How new innovations in transportation will impact the urban form

Moez Kilani
University of Lille, France

This paper focuses on economic reforms in urban transportation when major innovations are deployed at large scale. This research goes beyond the direct impacts on traffic flows and considers the impacts on the behavior of the passengers and economic activities. We first enumerate the major innovations related to transportation and then develop a model where we evaluate the impact of these changes on the urban equilibrium.

The development of information technologies allows passengers to get high quality data on traffic flows and public transportation services. The increasing availability of connected devices allows users to undertake some activities during their trips in public transportation, and this impacts the way travel time cost is evaluated. Autonomous cars are a new attractive transportation mode suitable for car sharing, and that can facilitate the transition to low-carbon energy systems [6]. Lighter transportation modes, like electric bikes and scooters, seem appropriate for many kinds of trips within the city. Most automobile companies are working on projects of autonomous cars. Advances in information technologies and intelligent guidance systems should make the new technologies more accessible and reinforce this dynamic. Many experts are convinced that urban transportation, in particular, will be largely impacted by this revolution.\(^1\) Road congestion, crowding in public transportation [4, 13] and emissions are serious concerns for urban planners in major cities around the world.

How will these innovations impact urban transportation and how should public policies deal with transportation issues in the future? To what extent can autonomous cars reduce congestion and externalities (congestion, emissions, noise pollution)? Will these changes favour urban sprawl? Should (part of) public transit subsidies be devoted to new and small modes like electric bikes? How to deal with all these changes and insure minimum accessibility for a wider part of the population?

While the engineering literature is well developed [7], very few transportation economists have already included autonomous cars in their models, and those who did, for example [11, 5], ignored the impact of this new mode on users’ behaviour on economic activities.

\(^1\)For example, the CEO of Renault PSA has publicly declared that taxis will be replaced by autonomous cars within two decades. See “Carlos Ghosn prédit la fin des taxis d’ici une vingtaine d’années”, in Challenges, published July 4\(^{\text{th}}\) 2015.
One of the main questions in this context is the organisation of the market of autonomous cars. We compare a system of centralized decision with other alternatives where, (i) each car takes its decision independently of the other cars; (ii) a group of some operators are managing the fleet of the autonomous cars. Under each of these configurations, the pricing of the service will have a distinct structure (monopoly, oligopoly), and the impact of this market organization will have an important influence on traffic flows, energy consumption and emissions. On the longer term, location decisions depend also on the equilibrium in the transportation system.

Existing open-source transport simulators, like MatSim or SUMO, have been already used to integrate autonomous vehicles which proved to be able to include autonomous cars [3, 1]. These models are useful to simulate the evolution of urban transportation, but their results usually dependent on the particular area of study. In this research we follow a microeconomic approach is used to reach more general conclusions. The other advantage of analytical models is that they require much less data.

Autonomous cars can optimize the usage of existing infrastructures but, as shown in [11], they may also lead to distortions in departure times, so that the precise impact is not clearly signed. We further explore these issues. Autonomous cars can lead to a decrease in the value of time. Standard urban economic models predict that this will favour urban sprawl. We discuss this issue within an urban economics framework, to characterize urban configurations induced by the changes in transportation.

We compare distinct market organizations of these activities and see whether a centralized system, possibly managed by existing transit agencies, is more efficient than a decentralized system or not. The existence of lighter modes, like electric bikes and scooters, will make transit stations more accessible and public transportation can be made more attractive by the adoption of some acceleration solutions (like skip-stop operations) or by a reconsideration of stations spacing [12, 2], especially for bus stations and new rail lines [10, 8, 9]. Indeed, changing the locations of existing rail stations is difficult in practice. The existence of new transport modes may lead to a decrease in the demand of public transport, possibly inducing a decrease in the service frequencies. This dynamic may lead to the well known Downs-Thompson paradox. Local authorities may then consider to restrict the usage of autonomous vehicles to the access to public transport services, with the objective to increase the efficiency in mass transit.\(^2\)

Our analysis shows, so far, that the optimal policies will depend on the marginal cost of supplying more trips using autonomous vehicles. Energy costs, is then one of the most important parameters. When this cost is very low, unrestricted autonomous system of autonomous vehicles is welfare improving. In this case the frequency of services in public transportation is low. If the energy cost is important then it advisable to use autonomous vehicles to increase the accessibility of passengers to main transit stations. In this case, service frequency in the public transport is high.

\(^2\)Notice that these issues raise some institutional problems.
References


