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Competition in Ride-Hailing Service Operations: Impacts on Travel Distances and Network Performance

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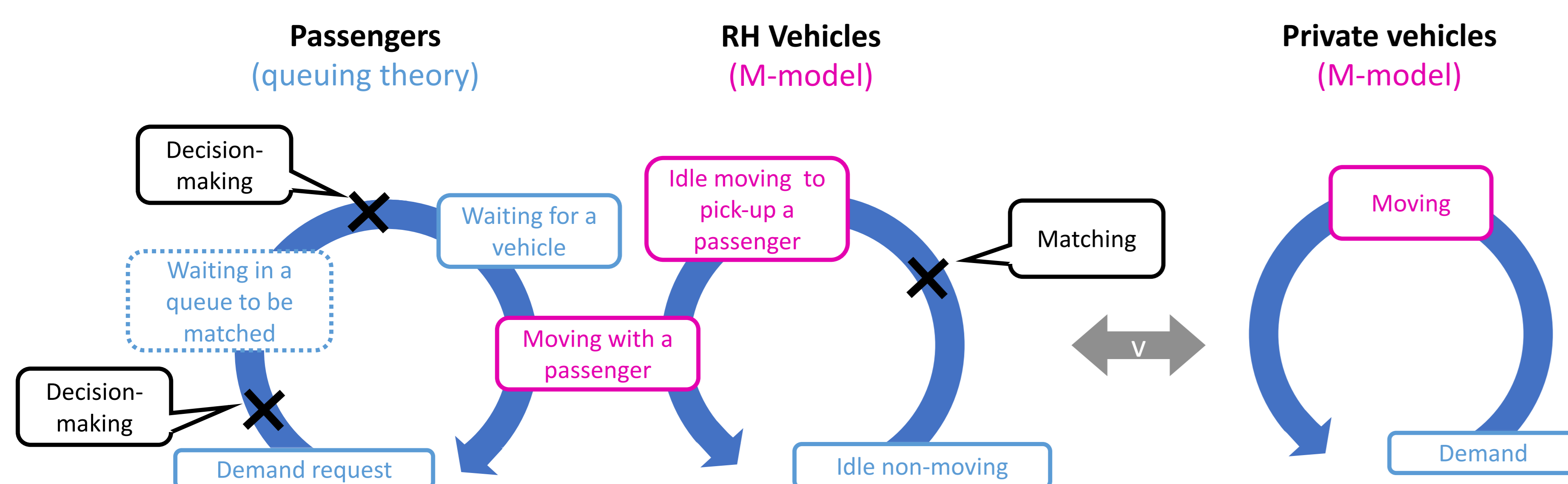
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Motivation

- Assess and compare different matching processes related to the different levels of competition.
- We propose a modeling and simulation framework based on the M-model MFD. It monitors the remaining travel distance of all vehicles. We focus on accurate dynamic estimation of trip lengths for the different vehicle states based on the immediate system state.

Assumptions



Scenarios (decision rules and cancelation):

