a parameter estimated of 0.16 but with a high standard error, while being female in a male-female pair has a lower estimate but with lower significance as well, this shows that when a male-female pair travels, the female is the

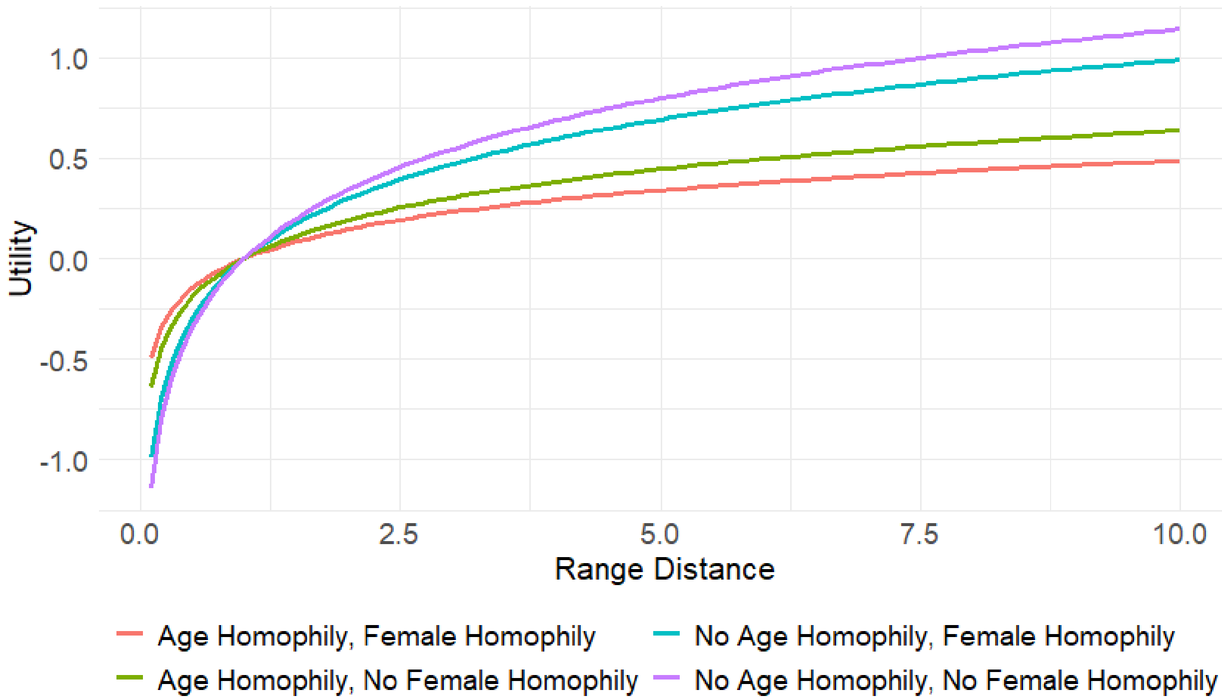

FIGURE 5 Relationship variables' effect on utility

individual that tends to have a lower distance sensitivity, therefore traveling more on average. The change in utility as influenced by gender variables is shown in Figure 7.

CONCLUSION

Our study confirmed that when two people want to meet, personal attributes, home locations and other activity locations of both persons matter. The results demonstrate the specific impacts of homophily and relationship strength on joint destination choice, and on visiting home versus out-of-home locations. The estimation of pair level and individual level destination choice models goes toward the understanding of the dynamics in group travel decisions.

A possible limitation of this study is that the dataset used focuses on destinations that are often visited by the ego. Therefore, destinations that may be picked occasionally or newly are not contained. This means our model can only speak to the joint destination choice process regarding usual or habitual locations. The model also does not have group travel of more than two persons yet and cannot see the impact of larger groups on joint destination choice. Future research could explore this further by looking at and looking at larger groups.

