



Analysis of the relationship between internet usage and allocation of time for personal travel and out of home activities: Case study of Scotland in 2005/6



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ABSTRACT

There is much debate among transportation researchers, practitioners, and policymakers regarding how the opening up of the online world is impacting on people's physical spatio-temporal patterns.

This paper presents a novel analysis of the relationship between internet usage and time use, with *time spent traveling* (during the course of a 24-h day) and *aggregate time spent at out-of-home activities* analyzed separately. The empirical analysis draws on the Scottish Household Survey, which contains a unique combination of a one-day travel diary paired with a pseudo-diary of online behavior that captures three distinct dimensions of internet activity: the *amount of time* that respondents spend online per week, the *types of tele-activities* that they perform, and *where* they access the internet.

The empirical findings include both *ceteris paribus* statistical association of specific dimensions of internet usage and aggregate (multi-dimensional) relationships. The latter suggest that (in the context of this dataset), internet usage correlates positively, net of confounding effects, with both time spent traveling and time spent at out-of-home activities.

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1. Introduction

The question of how people's online activity (what they do and how much time they spend online) affects day-to-day physical mobility is of increasing relevance to the transportation sector. The challenge that researchers face, however, is that no one single relationship characterizes how the virtual and physical worlds interact; multiple, sometimes countervailing pressures and processes each take place concurrently. Both the types of empirical evidence and analytical methods (which are themselves limited by the structure of empirical databases) available at present have substantial weaknesses which prevent researchers from providing the unambiguous quantification of impacts that policymakers seek.

Policymakers' interest is unlikely to fade, and therefore this challenge is likely to continue to attract transportation researchers' focus for the indefinite future. Due to the pace at which technology is evolving this issue is likely to become more pressing over time: the both the breadth of tele-activities and the attractiveness of the

user experience can reasonably be expected to continue improving rapidly in coming years.

Regional and national surveys of personal travel, administered via travel diary instruments, are one of the classical data resources employed in transport research. In the US, as in many other high-income countries, metropolitan regions regularly undertake large-sample household travel surveys. Together with the *National Household Travel Survey* (NHTS), data from these surveys form the best available representation of Americans' travel patterns. Surveys of this sort closely monitor travel and participation in out-of-home physical activities (e.g. a shopping journey to visit a store, the time spent at the store, and then the onward journey after the shopping activity), but there remains an open research question of how to adapt such data resources to the age of online connectivity. An example of current practice is the NHTS' questions regarding online activity, which are limited to: respondents' frequency of using the internet in the month prior to their interview, how many times the respondent purchased an item(s) through the internet in the past month, and how many of these purchases were delivered to their home (USDOT, 2009).

This paper draws on a large-sample and nationally-representative dataset from Scotland: the *Scottish Household Survey*. The unique data were collected via both a standard travel

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diary instrument and a rich pseudo-diary instrument that recorded multiple dimensions of online behaviour, including the self-reported amount of time per week the respondent spends online, binary (yes/no) indicators of participation in each of a set of 17 online-activity types, and where the respondent access the internet. Both the travel diary and online-activity pseudo-diary instrument packages were administered to respondents jointly via a single computer-assisted personal interview.

The analysis and findings presented here will be of use to researchers considering how standard practice in regional and national travel surveys should evolve to take better account of online activity. For instance, [Ciari and Stahel \(2013\)](#) report a trend of an increased share of time in recent years being allocated to in-home activities by respondents to the *Swiss National Travel Survey*, which they speculate may be linked with increased usage of information and communication technologies.

The present study builds on previous work drawing on the SHS data resource to investigate the linkages between online activity and both driving-license-holding ([Le Vine et al., 2014a](#)) and vehicle-miles of travel (VMT) ([Le Vine et al., 2014b](#)). Here we focus on the more fundamental issue of time use, specifically the interaction between people's time-allocation for physical activities and travel on the one hand and their online-usage profile on the other. This paper also extends from previous studies of this line of enquiry by bringing into the analysis the location of people's internet access (whether at their home and/or at fixed out-of-home places). The research objective is to identify the statistical relationships (both for individual dimensions of online activity and their aggregate net effects) between people's online-usage profiles and both aggregate time spent traveling and aggregate time spent out-of-home.

