

Modeling and Analysis of Collaborative Consumption in Peer-to-Peer Car Sharing

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We are witnessing a paradigm shift away from the exclusive ownership and consumption of resources to one of shared use and consumption. This paradigm shift is taking advantage of innovative new ways of peer-to-peer sharing that are voluntary and enabled by internet-based exchange markets and mediation platforms. Value is derived from the fact that most resources are acquired to satisfy peak demand but are otherwise poorly utilized (e.g., the average car in the US is used less than 10 percent). Several successful businesses in the US and elsewhere, such as AirBnB for rooms in private homes, Uber for taxi service, LiquidOffice for office space, RelayRides for private car sharing, and TaskRabbit for errands, among many others, provide a proof of concept and evidence for the viability of the collaborative consumption concept. Collectively, these businesses and other manifestations of collaborative consumption are giving rise to what is becoming known as the sharing economy¹.

Collaborative consumption has the potential of increasing access while reducing investments in resources and infrastructure. In turn this could have the twin benefit of improving consumer welfare (individuals who may not otherwise afford a product now have an opportunity to use it) while reducing societal costs (externalities, such as pollution that may be associated with production, distribution use, and disposal of the product). Take cars for example. The availability of a sharing option is likely to lead some to forego car ownership in favor of on-demand access. In turn, this could result in a corresponding reduction in road capacity and parking infrastructure. However, increased collaborative consumption may have other consequences, some of which may be undesirable. For example, greater access to cars could increase car usage and, therefore, lead to more congestion and pollution if it is not accompanied by a sufficient reduction in the numbers of cars. This could occur if sharing leads to speculative investments in cars and price inflation, or if yet it affects the availability and pricing of other modes of public transport (e.g., taxis, buses, and trains).

Collaborative consumption is not a new concept. However, recent technological advances in several areas have made it more feasible by lowering the associated search and transactions costs (e.g., online market platforms, electronic payments, and two-way reputation systems). Other drivers behind the rise of

¹ The rise of collaborative consumption is well documented in the recent book “What’s mine is Yours” by Botsman and Rogers (2010).

collaborative consumption are societal and include the increased population density in metropolitan areas around the world, increased concern about the environment (collaborative consumption is viewed as a more sustainable alternative to traditional modes of consumption), and increased desire for community and altruism among the young and educated.

Collaborative consumption raises several important questions. How does collaborative consumption affect ownership and usage of resources? Is it necessarily the case that collaborative consumption leads to lower ownership, lower usage, or both (and therefore to improved sustainability)? If not, what conditions would favor lower ownership, lower usage, or both? Who benefits most from collaborative consumption, those who own, those who rent, or the platform that matches owners and renters? How would the platform set prices, commissions, and membership fees and under what conditions would choices for these parameters lead to socially desirable outcomes? To what extent would a private platform (a platform that maximizes its own profit) improve social welfare? How far would the resulting social welfare be from that obtained under a public platform (a platform that maximizes social welfare)? What public policies, if enacted, would ensure that collaborative consumption would lead to higher social welfare?

In this paper, we address these and other related questions in the context of peer-to-peer car sharing². In particular, we consider an equilibrium model with a finite population. In the absence of collaborative consumption, each individual makes a decision about whether or not to own a car. In the presence of collaborative consumption, each individual decides on whether to own, rent from others who own, or neither. Owners incur the fixed cost of ownership but can now generate income by renting their cars to others who choose not to own. Renters pay the rental fee but avoid the fixed cost of ownership. The rental price may be set by a third party platform (an entity that may be motivated by profit, total social welfare, or some other concern) or it may arise naturally over time as part of an equilibrium (we focus on the former). The platform extracts a commission from successful transactions (a percentage of the rental revenue generated). The platform may also impose fixed membership fees on the owners, the renters, or both.

In equilibrium, there is a probability that an owner, whenever she decides to put her car up for rent, is successful in finding a renter. Similarly, there is a probability that a renter, whenever he decides to rent, is successful in finding an available car. The probability that an owner finds a renter increases with the number of renters (or equivalently decreases with the number of owners). Similarly, the probability that a renter finds an available car increases with the number of owners (or equivalently decreases with the

² We expect our models, analysis, and results to apply more broadly to other forms of resource sharing.

number of renters). The owner incurs a fixed cost of owning a car, a variable cost due to her own usage, and a variable cost due to the usage by a renter. The renter, in addition to paying the rental fee, incurs a loss of utility due to driving someone else's car. Individuals are heterogeneous in the utility they derive from car usage, with their type specified by their usage level.

We examine how a market equilibrium emerges and the associated number of owners and renters as well as car usage. We compare car ownership and car usage in economies with and without collaborative consumption and the corresponding social welfare. We also study the impact of car sharing on the environmental footprint of mobility and the use of public transit.

We show that, depending on the rental price, collaborative consumption can result in either lower or higher ownership. In particular, when the rental price is sufficiently high (above a well-specified threshold), collaborative consumption leads to higher ownership (more cars). Moreover, the threshold above which prices must be for this to occur is decreasing in the cost of ownership and increasing in the commission fee. This is perhaps surprising as it shows that collaborative consumption is more likely to lead to more cars (and not less) when the cost of owning a car is high. Collaborative assumption in this case allows individuals to offset the high ownership cost and pulls in a segment of the population that may not otherwise choose to own. The reverse is of course also true. Collaborative consumption is more likely to lead to lower car ownership when the ownership cost is low. Similar to ownership, collaborative consumption can lead to either higher or lower usage than that in the absence of collaborative consumption. In particular, if the rental price is sufficiently high (again above a well specified threshold), collaborative consumption leads to higher usage. This threshold is increasing in the commission fee. Hence, when the cost of ownership is high, collaborative consumption is more likely to lead not only to more cars but also to more usage.

These results have implications for public policy. In regions, where the cost of car ownership is high, the results imply that, unless rental prices are kept sufficiently low or the commission extracted by the platform is made sufficiently high, collaborative consumption would lead to more cars and more usage not less. On the other hand, in regions where the both cost of ownership and rental prices are low, it may be desirable to encourage collaborative consumption as it can have the double benefit of reducing both the number of cars and the amount of usage.