Reply to Lopez et al.: Sustainable implementation of taxi sharing requires understanding systemic effects

We have recently developed a method that allows the quantification of spare capacity in urban taxi systems through trip sharing (1), hence making it more efficient and less resource intensive—all other things being equal—in particular fares, which can be modified by public policy. In their comment on our study, Lopez et al. observe that a complete evaluation of the environmental sustainability of taxi sharing requires not only considering direct impacts, but also indirect impacts (2). We fully agree with this observation. For limiting the scope of our analysis (1) to a manageable extent, and in lack of an established methodology for quantifying the impacts of vehicle sharing at the granularity of single trips, we were not able to account for effects that can be considered as exogenous to the taxi system. Indeed, urban and regional models are composed of both exogenous and endogenous variables, and "much of the ongoing research agenda can be focused on transferring variables from the exogenous to the endogenous category" (3). The extensions suggested by Lopez et al. (2) and in our report (1) go exactly along this direction.

In a broader context, our work is part of recent efforts toward a rigorous, data-centric science of cities, which approaches urban issues by regarding cities as complex systems (4). The hallmark of such systems is a large number of interacting subsystems, typically far from equilibrium, where small interventions can have massive, counterintuitive consequences. Because of these features, further investigations of system-wide socio-economic impacts of new transportation models will be of vital importance. For the case of taxi sharing, our research efforts (1) happened to be at the very first step of catching up with recent urban realities in which sharing systems are rapidly proliferating in parallel with traditional modes of transportation and ownership.

Regarding the assessment that taxi sharing would imply lower fares than traditional taxi systems, including possible unintended negative consequences (2), let us point out that the reduced costs provided by sharing are not necessarily translated into corresponding fare reductions. Indeed, fares for shared rides could be designed with the goal of maximizing a city-wide utility function that can certainly include emissions in the optimization process. In principle, it is even possible to stipulate "carbon footprint"-optimal fares for shared rides. Before doing so, however, we need to gain a better understanding of the impacts of policy interventions on the proper functioning of cities (4). Although optimal fare design has been widely investigated for traditional taxi systems (5), to the best of our knowledge no analysis of optimal faring strategies for shared taxi systems exist to date.

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