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Quantifying the relative contribution of factors to household vehicle miles of travel

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ABSTRACT

Household vehicle miles of travel (VMT) has been exhibiting a steady growth in post-recession years in the United States and has reached record levels in 2017. With transportation accounting for 27 percent of greenhouse gas emissions, planning professionals are increasingly seeking ways to curb vehicular travel to advance sustainable, vibrant, and healthy communities. Although there is considerable understanding of the various factors that influence household vehicular travel, there is little knowledge of their *relative* contribution to explaining variance in household VMT. This paper presents a holistic analysis to identify the relative contribution of socio-economic and demographic characteristics, built environment attributes, residential self-selection effects, and social and spatial dependency effects in explaining household VMT production. The modeling framework employs a simultaneous equations model of residential location (density) choice and household VMT generation. The analysis is performed using household travel survey data from the New York metropolitan region. Model results showed insignificant spatial dependency effects, with socio-demographic variables explaining 33 percent, density (as a key measure of built environment attributes) explaining 12 percent, and self-selection effects explaining 11 percent of the total variance in the logarithm of household VMT. The remaining 44 percent remains unexplained and attributable to omitted variables and unobserved idiosyncratic factors, calling for further research in this domain to better understand the relative contribution of various drivers of household VMT.

1. Introduction

Vehicle miles of travel (VMT), a key measure of travel demand, is on the rise in the United States and countries around the world (Bastian et al., 2016; Polzin, 2016). Predictions of the peaking of travel, largely made during the period of the great recession, are

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proving to have been premature (Polzin, 2016). While there are signs of some shifts in residential location and travel choices, most notably related to the lower levels of vehicle ownership and mobility depicted by millennials and a move towards urban living among different generations (Badger, 2014; Logan, 2014), the fact of the matter is that total VMT has grown steadily in the United States since 2012 and has reached record levels in 2017 even after accounting for population and employment growth (Economic Research, 2017). Increases in VMT are associated with higher levels of congestion and delay, energy consumption and greenhouse gas emissions, and roadway crashes (Sacramento Area Council of Governments, 2016) – adversely affecting human health, quality of life, and community resiliency and sustainability (Levy et al., 2010). The growing presence of transportation network companies that provide mobility-as-a-service and the potential advent of autonomous vehicles may further contribute to an increase in VMT as travel becomes increasingly convenient and less burdensome, thus resulting in a reduced value of travel time.

For the reasons noted above, planning professionals in cities around the world are continuously seeking ways to reduce vehicle miles of travel without inhibiting household and business activity engagement. Formulating policies, strategies, and transportation infrastructure improvements that would reduce VMT is difficult, however, in the absence of an accurate understanding of the contribution of various factors to total VMT. This paper aims to provide a comprehensive understanding and quantification of the relative effects of various factors on household vehicle miles of travel. The analysis focuses on household VMT because it constitutes more than 75% of total VMT in the United States (AASHTO, 2013), and hence strategies aimed at curbing household VMT would likely yield the most benefits to communities.

There is undoubtedly an abundance of research that has examined the effects of various factors on household VMT in various geographic contexts (e.g., Millard-Ball and Schipper, 2011; Bastian et al., 2016). However, research to date has not adequately documented the *relative* contribution of various factors to explaining household VMT, thus calling for a more holistic and comprehensive analysis that is capable of doing so. While some studies explain the effects of socio-economic and demographic characteristics on VMT, others focus on examining the effects of built environment attributes on VMT. These studies are undoubtedly valuable, but it is also important to quantify the relative contribution of different factors to household VMT. By doing so, it is envisioned that planners and policy makers will be able to develop targeted policies that more effectively reduce vehicular travel. If, for example, built environment attributes are found to explain the variation in household VMT more than other factors (such as socio-economic and demographic factors), then decision-makers may realize the most benefits (in terms of VMT reductions) by implementing policies that foster more walkable, dense, and diverse built environments. On the other hand, if social interaction and spatial dependency effects are found to contribute more heavily to explaining variance in household VMT (relative to other factors), then policy makers may be well served by focusing resources on social media and public information campaigns that would facilitate spread of awareness (say, about use of alternative modes of transportation) through network diffusion mechanisms. While literature provides some information about the effects of these factors when viewed independently or in pairs, there is a lack of research dedicated to explaining the relative contribution of various factors in a comprehensive framework. This research effort is aimed at addressing this critical gap in the existing literature. Not only does this paper aim to offer insights on the relative contribution of various factors to household VMT, but the paper also aims to offer a rigorous methodological framework that is generalizable and can be applied in any geographical context. Thus this study is motivated by both methodological and empirical objectives with a view to help advance the development of sustainable communities.

This paper considers four different factors that may explain the variance in household VMT. These include household and person socio-economic and demographic characteristics, residential built environment attributes, residential self-selection (i.e., lifestyle preference) effects, and human social and spatial dependency effects. As noted earlier, while there are a number of research efforts that have examined the effects of subsets of these factors on household or personal VMT, there is no study that examines the relative contribution of each of these effects on household VMT in a singular holistic framework. The four factors considered in this paper are those that have been shown to influence household VMT in significant ways. Household socio-economic and demographic characteristics, such as household size, number of children, number of workers, and household income affect household VMT. Built environment attributes including land use density, population and employment density, parking availability and pricing, distance from residence to work centers, and multimodal accessibility (to destinations) affect household VMT. Residential self-selection effects capture the notion that individuals may choose to locate (live and work) in built environments that are consistent with their attitudes (e.g., environmental sensitivity) and lifestyle preferences (e.g., car-free lifestyle). The fourth and final factor considered in this paper is the socio-spatial dependence effect. Household VMT may be shaped by social interaction and spatial dependency effects, capturing influences engendered by people's interactions and geographic proximity. It should be noted that, even after accounting for these four factors, a residual unexplained effect will inevitably exist.

The analysis in this paper is performed on the 2010–2011 Regional Household Travel Survey (RHTS) of the New York Metropolitan Transportation Council (NYMTC). From the fall of 2010 through the fall of 2011, travel data was collected from 19,000 households across 28 counties in New York, New Jersey, and Connecticut (New York Metropolitan Transportation Council, 2011). After merging built environment data with the travel survey records, a joint model of residential location (density) choice and household VMT – accounting for residential self-selection and socio-spatial dependency effects – is estimated to unravel the relative contribution of various factors in explaining variance in household VMT.

The remainder of the paper is organized as follows. The next section presents a brief discussion of factors that influence household VMT. The third section presents a data description, the fourth section offers a description of the methodology, and the fifth section presents model estimation results. The sixth and final section offers a discussion and interpretation of the results together with concluding thoughts.