

The Potential Distributional Impacts of Automated Vehicle Technologies

Leslie Martin

Zan Fairweather

January 20, 2019

Automated vehicle (AV) technologies make two key contributions. First, they improve access to private ride services for those who can't drive: children, the elderly, and the disabled. AVs have the potential to make life significantly easier for carers who currently spend a large fraction of their day shuttling young ones to school and other activities. They also have the potential to reduce social isolation for the elderly and disabled.

AVs also lower the marginal cost of driving. By substituting labor for capital, they reduce the marginal cost of supplying on-demand or shared trips. Vehicles that can park themselves can also make commuting into dense urban areas significantly cheaper by reducing the time cost or sticker cost of parking. And by freeing drivers from the need to monitor and react to road conditions, AVs make drivers into passengers, which may dramatically reduce the private cost of sitting in traffic. As AV technology improves, time spent on the road will be used for other activities, from sleeping to working to watching videos, reducing both the time cost associated with traffic and the frustration.

AVs do not, however, lower the externality associated with driving. They do not lower the environmental cost of fuel or, more importantly, the cost that each additional driver imposes on others at congested times. AVs accentuate the wedge between private and social costs.

This paper attempts to quantify the potential distributional cost of the induced demand caused by that wedge. It focuses on the transition between our current scenario, where everyone drives a traditional vehicle, to one where everyone can afford a AV. We are particularly interested in the intermediate stage when only a subset of the population has switched to AVs, and enjoys a low marginal private cost of driving, while others have not, and potentially find themselves on roads that are much more congested, experiencing a decrease in quality of life. We look to several cities in the United States, and turn to household travel surveys to make predictions about where we should be particularly concerned about the distributional impacts of AV technology.

We propose a model in which adoption comes both from commuters in traditional vehicles and current users of public transit. The advantage of AVs over public transit come from the passenger's ability to pick co-commuters, have door-to-door service, and enjoy individually-tailored comfort. In our model, the increased congestion comes exclusively from adoption from this latter group.

To conduct our analysis we turn to a few publicly available data sources. We use commute patterns

by city, mode of transport, and household income level from the 2017 National Household Travel Survey (NTHS) to produce statistics for the 52 largest cities in the United States. We apply a simple diffusion model of adoption to the different population stocks to estimate the increased number of commuters on the road in each city, by income group, as a fraction of total adoption nationwide. We assume a distribution of adoption by income group that reflects adoption distributions previously observed in NTHS data for adaptive cruise control. Finally, we consider the interaction of AV technology with availability of public transit, using the Federal Highway Administration’s Census Transportation Planning Products that includes data on worker flows between census tracts. This dataset is based on the 2006-2010 American Community Survey (ACS).

We argue that cities that will see large distributional cost during this transition are those that (1) are already at or near congested road conditions at peak times, and (2) have many high-income commuters who are currently on public transit, and (3) have many low-income commuters who are currently on the road. For example, although a city like Austin, TX is likely to have many early adopters of AVs. These adopters are already commuting to work by car, so AVs are unlikely to change congestion in Austin, unless or until wealthier households start opting for homes farther from the city center. New York has a large number of high-income commuters on public transit, but few low-income commuters driving into the city. In New York increased congestion is likely to fall primarily on middle- to upper middle-income commuters. Cities like Washington DC, San Francisco, and Chicago are the ones for which we estimate the largest potential losses among lower income commuters, particularly those who live far from public transport.

We discuss a few caveats. The engineering literature is quick to cite the countervailing congestion *benefits* of AVs. These come from improved traffic throughput, reduced accident-related delays, and the additional supply of inner city lanes made available when there is no more need for street parking. We argue that most of these benefits accrue once AVs are the only cars on the road, whereas a lower marginal cost of driving induces VKT demand immediately. We are concerned about the transition period, when AVs co-exist with traditional vehicles. In addition, most of the congestion benefit estimates that we have seen are significantly lower than best available estimates of induced demand (Brenden and Kristoffersson 2018: 20-70%, BCG and WEF 2018: 16% if shared rides, else higher, Harper et al. 2016: 10-20%, Bierstedt et al. 2014: 5-20%).

