Balancing concerns of occupancy rates and passenger inconvenience in ridesharing

Sharing economy (SE) is emerging as a new economic trend in the way goods and services are produced and consumed. According to Horton and Zeckhauser (2016), “…[SE] exploits the complementarity of resource availability and demands to enable exchange of resources among ubiquitously connected users through internet”. SE can help conserve resources and promote greater resource utilization. Shared mobility (the sharing of a journey or a vehicle) is an integral part of SE which focusses on exploiting the resource availability for individual mobility. Ridesharing (RS) is a form a shared mobility in which individual travelers share a vehicle for an one-time trip and split travel costs. The sharing of a trip amongst people with similar travel itineraries and schedules allows for increased occupancy rates, reduced congestion and carbon emissions (Agatz et al. 2012, Furuhata et al. 2013). Although the concept of RS has been around since 1950s, it is the recent advances in navigation and communication and proliferation of smartphone technologies that has made RS possible on real-time basis and a viable alternative to private transport. This has led to emergence of many RS firms like Uber and Lyft.

An important challenge confronting RS firms is low occupancy rates of vehicles - more than 90% of rides operate less than the available capacity (AASHT 2013). RS firms can defray their costs of operations easily when the occupancy rates during these rides are high. While it is in the interest of the firm to increase the occupancy rates, the participants are put to a great deal of inconvenience due to extra travel time, detours and sharing of personal space. The upside, however, to participants is the higher savings in their fare. An individual’s decision to participate or not is determined by the net benefit he receives. When there is no net perceived benefit, the prospective participants
may opt-out of RS and travel solo. Thus, the firm has to be mindful of the tradeoff between occupancy rates and participants’ inconvenience while designing how the gains from RS is distributed amongst participants.

In this paper, we devise a benefit-sharing mechanism that addresses both the concerns of occupancy rates and participants’ inconvenience. We have modeled the problem of devising a benefit-sharing mechanism using cooperative game theory (CGT). CGT provides us with concepts to develop allocation mechanisms that are ‘stable’ and ‘fair’. Intuitively, a stable allocation is one in which there is no incentive for any participant to break-away from the coalition and a fair allocation is one that ensures every participant is adequately compensated for his efforts. Improvising on the existing solution concept of Core and Shapley value, we have developed a new solution concept that provides conditions under which coalition is stable and allocation is fair.

Through this study, we have developed a possible means of addressing the issue of low vehicle occupancy rates faced by RS firms. The important aspect of these mechanisms is that it factors the inconvenience experienced by participants due to detouring and sharing of personal space with co-travelers. It is independent of RS matching process and also accounts for heterogeneity of participants sharing a ride. From a practical standpoint, the decision rules developed based on the new solution concept helps us to identify conditions under which a new request for a shared ride can be accepted. We have also provided upper bounds on the maximum distance a group of participants can travel as a part of shared ride. These decision rules can provide guidance to managers of RS firms on when to accept a new RS request without compromising the convenience of the passengers.
References


