Autonomous Vehicles for Ride-Hailing
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Research Question
How does the deployment of autonomous vehicles (AVs) impact the ride-hailing platform, human drivers, and riders? How does the platform manage the spatial mismatch between supply and demand through
• vehicle repositioning
• supply dimensioning through the sizing of the fleet of AVs, and the choice of wages paid to humans driving conventional vehicles (CVs)
• assignment priorities (prioritizing AVs or CVs in assigning trip requests)

Model Description
We adopt a fluid model to study a setting where a ride-hailing platform operates with a mixed fleet of AVs and CVs.

Distinctions Between AVs and CVs
Cost Structure.
• The platform incurs a fixed cost for purchasing AVs.
• The CVs are driven by independent drivers, who are heterogeneous in their opportunity costs. The platform pays drivers a fixed wage per unit time of service.

Controllability. Upon completing a trip transporting a customer, vehicles can either stay at the location where the trip terminated or reposition to another location.
• The repositioning of AVs is under the control of the platform.
• The repositioning of CVs is in the hands of the drivers who act strategically to maximize their own earnings.

Results
• It is optimal for the platform to prioritize AVs when assigning vehicles to customers.
• Compared to a system without AVs, a system with AVs (weakly) improves platform profit and customer service level.
• A system with AVs improves driver welfare if the labor pool size and AV purchase cost are moderate and hurts it (weakly) otherwise.

CV-Prioritized/Random Assignment Policy
• The optimal strategy and corresponding outcomes under the CV-prioritized policy are identical to those under the random assignment policy.
• The AV-prioritized policy, relative to the CV-prioritized/Random assignment policy, (weakly) increases platform profit and customer service level and either increases or decreases driver welfare.

Comparison result of driver welfare in systems with and without AVs.
• Under the AV-prioritized policy, CVs can only serve demands that AVs cannot fulfill.
• By varying the supply and repositioning of AVs, the AV-prioritized policy allows the platform strong control over the repositioning of CVs.
• The platform can use CVs more effectively (by using AVs to push CVs to reposition) to increase its profits, which may align with drivers’ interests.

Comparison result of driver welfare under the AV-prioritized policy and the CV-prioritized policy (random assignment policy).
• Under the CV-prioritized/Random assignment policy, the platform has less control over the repositioning of CVs than it does under the AV-prioritized policy.
• It is no longer optimal for the platform to use AVs to push CVs to reposition. Rather than that, the platform would prefer repositioning AVs (if any) to fulfill more demand at the high-demand location.