Nevertheless, the results substantiate the impact of both persons' attributes on joint leisure destination choice. While this finding is not unexpected, almost all transport models have ignored this issue. The traditional trip-based approach McNally (2000) does not account for coordinated destinations of travelers. Activity-based travel demand models Rasouli and Timmermans (2014) in principle provide the opportunity to coordinate travel destinations of people who want to meet, though this is typically ignored. While intra-household coordination is fairly established in activity-based models Gliebe and Koppelman (2002), activity-based model in practice typically do not coordinate travel for agents of different households. As most of these trips for joint activi-

TABLE 4 Model using separate distances for ego and alter

Variables	Coefficients	Std. err.	p-value
Non-home destination distance			
Non-home ego distance	-1.45	0.08	0.00
Non-home alter distance	-1.12	0.09	0.00
Non-home distance * Older in older-younger pair	0.53	0.09	0.00
Non-home distance * Female in female-female pair	0.16	0.05	0.11
Non-home distance * Male in male-female pair	0.06	0.08	0.34
Non-home distance * Female in male-female pair	0.12	0.07	0.07
Public transit stops			
Non-home ego distance * Number of PT stops - Ego home	0.16	0.03	0.02
Non-home alter distance * Number of PT stops - Alter Home	0.21	0.04	0.00
Attractiveness			
Attractiveness	0.56	0.02	0.00
Number of observations			2210
ρ^2			0.14
AIC			15567
BIC			15615
LL Start			-9081
LL End			-7774

ties are for leisure purposes, the growing relevance of leisure travel suggests that simulating joint destination choice is only becoming more important.

The agent-based representation of activity-based models provide the opportunity to simulate the coordinated destination choice. There are two ways to realize this.

1. The model generates individual trips for each agent. Using parameters presented in this paper, it is straightforward to select two or more suitable trips of the same purpose at about the same time that receive the same destination location and the same arrival time.
2. Joint activities could be selected as a new type of activity. Instead of generating the activity type ”leisure”, the model selects explicitly for an ego agent ”leisure alone”, ”leisure with two”, etc. Next, alter agents from the ego-agent's social network can be selected to join the activity. The time of the activity can be coordinated to fit the activity schedules of both the ego and the alter, just as it happens in real life.

Both approaches are likely to generate comparable activity patterns. The second approach saves the work of overwriting an already selected destination and arrival time for the alter agent.

The simulation of joint destination selection has ready and relevant applications. For one, ride-pooling has received more interest to reduce the number of car trips. Friends who meet are much more likely to either car-pool or ride-pool than disconnected trips. The previous application of the framework proposed by Ji et al. to see implications on epidemic spread patterns would could also benefit from applying a joint destination framework using empirically estimated results.

This study has gone towards deepening our understanding of how our social nature influences the way we travel. It highlights the importance of considering social relationships and personal attributes in travel behavior models. The work remains to be done to translate these findings

