

A collective discrete choice model of personal mobility vehicle (PMV) ownership: A group-based stated preference approach

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Extended Abstract (997 words)

Modeling household decision-making is one of the key components in travel behavior analysis, since household members usually share resources (such as vehicles) and tasks (such as pick-up and drop-off of children), and often conduct activities together (such as leisure). The objective of this study is (1) to enrich our theoretical and empirical framework for modeling household decisions by explicitly taking into account *preference-based and attribute-based altruisms* (the details will be explained below), and (2) to empirically apply the model to the household decision on personal mobility vehicle (such as mobility scooter) ownership based on a group-based stated preference survey data.

The most widely used household model in the transportation field is a unitary household model, where a household is assumed to behave as a single decision maker. For example, a number of trip generation models have been developed as a household decision rather than an individual decision. On the other hand, it has been claimed that these models do not take into account each individual's preference in the household.

Since 1990s, a number of household decision-making models have been developed, where multiple household members are explicitly considered. One of the typical models is developed based on a discrete choice model. [Yamamoto et al. \(2001\)](#) developed a main

driver choice model for the households who share vehicle(s). [Srinivasan and Athuru \(2005\)](#) modeled the allocation of maintenance activities among household members. In these models, alternatives are household members, and thus it is assumed that one who has a highest utility would be chosen. Applying such discrete choice models to describe household behavior has been criticized, since the underlying household decision mechanisms are not well elaborated. Although these models were developed based on the utility maximization theory, the meaning of the utility is ambiguous ([Timmermans, 2006](#)). There are several models that explicitly consider the household decision mechanisms, such as [Timmermans et al. \(1992\)](#), [Molin et al. \(1997&2000\)](#), and [Vovsha et al. \(2003&2004\)](#): For example, [Timmermans et al. \(1992\)](#) modeled a joint decision making of residential location choice with explicit consideration of each household member's preferences, based on information integration theory ([Anderson, 1981](#)). The core idea of these models is that the weighted average of household members' preferences is assumed to be a household preference, and thus the model allows us to evaluate the impact of changes in individual preference on the household preference.

[Zhang et al. \(2002&2005\)](#) and [Zhang and Fujiwara \(2006\)](#) pointed out that household decision-making models based on the weighted average of household members' preferences do not reflect the fact that household members take care of each other, and propose non-unitary household models with considerations of interactions between household members. Also, [Kobayashi et al. \(1996\)](#) developed a random matching model for within-household joint trip generation by two household members, incorporating altruistic and paternalistic motives between household members. In these models, it is assumed that a household member's *preference* would affect the preferences of the rest of members, some of which may be attributed to a caring and altruistic attitude and behavior.

On the other hand, in some other contexts, a household member would pay more attention to others' *attributes* and *situations* rather than others' *preferences*, possibly inducing a different type of caring and altruistic attitude and behavior. For example, in the case of car use decision of an elderly household member, while elderly prefers to travel by a car, other household members may prefer him/her to use public transport due to the safety concern. In this case, household members do not really care about elderly's preference or utility (i.e., preference-based altruism), but his/her attribute or situation such as his/her ability of driving (i.e., attribute-based altruism). However, to the authors' knowledge, existing models in the transportation field could not deal with such an attribute-based altruism.

In this study, we develop a collective discrete choice model of personal mobility vehicle (PMV) ownership, where the both preference-based and attribute-based altruisms are explicitly taken into account. The original collective household model was proposed in the field of labor economics by [Chiappori \(1988&1992\)](#). We first give a comprehensive review on the existing collective household models, and then develop a collective model of household discrete choice behavior that explicitly considers both preference-based and attribute-based altruisms. We then focus on the empirical applicability of the model. A major difficulty to use the model in empirical studies is that preferences at both individual level and household level need to be observed to identify preference-based and attribute-based altruisms (due to this difficulty, most empirical studies assume that there is no altruism attitude and behavior). To obtain all necessary information, we conducted a group-based (household-based) stated preference survey which took the following three steps: we first asked an elderly member in a household to choose one PMV for his/her own use, and then asked a non-elderly member in the same household to choose one for the elder's use. Finally, we asked both of them to select one PMV through dialogues (i.e., household collective choice). The PMVs shown in the survey include mobility scooter, power-assisted bicycle, and small electric vehicle (see Figure 1). Not owning any vehicle is also included as an alternative, and thus there are four alternatives in the choice experiment.



Figure 1. Personal mobility vehicles focused on in this study

Our preliminary empirical results (which only taken into account the attribute-based altruism) indicate that the PMV ownership decision is decided neither solely by the elderly nor solely by the non-elderly, but depending on the relationships between elderly and non-elderly. This means that, even when we focus on the individual use of PMVs, other household members' preferences need to be explored to understand and predict the PMV demand. In the presentation, we will show the estimation results which take into account both types of altruisms. A structural estimation method (e.g., [Aguirregabiria, 2004](#)) will be used for the model estimation, since individual preferences (represented by choice probabilities) are endogenous variables in the collective household model.

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