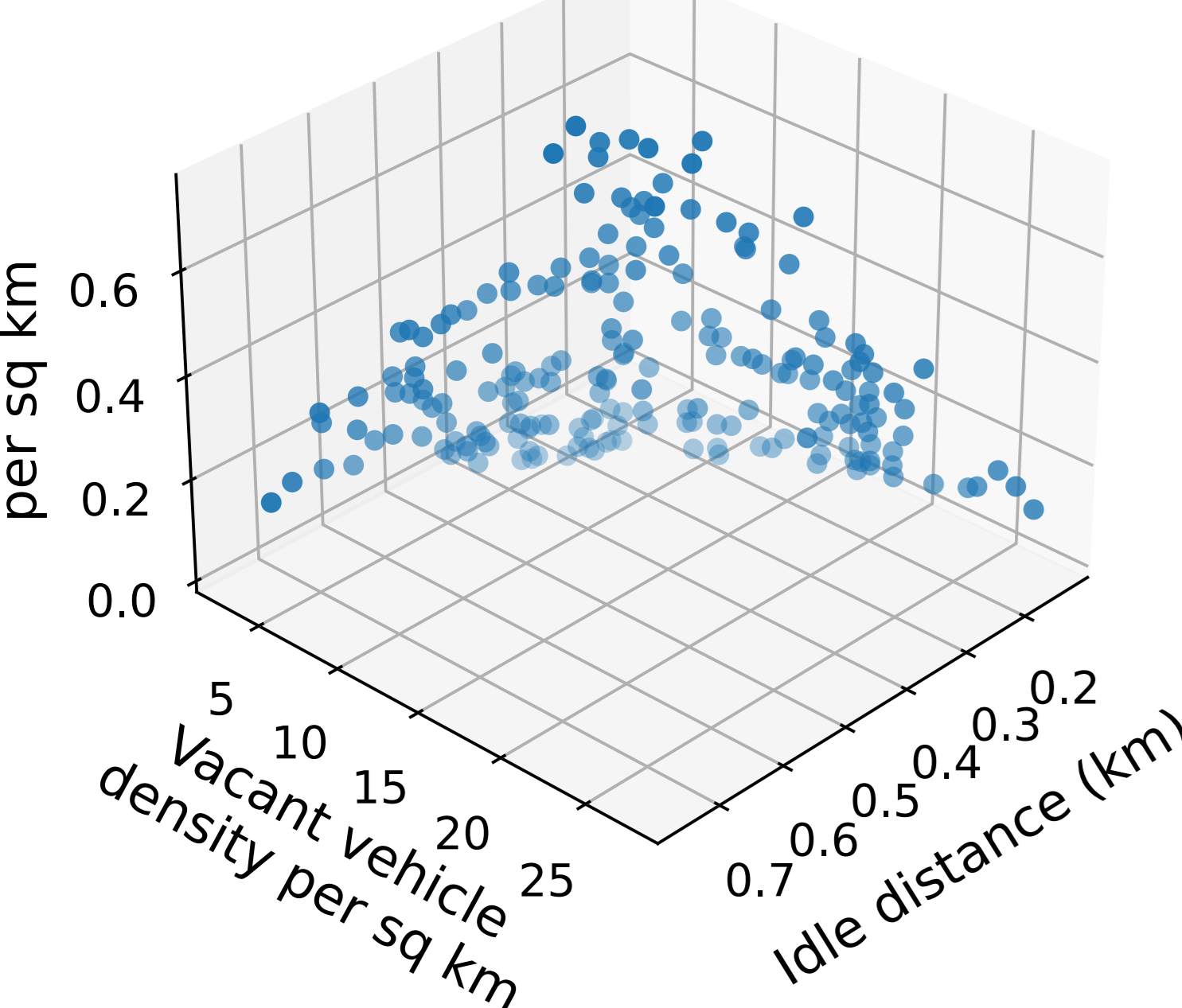
- Competition** (no interaction among the companies except network speed).
- Cooperation** (full data sharing – monopoly scenario).
- Coopetition** (demand request transfer to rival's company after an exclusive time period).

Queue waiting time threshold – 3 min.
Idle distance threshold for matching.

