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Estimating potential increases in travel with autonomous vehicles for the non-driving, elderly and people with travel-restrictive medical conditions

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ABSTRACT

Automated vehicles represent a technology that promises to increase mobility for many groups, including the senior population (those over age 65) but also for non-drivers and people with medical conditions. This paper estimates bounds on the potential increases in travel in a fully automated vehicle environment due to an increase in mobility from the non-driving and senior populations and people with travel-restrictive medical conditions. In addition, these bounding estimates indicate which of these demographics could have the greatest increases in annual vehicle miles traveled (VMT) and highlight those age groups and genders within these populations that could contribute the most to the VMT increases. The data source is the 2009 National Household Transportation Survey (NHTS), which provides information on travel characteristics of the U.S. population. The changes to light-duty VMT are estimated by creating and examining three possible travel demand wedges. In demand wedge one, non-drivers are assumed to travel as much as the drivers within each age group and gender. Demand wedge two assumes that the driving elderly (those over age 65) without medical conditions will travel as much as a younger population within each gender. Demand wedge three makes the assumption that working age adult drivers (19–64) with medical conditions will travel as much as working age adults without medical conditions within each gender, while the driving elderly with medical any travel-restrictive conditions will travel as much as a younger demographic within each gender in a fully automated vehicle environment. The combination of the results from all three demand wedges represents an upper bound of 295 billion miles or a 14% increase in annual light-duty VMT for the US population 19 and older. Since traveling has other costs besides driving effort, these estimates serve to bound the potential increase from these populations to inform the scope of the challenges, rather than forecast specific VMT scenarios.

1. Introduction

Many seniors (those over age 65) and people with medical conditions often face challenges traveling freely and independently and must rely on family, friends, government, or other providers to meet their basic mobility needs.

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Automated vehicles represent a pathway that could increase the mobility, and hence the vehicle miles traveled (VMT), of the senior and disabled populations by decreasing human involvement during driving (Anderson et al., 2014). The objective of this paper is to estimate bounds on the impact of a fully automated vehicle environment based on VMT by the current U.S. population 19 and older due to new demand from currently underserved populations. The results from this analysis are intended to provide insight on the magnitude of potential future increases in total travel demand from these underserved populations under vehicle automation. In addition, this bounding analysis presents the current basic travel characteristics of: adult non-drivers, the elderly (those over age 65) without medical conditions, and adults with a travel restrictive medical condition, and determines which of these three demographics could increase there VMT the most in magnitude due to vehicle automation. Within each of these underserved populations, we also highlight the age group and gender combinations that could contribute the most to these increases in total light-duty VMT. We also highlight the data, results, and assumptions of previous studies that have estimated how VMT could change due to vehicle automation. Although travel from working age drivers (ages 19–64) without medical conditions could either increase due to easier travel from automated vehicles or decrease due to various effects from car-sharing, urban density, and VMT rebound (Anderson et al., 2014), this paper is only concerned with changes in the travel patterns of the elderly, non-driving populations, and those with a travel restrictive medical condition relative to current conditions. This provides a bound to help understand the magnitude of the benefits and challenges of a transition to vehicle automation. The primary source of data for this project is the 2009 National Household Transportation Survey (NHTS), which provides information on current travel characteristics of the U.S. population (USDOT, 2011).

According to the Current Population Survey (CPS), there were about 34.2 million people in the U.S. age 65 and older in 2003 (U.S. Census Bureau, 2003). From 2003 to 2013 the senior population has increased by about 27% to almost 43.3 million people (U.S. Census Bureau, 2003, 2013). In the U.S. and other industrialized nations, the senior population is expected to continue to grow in both absolute terms and relative to the rest of the population. By 2030 it is projected that there will be roughly 74 million seniors living in the United States that will represent close to 26% of the total US population (Rosenbloom and Winsten-Bartlett, 2002).

A large increase in the travel of seniors would result in many current transportation systems facing challenges in providing efficient and reliable service to users. Among today's senior population, driving by car is still the most common mode of transportation. About 89% of all trips made by seniors are by automobile, and 80% of all trips made by those with a medical condition are by automobile. Very few older Americans rely on walking, biking, or transit to make trips and this trend is likely to continue (Santos et al., 2011). For example, working adults who used public transit for non-work trips before retirement, tend to rely on an automobile for these same trips once they enter retirement. Although older adults depend heavily on light-duty vehicles (LDV) for the large majority of trips, the percentage of trips made as drivers declines with age and this trend is especially evident within the older female population who often stop driving at an earlier age than their male counterparts (Reimer, 2014). With autonomous vehicles, these groups could continue to use LDVs, either as self-driving taxis or private vehicles.

While issues related to mobility exist within the senior population due to reduced cognitive abilities and increased medical issues or disabilities, there are indications that today's senior population is healthier and possesses more disposable income than their previous senior cohort (Currie and Delbosc, 2010; Cutler, 2001). Due to the increasing size, overall wealth, and life expectancy of the senior population, advancements in personal mobility will inevitably become more important. Páez and Farber (2012) found that people with disabilities who have used a car within the past 12 months are about 28% more likely to desire more leisure activities compared to those who have not (Páez and Farber, 2012).

Many companies have announced plans to develop self-driving vehicles, and twelve companies have applied to test self-driving cars in California as of 2016 (Chew, 2016). Vehicle automation has the potential to greatly improve travel by reducing congestion, travel times, crashes, and potentially energy consumption (Anderson et al., 2014; Brown et al., 2014; Harper et al., 2016; Levin and Boyles, 2015; Mersky and Samaras, 2016; Wadud et al., 2016). The ability for smart vehicles to interact with smartphones and act as a taxi service to transport people to their destinations also serves as an advantage, reducing travel costs by almost 75% (Litman, 2013). This technology could also potentially have large environmental benefits by reducing energy consumption and greenhouse gas emissions (GHGs) from the ability to deploy vehicles according to each trip's occupancy (right-sizing) (Greenblatt and Saxena, 2015). Fully self-driving Level 4 automated vehicle technologies, as defined by the National Highway Traffic Safety Administration (NHTSA) (NHTSA, 2013), will likely promote an increase in per capita VMT within the elderly, disabled, and non-driving populations due to their potential latent demand and since they would rely less on walking, public transit, or family members and friends for daily travel. At high market penetration rates, automated vehicles could increase accessibility to jobs, leisure, and resources for both low and high-income groups (Childress et al., 2015). Higher accessibility to jobs for low-income groups would likely increase employment, provide better job opportunities, and increase disposable income along with travel (Ihlanfeldt and Sjoquist, 1990; Shen, 1998).

There have been several researchers who have estimated how VMT could change in the future due to automated vehicles, and each result depends on the data and assumptions used. Wadud et al. (2016) estimates that vehicle automation could increase VMT anywhere between 2% and 10% from increased travel due to new user groups. As an upper bound, the authors assumed that everyone aged 62 and above will travel as much as a person 62 years of age. Fagnant and Kockelman (2015) assumes that vehicle miles traveled (VMT) per automated vehicle is 20% higher than a non-automated vehicle at a 10% market penetration rate and 10% higher at a 90% market penetration rate, resulting in an increase in total VMT of 2% and 9%, respectively (Fagnant and Kockelman, 2015). A recent agent-based analysis of shared autonomous vehicles estimated overall