We are also setting aside the issues involved in the longer run. AVs may cause populations to reshuffle around cities. Automated response in AVs could make dynamic prices easier to implement. Labor force composition determines flexibility of working hours and peak commutes. Congestion pricing, riding sharing with improved commuter matching, and changes in labor force composition may provide significant congestion relief. Public transport needs may change. Indeed, funding for public transport may be at risk if AVs further shift its user base to lower income households.

In conclusion, we argue that AVs may provide dramatic improvements in quality of life for those who can afford them. And, in some key markets, AVs are likely to make things significantly worse for middle- and lower middle-income households.

Figure 1: Commuting miles by mode and income from US 2017 National Household Travel Survey (NHTS)

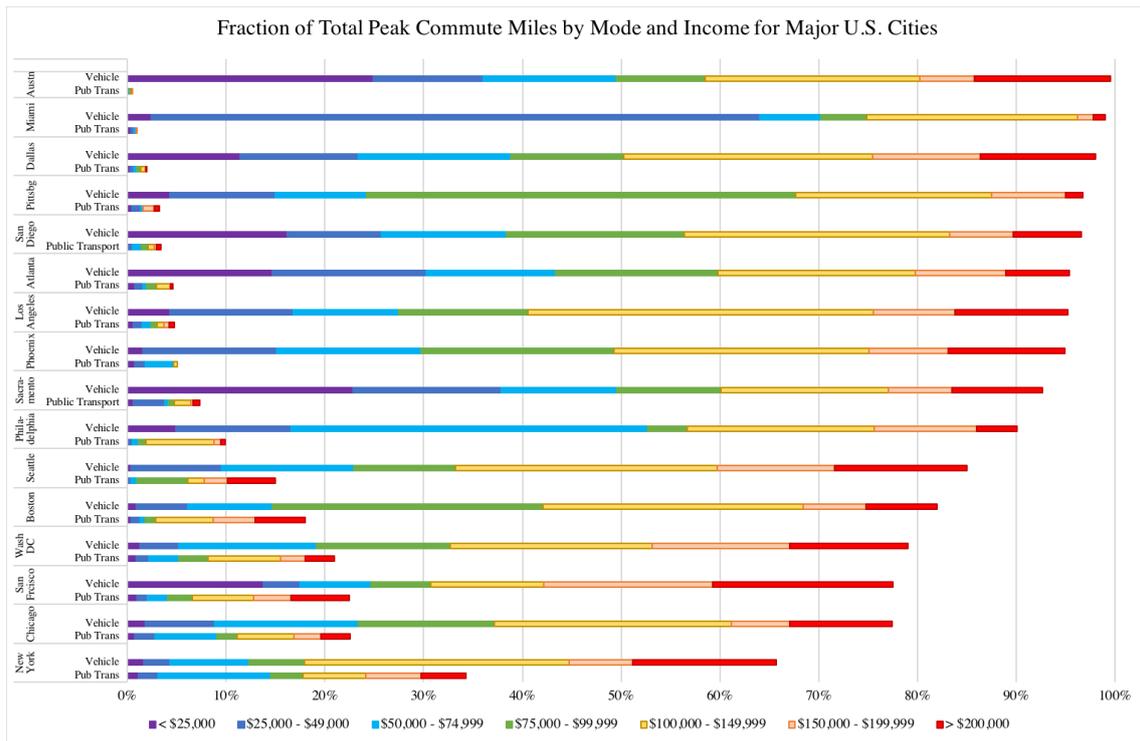


Figure 2: Additional vehicles on the road, based on income and commute patterns from 2017 NHTS, as a function of adoption across entire US, with allocation of adoption to cities a function of each city's income distribution