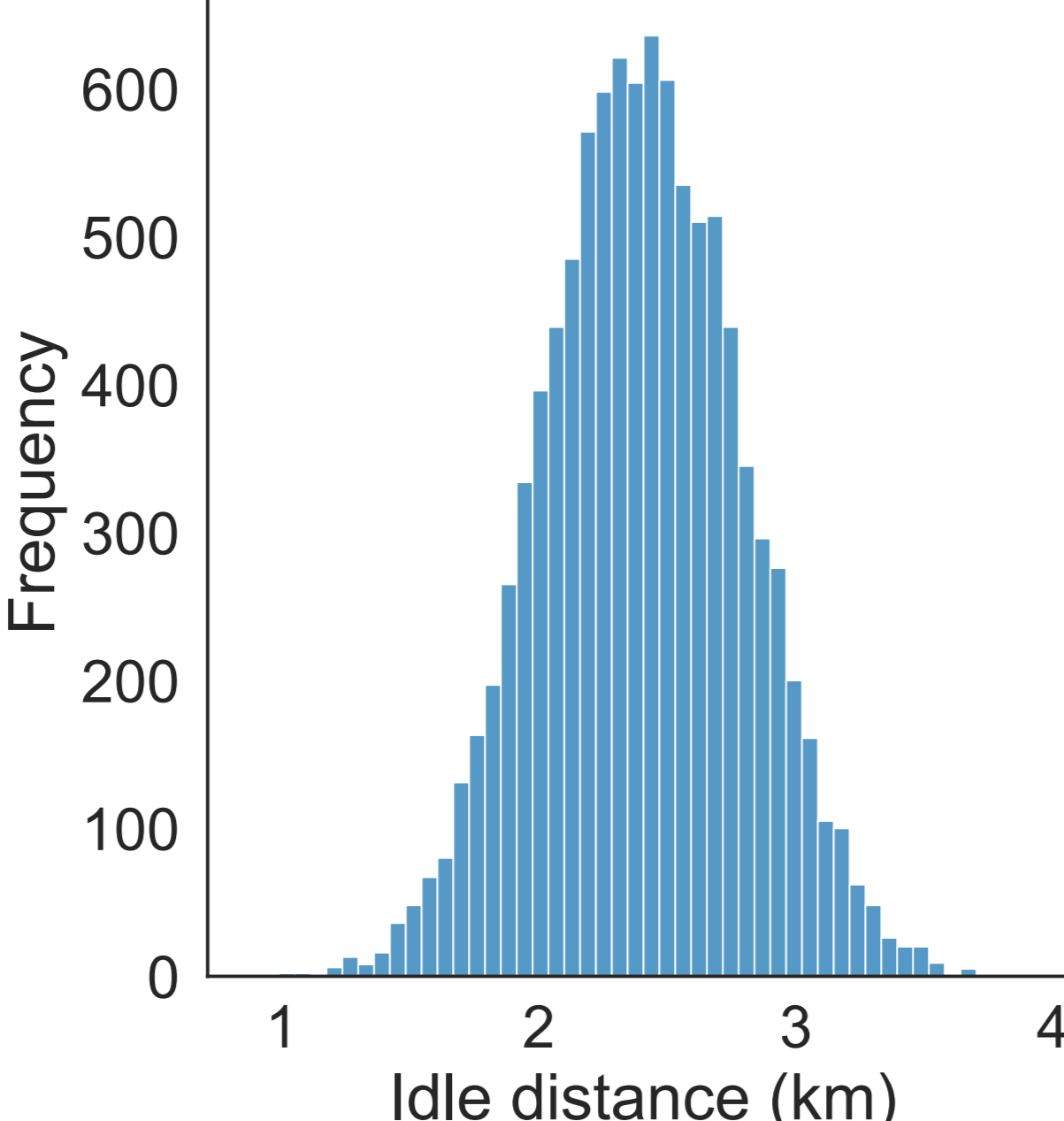
Methodologies

Proxy simulation – estimating distance distribution

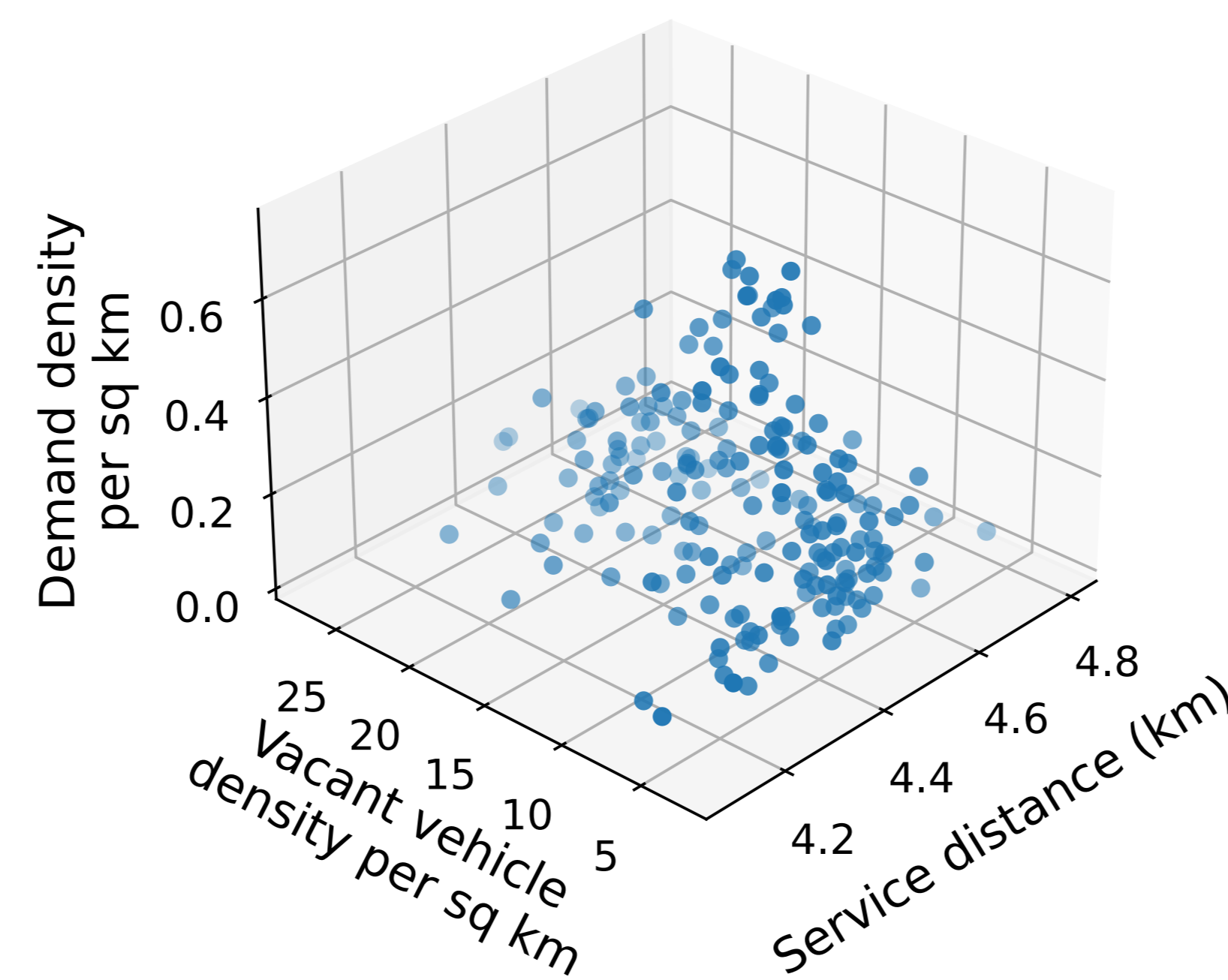
Idle trip when RH vehicles are available



Idle trip during shortage of RH vehicles



Service distance



Key idea:

Cooperation/competition between companies changes which vehicle can fit a travel request. The key factor is the **distance between the customer and the matched vehicle**. It depends on the **demand density** and its distribution among the companies, and the company's number of **vacant vehicles**.

Matching - Cobb-Douglas function:

$$L^{RHI}(t) = F(\lambda(t), n^l(t))$$

$F(x)$ - regression function
 $L^{RHI}(t)$ - average idle distance
 $\lambda(t)$ - demand rate
 $n^l(t)$ - number of vacant RH vehicles

M-model:

$$O^K(t) = \left[n^K(t) + \alpha \left(\frac{M^K(t)}{L_K^*} - n^K(t) \right) \right] v(t)$$