As is typically the case with travel survey data (though not always, cf. [Roorda et al., 2005](#)), we are limited to purely cross-sectional data so cannot assert with any confidence whether or not the statistical relationships discussed later in this paper are evidence of genuine causal mechanisms. The discussion of results address both *ceteris paribus* (i.e. net of confounding effects) statistical relationships that arise from the three specific dimensions by which the data characterize internet use (time spent online, types of activities performed online, and location-of-internet-access) and the *aggregate* effects when the individual effects associated with these three dimensions of respondents' internet usage are combined. Throughout the discussion of findings, we make clear which of these two is being discussed.

The remainder of this paper is organized as follows. Section 2 contains a brief discussion of the relevant background. Section 3 describes the SHS dataset in more detail along with the statistical methods employed in this study. The results are presented in Section 4, and Section 5 concludes the paper with a summary of this study's findings and their implications for travel survey methods.

2. Background

[Mokhtarian \(2002\)](#) proposed what has become the seminal taxonomy of interactions between online activity and physical mobility. *Substitution* (whereby an online activity leads once to not perform a physical activity that would require travel) and *complementarity* (whereby an online activity may generate participation in a subsequent out-of-home activity) are the most widely-discussed. The taxonomy also includes *neutrality* (where an online and a physical activity do not affect one another) and *modification* (whereby an online activity leads a physical activity or the travel to it to be changed in some way that neither suppresses nor induces physical mobility).

The question of which of these types of effects is dominant is an empirical question, and researchers have investigated various aspects of the linkages between internet usage and physical mobility on this basis. [Roy et al. \(2014\)](#) looked at the interaction between phone calls and physical travel, finding the two to be substitutes for some social groups and complements for other people.

On the specific research question of the relationship between internet usage and time-allocation, the extant literature is predominantly limited to context-specific studies of specific activity types. [Wallsten \(2015\)](#) reports a net 'crowding out' (or substitution) effect of time spent on online leisure activities and time spent in various types of 'offline' activities: leisure, work, sleep, education and traveling. [Falck et al. \(2014\)](#) analyzed the relationship between voter turnout and internet availability, and report *inter alia* a finding of internet usage serving as a partial substitute for watching television. [Taipale \(2012\)](#) reports empirical results showing that, among only males, Internet usage serves as a substitute for reading printed newspapers, and [Schwanen et al. \(2014\)](#) report that, amongst women, time spent online is negatively associated with time allocation for in-store grocery shopping and cooking, among other household maintenance activities. [Griffiths \(2012\)](#) reports mixed evidence as to whether online sexual behavior is a complement or substitute for offline sexual activity, with the effect varying across individuals. In a study that considered time allocation for in-home activities, out-of-home activities, and traveling, [Lee-Gosselin and Miranda-Moreno \(2009\)](#) found that mobile phone users spent less time at home and more time traveling than non-users, but the opposite with regards to internet users (more time spent at home and less time spent traveling, in comparison to non-users).

An exception is the study reported in [Ren and Kwan \(2009\)](#), which employed an activity diary that included both physical and internet activities (Ohio, USA, $n = 392$ internet users). The authors reported findings that documented gender-specific effects in the relationship between physical and virtual activity participation, and which further highlighted the importance of disaggregating by virtual-activity-type when characterizing internet usage.

In an earlier study, [DiMaggio et al. \(2001\)](#) reviewed the relevant literature on online activity and physical activity; the authors concluded that "a recurrent theme across domains is that the internet tends to complement rather than displace existing... patterns of behaviour" (p. 307). A more recent detailed survey of the literature can be found in work by [Andreev et al. \(2010\)](#). While Andreev et al. did not attempt to identify aggregate effects on physical activity/travel behavior associated with each of the wide set of online-activity types, the authors report that the preponderance of studies in the literature suggest that *complementarity* is generally reported as the dominant effect for tele-shopping and tele-leisure activities, whereas *substitution* with physical mobility is the net effect of tele-work. With respect to tele-work, however, a number of studies have reported it to be a net substitute of work-related mobility but a net complement of non-work-related mobility (e.g. [Hodge and Koski, 1997](#); [Kwan, 2002](#); [Sasaki and Nishii, 2003](#)). In their later survey of the literature, the conclusion of [Aguilera et al. \(2012\)](#) with respect to the complementarity versus substitution debate is that "In spite of a large amount of empirical research, the answer is still fairly unclear, even though the idea of complementarity or [travel] generation dominates" (p. 664).

3. Data and methods

The empirical database employed in this study was the *Scottish Household Survey*, which is a large-sample (approximately 14,000 households/year) general social survey undertaken continuously by the Scottish Executive since 1999 ([Hope, n.d.](#)). The SHS dataset

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