

## Cross- vs. In-Region Courier Routing in On-Demand Delivery

The on-demand delivery firms for food and grocery have grown rapidly. One claimed benefit of those firms is the potential to optimize courier routing by sharing couriers across the city and among many vendors, such as restaurants or grocery stores. However, it is puzzling to observe that the largest food-delivery platforms do allow restaurants to employ their own delivery units and grocery delivery pair couriers with single warehouses to deliver in their local neighborhood. To study whether and how sharing couriers across the city benefits a firm, we consider a spatial queuing model in which couriers are servers, and it takes a different amount of traveling time to serve customers depending on their vendor of choice, their own location, and the dispatch policy. Surprisingly, we find that in many cases, the in-region policy with a dedicated courier to each vendor can outperform the cross-region policy with a shared courier fleet among vendors. This result is attributed to the randomness and (potential) imbalance in the courier allocation that cross-region routing creates. Under the growth target strategy of achieving an exogenous demand rate, if the market is sufficiently large, the cross-region policy achieves a higher profit than the in-region one, and otherwise, if the market is small, the in-region policy is more profitable. However, under the profit maximization strategy of endogenizing the demand rate, we find that it is even more likely the in-region policy is optimal: in addition to a market size condition, a high enough service value is required for the cross-region policy to be optimal. This is because, under profit maximization, the firm may want to increase the delivery fee and limit distant customers, which reduces the benefit of cross-region routing. In addition, we show that in those markets where restaurants have a more distinctive cuisine, the cross-region policy tends to do better, and otherwise, in those markets with similar restaurants, the in-region policy has an edge. Lastly, we extend the results from the base model to account for multiple couriers and impatient customers.