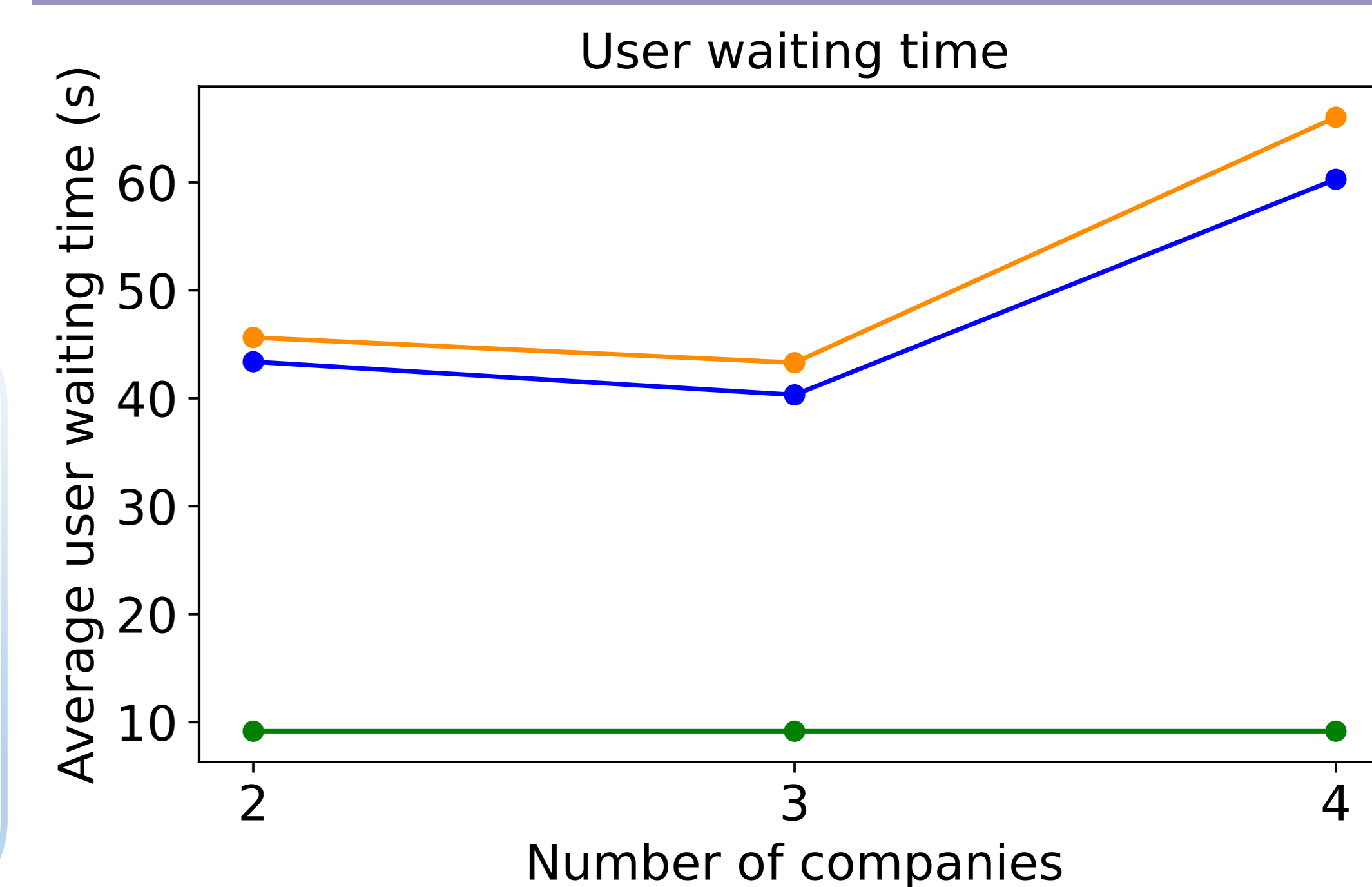
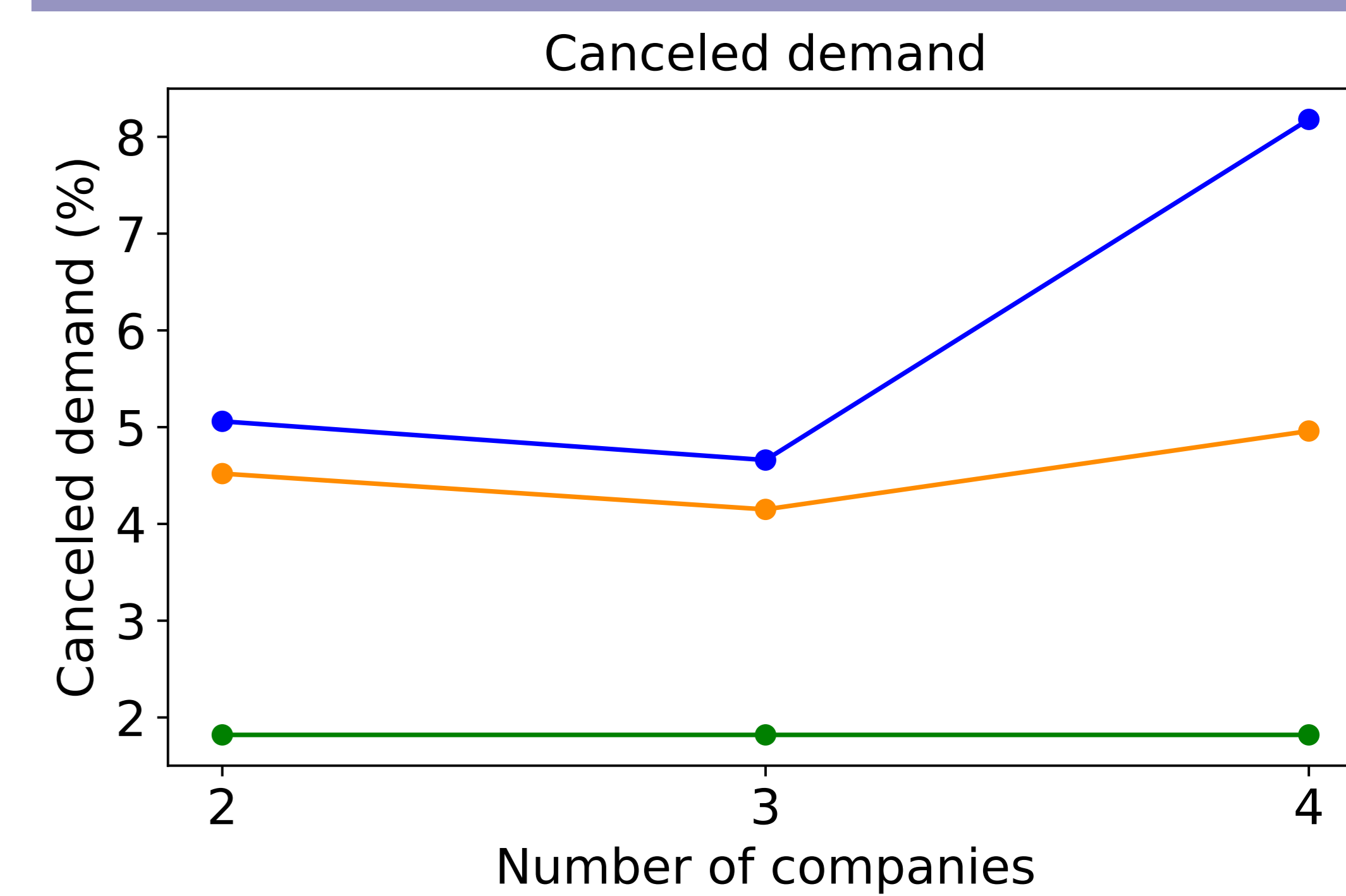
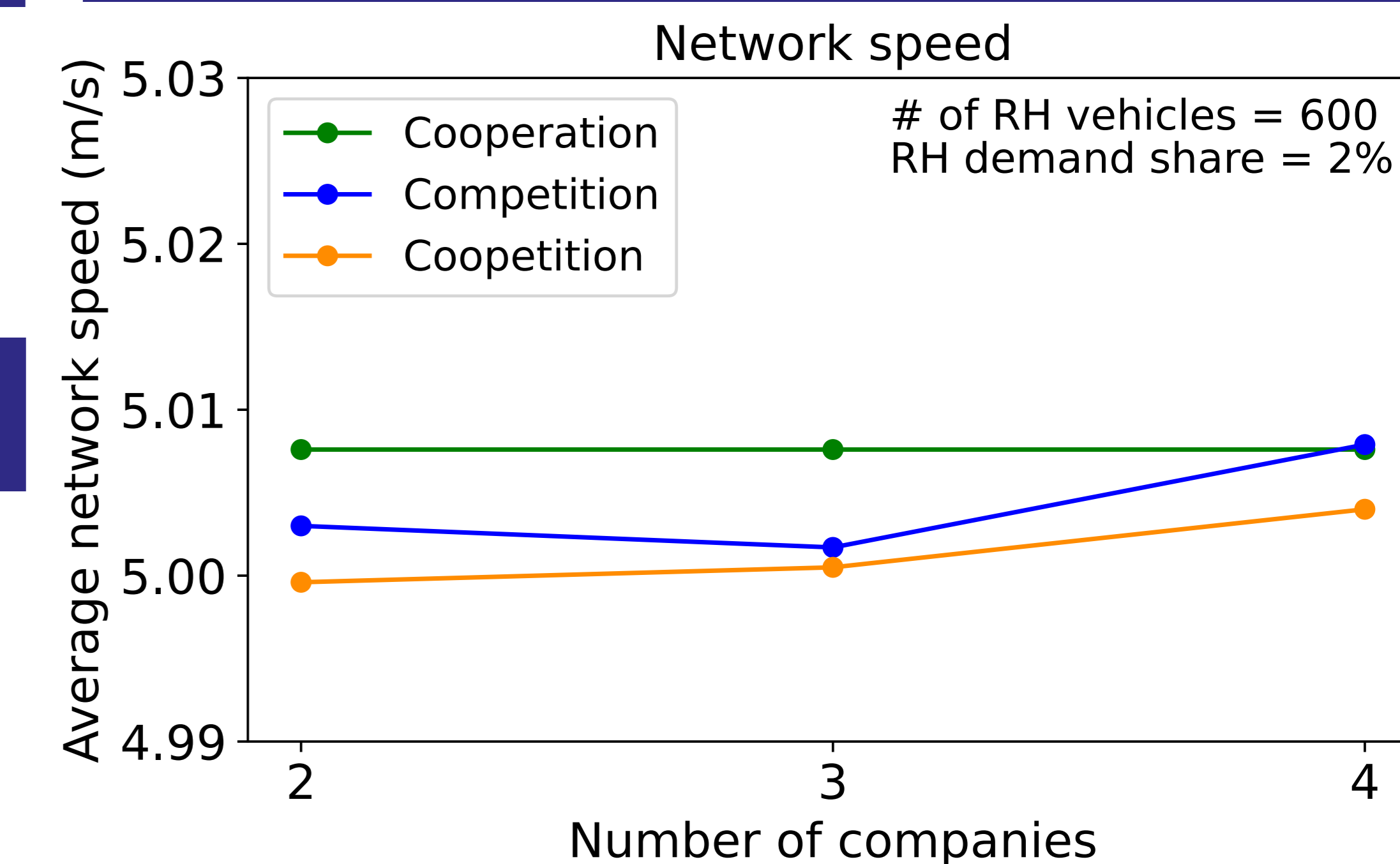
$$L_K^*(t) = \frac{(L^K(t))^2 + \sigma^K(t)^2}{2L^K(t)}$$

Estimated from proxy simulation

Conclusion and perspectives

- The level of competition significantly impacts the user service quality for the same total number of vehicles.
- For a low market share (2%), the impact of competition is marginal on the network congestion. It becomes much higher for a high market share (15%).
- Next step is to study how additional authority policies and restrictions or new cooperation scenarios might influence the system and service quality.

Results



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