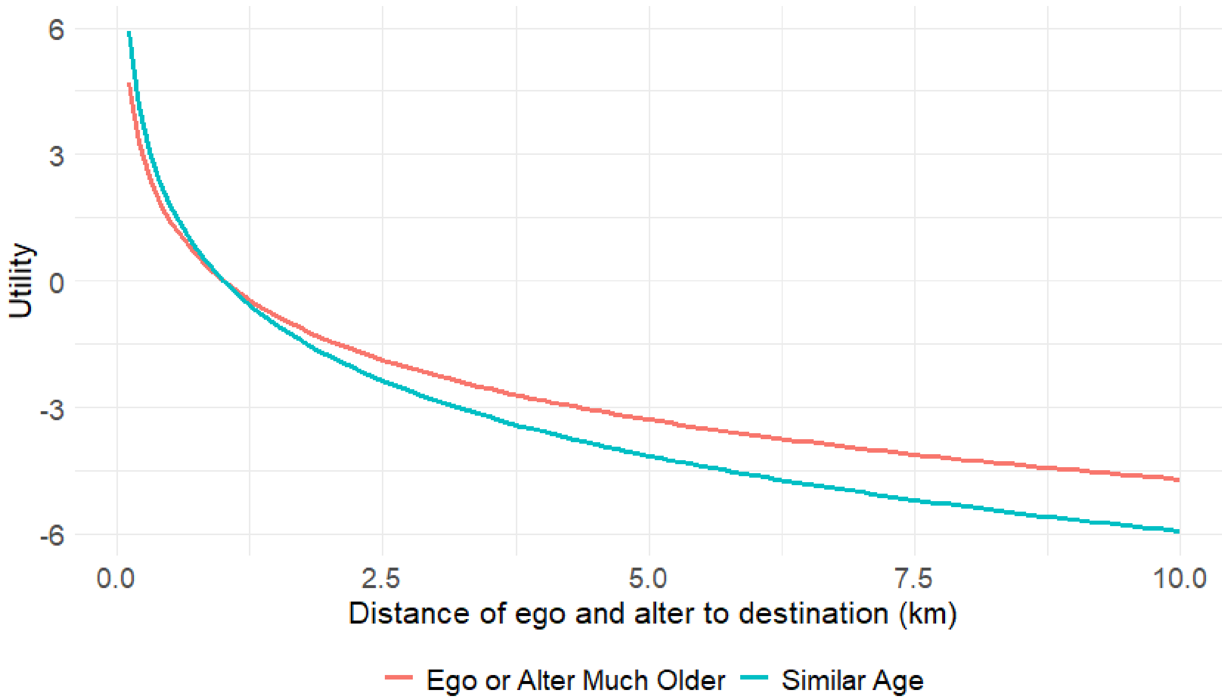

FIGURE 6 Effect of age homophily on probability

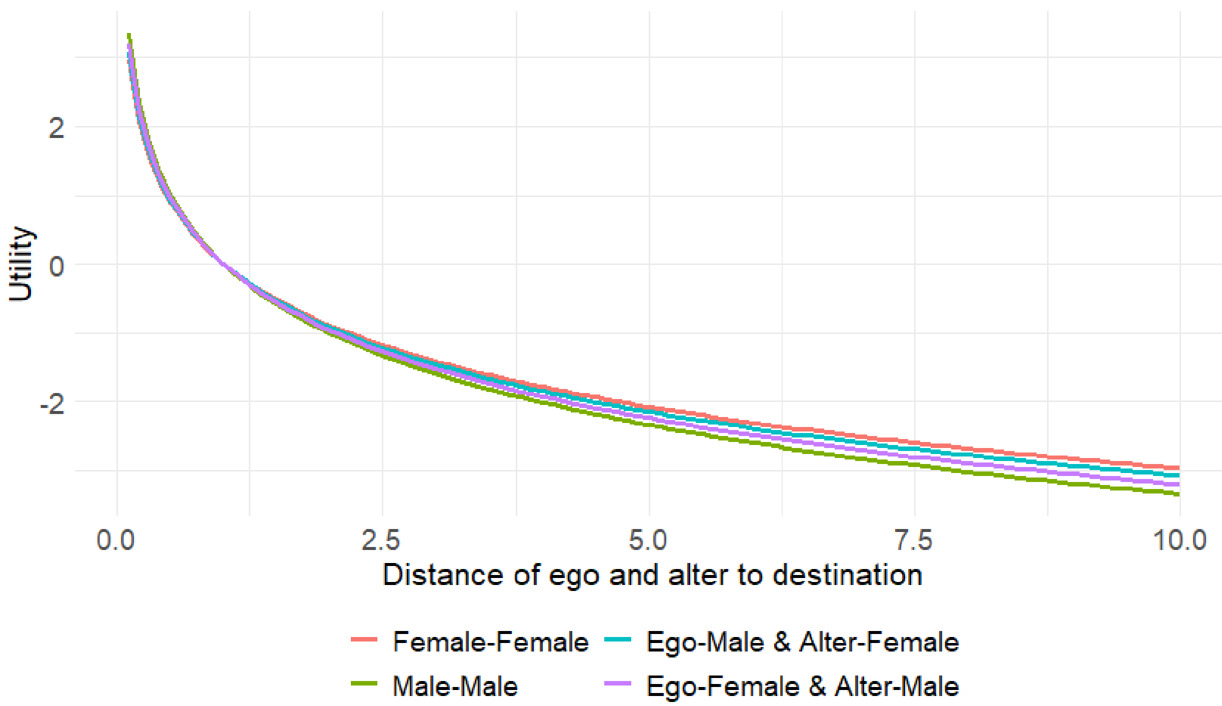

FIGURE 7 Effect of gender homophily on probability

into better tools to serve our travel needs as a society.

AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: B. Gramsch-Calvo, J. Ji, R. Moeckel, K.W. Axhausen, G. Parady; data gathering and preparation: B. Gramsch-Calvo, J. Ji, K.W. Axhausen; analysis and interpretation of results: J. Ji, B. Gramsch-Calvo; draft manuscript preparation: J. Ji, B. Gramsch-Calvo, G. Parady, R. Moeckel, K.W. Axhausen. All authors reviewed the results and approved the final version of the manuscript.

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