

報告番号	甲 第 14247 号
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主 論 文 の 要 旨

論文題目 Comparisons between Traditional Taxi Services and Online Ride-hailing: A case study of Amoi, China
(タクシーサービスとライドヘイリングの利用実態の比較：中国，廈門市の事例研究)

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論 文 内 容 の 要 旨

Online ride-hailing services (RH) is one of the landmark events that has emerged in the personal mobility market during the past decade. In contrast to traditional taxi services (TX), which have been developed based on street-hailing rides, RH are offered via smartphone platforms, directly connecting passengers to rides provided by private drivers using private vehicles. TX and RH have nowadays comprised the two polarities of the commercial personal mobility market.

However, the relationships between these two parties have not been sufficiently investigated in literature. The potential interdependence might be inferred, but few evidence based on statistical examinations with real-field data could be given. By contrast, researchers tend to explore more on the relationships between urban factors and either TX or RH using statistical methods. Two basic but vital questions—“Do TX and RH have certain homogeneity or heterogeneity in terms of their mobility patterns?” and “What interrelationships (competitive or complementary) exist between TX and RH?”—remained poorly understood.

Supported by data for both TX and RH from Amoi City, China, this study proposes a three-fold framework to compare their mobilities, including 1) the spatial distributions

of departures and arrivals by rank-size and odds-ratio analyses, 2) the statistical characteristics of trip distances by considering distance-decay effect, and 3) the significant components inherent in the mobility processes by Nonnegative Tensor Factorization (NTF). Findings suggest that TX and RH have spatial homogeneity in travel demand, but TX demand heterogenizes much faster with changes in population density. The relative balance between TX and RH shows opposite trends inside and outside Amoi Island. The meta-patterns detected by NTF suggest that TX feature exclusive nighttime intensities, whereas RH exhibit more prominent morning peaks. It is also noteworthy that although RH play a significant role in cross-strait interactions during daytime, there lacks efficient services to maintain such interactions at night.

This study also puts forward a graph-based community detection approach by considering the properties of the Laplacian matrix. It differs from other community detection methods for being able to learn a block diagonal similarity graph that directly gives the community structure with predefined number of components, and avoiding the post-processing procedure of questionable robustness. It is especially suitable for real-world graphs such as the mobility graph for it can enforce a k -community structure on the graph despite of the graph quality. With this method, community structures are revealed from the OD graphs of TX and RH. Empirical comparisons suggest that RH are more likely to implement spatial segregation demarcated by communities, whereas TX serve more for cross-community trips. The differentiation of trip purposes across communities is investigated by Poisson regression with OD frequencies and POI densities being the dependent and explanatory variables, respectively. The estimation results suggest that trip purposes related to residence, healthcare, education and government have shown certain spatial differentiation demarcated by communities; whereas dinning and transfer demands could make global contributions to the occurrence of trips.

Further, this work examines the underlying interrelationships between TX and RH. The concern of interdependence across these two types of demands is addressed by introducing a bivariate Tobit model, in which these two demand variables are treated as censored data and are cross- incorporated in a simultaneous equation system. Parameter estimation is implemented with POI densities as major explanatory variables. The conjecture about the interdependence is verified, and three types of significant interrelationships are identified: two-way competitive, unilaterally competitive and complementary. Under most spatiotemporal contexts, RH act as a

formidable competitor for TX, whereas TX only show significant competitiveness in half of the cases. The western residential area of Amoii Island is found to be a blue ocean during the early morning, in which these two parties are complementary to serve an unsaturated market. From empirical analyses, it is concluded that TX will coexist with RH for the foreseeable future, and reasonable resource allocation is needed on both sides for the sustainability of the mobility market.

The methodology and findings should provide valuable insights for practitioners and decision-makers in framing strategies and regulations towards the common sustainable future of TX and RH, and other mobility services. Given sufficient data support, future research could also be developed to examine the impacts of epidemic-specific factors on these services.