



Modelling correlation patterns in mode choice models estimated on multiday travel data



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ARTICLE INFO

Article history:

Received 15 May 2016

Received in revised form 21 October 2016

Accepted 18 November 2016

ABSTRACT

Understanding individual choices over time and measuring day-to-day variability in travel behaviour is important to capture the full range of travel behaviour. Although not very common, to date several multi-day travel surveys have been conducted and panel data is available to model different transport choices. However, determining the length of a panel that allows revealing variability in travel behaviour remains an open question. Also, no final agreement has been reached about modelling the various dimensions of correlation over the repeated observations. In this paper, we use the six-week panel data from the Mobidrive survey to estimate a mode choice model that accounts for correlation across individual observations over two time periods: all days of a single week and different days of the week (e.g. all Mondays) in the wave. We first analyse these effects separately, estimating different models for each type of correlation; then we try to disentangle the relative effects of each type of correlation, estimating both types jointly. We found that both types of correlation appeared highly significant when estimated alone, while only the correlation across a given day over the six-week period remained significant, when both types were estimated jointly. This implies that for the Mobidrive panel there is much less variability in mode choice across weeks than across the days of each week. It also suggests that one week could be an appropriate length for a panel to estimate modal choice and to correctly reveal day-to-day variability.

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1. Introduction

Transport planners and modellers have often questioned if a one-day data set is able to capture the full range of travel undertaken by an individual, as there are many activities that are not necessarily performed on a daily basis. In these days, they are still confronted with the problem of measuring variability (day-to-day, week-to-week) in travel behaviour. However, although several multi-day (or panel data¹) travel surveys and more advanced modelling techniques are now available, analyses based on these kind of data are still not a standard tool for travel behaviour modelling and demand forecasting.

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¹ In this paper we use the term “panel data” to indicate a typical revealed preference survey repeated several times (strictly speaking, repeated data from a stated preference survey could also be considered a panel).

Panel data can be classified into two categories: “long survey panels” and “short survey panels”. The first consists of repeating the same survey (i.e. with the same methodology and design) at “separate” times; for example, once or twice a year, for a certain number of years. Long survey panels have been extensively used in the past to gain insights into activity scheduling and planning, to study dynamic effects, and for their ability to identify temporal variation in travel behaviour (Hanson and Huff, 1988; Jones and Clarke, 1988; Pas, 1988; Pas and Sundar, 1995).

The “short survey panels” are, in general, more recent applications and consist of multi-day data where repeated measurements are collected on the same sample of units over a “continuous” period of time (e.g. seven or more successive days), but the survey is not necessarily repeated in subsequent years. In 1999 Axhausen and his group collected a six-week travel survey (called Mobidrive) for the German cities of Karlsruhe and Halle. A similar survey design, improved with the experience gained in Germany, was transferred in 2003 to Thurgau (Switzerland). These panels have been used to detect rhythms of daily life (Axhausen et al., 2002), to compare different indices that measure similarities of travel behaviour (Schlich and Axhausen, 2003), to draw evidence on the parametric assumptions behind the value of time distribution (Cirillo and Axhausen, 2006), to examine the length between successive participations in several activity purposes (Bhat et al., 2005), to explain current behaviour on the individuals’ history and experience (Cirillo and Axhausen, 2010), to study the intrinsic variability in individual preferences for mode choice, the effect of long period plans and habitual behaviour in daily mode choices (Cherchi and Cirillo, 2014), to account for the dynamic effect of inertia over time in the mode choice (Cherchi et al., 2013) and to study the effect of intra-individual variation in preferences in the estimation of equity effects of congestion charges (Börjesson et al., 2013).

On the other hand, data from Mobidrive and a three-day activity diary collected in Santiago in 2003, were used by Jara-Díaz et al. (2007) to estimate discrete-continuous mode choice and activity duration models. Furthermore, a two-day time-use diary, extracted from the 2002 US National Panel Study of Income Dynamics, was used by Copperman and Bhat (2007) to examine time-use in children’s activities. Using a seven-day diary from the Flemish Time-Use Surveys, Minnen et al. (2015) studied transport habits under different delineations of the time-use data and for different assumptions about regularity (i.e. varying its *tempo* and *timing*), while Minnen and Glorieux (2011) discuss the length of the time-use survey in order to capture the organization of individuals along cycles of work and leisure.

A Computerized Household Activity-Scheduling Survey (CHASE) was designed in Toronto (Canada) over a period of seven days (Doherty and Miller, 2000) and used to estimate a demand model system for daily activity programming (Khandker and Miller, 2007). Stopher et al. (2008) pioneered the use of Global Positioning Systems (GPS) as a means of measuring personal travel; they used a 28-day GPS survey of 50 households to analyse the variability in daily travel of individuals and the proportions of variance due to intrapersonal and interpersonal variability. Finally, Vanhulsel et al. (2007) introduce an extended reinforcement learning approach to produce weekly activity patterns in Belgium.

The Santiago Panel (2006–2010) combines both “short” and “long” survey panel approaches (Yañez et al., 2010), as it is a five-day pseudo diary that has been repeated five different times, just before and four times after the implementation of the radically new Santiago’s public transport system (Muñoz et al., 2009). Data from this panel have been used to study the effect of shock and inertia in individual behaviour and to examine the effect of repeated observations (Yañez et al., 2008) and, more recently, to study the evolution and persistence of modality styles and travel mode choice behaviour in a dynamic context (Vij, 2013).

In a developing country context, the National Planning and Development Agency of the Republic of Indonesia and the Japan International Cooperation Agency collected SITRAMP 2004. It contains an activity diary survey for respondents from households within the Jakarta Metropolitan Area for two consecutive weekdays, Thursday and Friday, and two consecutive weekend days, Saturday and Sunday; this dataset was used to study day-to-day variability in travellers’ activity-travel patterns (Dharmowijoyo et al., 2016). A multi-dimensional three-week household time-use and activity diary was collected in the Bandung Metropolitan Area, Indonesia. Preliminary analyses have been conducted to examine the use of motorised modes, activity participation and multi-tasking, and the relation between transport choices and physical health (Dharmowijoyo et al., 2016).

Although this literature review is not exhaustive by any means, it clearly shows that the use of panel data, especially short survey panels, has recently increased. Nevertheless, the applications mainly refer to time-use, activity choice and activity duration, while estimation of mode choice models with panel data has received less attention. Another topical element in the recent literature is the importance of day-to-day variability and the correct length of the panel to allow revealing or avoiding such variability. A number of questions related to modal choice are still open. Do individual choices differ among days of the same week? Do they differ among weeks? Do we really need to have information on several weeks to capture individual behaviour dynamics?

There are several ways these problems can be addressed. Properly accounting for the various dimensions of correlation over the repeated observations provided by a given individual is crucial to understand the long-term structure of individual choices and should give insights into the proper length of the survey. It should also allow to correctly estimating models and properly use them in prediction. In this context, the use of short survey panels appears fundamental as several dimensions of correlation across responses can be studied, i.e. over trips made the same day, the same week, a given day-of-week in a longer period, and/or over individuals and households.

In this paper, we use the six-week panel data from the Mobidrive survey to estimate a mode choice model that accounts for correlation across individuals over two time periods: a single week and a day of the week (i.e. all Mondays) in the whole panel. We first analyse these effects separately, estimating different models for each type of correlation. However, in that

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