RANDOMNESS IN DAY-TO-DAY TRAVEL TIME AND ITS IMPLICATIONS FOR AVERAGE TRAVEL TIME EXPENDITURE

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ABSTRACT

For the past fifty years, there has been a wide debate over the question of whether people around the world have a stable travel-time budget (TTB). The concept of a stable TTB refers to the idea that an individual's average daily amount of time spent on travelling tends to be relatively constant [1]. Most of the research into travel-time budgets has used large aggregate data sets and has shown that the average amounts of time spent on travelling are around one hour to one-and-one-half hours per day [2]. 'Travel Time Expenditure' (TTE) which is the amount of time spent on travelling can readily be measured while a TTB refers to what a person is actually willing to expend, and is not directly measurable. Although it might be possible to estimate TTB from observed TTE, empirical work on TTB has fallen into the trap of equating observed travel-time expenditures with unobserved travel-time budgets.

One-day trip data from household travel surveys were used in the past research on TTB to obtain an average TTE from random samples. An issue raised by averaging the data across the population (sample) is whether the observation of a stable or even constant travel-time expenditure arises from a statistical construct called regression to the mean (RTM)[3,4], or whether such a stable or constant value is a behavioural construct [2]. In general, regression to the mean simply states that the more observations one has, the closer the mean becomes to a stable value- when the observations are drawn at random from the population. Using the average values of TTE to represent TTB runs the risk of the results being affected by RTM, because the amount of time spent on travelling by *n* individual people could be a random phenomenon. However, for RTM to hold true, the underlying attributes must be largely the result of random events.

A key limitation of one-day diary data is the inability to address the potential intrapersonal variability of travel-time expenditure over time for a given individual. Given that previous studies on travel behaviour research show that individual travel patterns are characterised by repetition and variability, this limitation seems all the more a significant concern. In this respect, multi-day panel data can be used to explore some of the scheduling behaviour of an individual's travel patterns. If the daily time spent on travelling at an individual level is purely a statistical construct, then averaging over a number of days provides no illumination of the issue of the stability of travel-time expenditures. On the other hand, if it is a behavioural construct, then it would provide potentially strong evidence of stability in travel-time expenditures. Obviously, then, analysing multi-day panel data that contain observations over at least a few weeks gives the opportunity to examine multiple weekly cycles of travel pattern at an individual level. Only a few empirical studies in the literature based on such data exist.

When multiple observations are made on the same individual, RTM is likely to arise if the phenomenon being observed varies as a result of random processes alone [5]. Because the amount of time taken for a specific trip from day to day will have a random component, arising from minor variations in the level of traffic, weather conditions, possible traffic incidents, etc., it is unclear whether variations in total travel-time expenditures from day to day could be regarded as a purely random phenomenon, or if the expenditures can be regarded as non-random phenomena. Besides, some researchers also suggest that an individual's travel patterns are largely dependent on habitual factors and this habitual pattern is stable at least in the short run [6].

This paper assesses the question of whether the time spent on travelling by an individual from day to day is entirely a random phenomenon. Data from a personalised GPS survey from a panel of 50 households in South Australia carried out for a continuous period of 28 days covering both week days and weekend days were employed for testing the randomness of travel time expenditure on a day-to-day basis for each individual. The data were collected in two waves in 2005 and 2006. The unique feature of the personalised device is that it records, for each individual, the time spent in all modes of travel throughout the entire survey period with a high degree of precision. This study investigates the randomness of daily individual time spent on travelling over 28 consecutive days for two waves (in some instance, in total 56 days travel time data for a single respondent) using some of the tests recommended by the US National Institute of Standards and Technology (NIST) for randomness such as the Runs Test, the Monobit Test, Mourer's Universal Statistical Test, Chi-squared Test, Kolmogorov-Smirnov Test, Serial-Correlation Test and the Serial Test. Three scenarios typify events that may occur due to empirical testing. The analysis of the level of significance values (p-values)

does not indicate a deviation from randomness. Alternatively the analysis clearly indicates a deviation from randomness. In the third extreme the analysis is inconclusive. If time spent travelling for an individual on a daily basis is found to be a non-random event then, the tendency of time spent on travelling over a number of days for a specific individual to approach closer to a mean value over a number of days is a behavioural construct and not a statistical construct. In this case, the average time spent on travelling over a period of time can be considered to be indicative of the existence of a stable TTB. Knowing the nature of travel time variation, in the spectrum of perfectly repetitious to purely random, would also contribute not only to a better understanding of daily travel behaviour but also to better development and evaluation of transport planning measures.

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