

ABSTRACT

Zhang, Wenbo Ph.D., Purdue University, December 2018. Fundamental of App-Based Taxi Service Modeling: Demand, Supply, Pricing, and Network Performance. Major Professor: Prof. Satish V. Ukkusuri.

The app-based taxi services (ATS) has disrupted the traditional taxi industry leading to transformative changes in the urban taxi markets and its impacts on mobility, design and environment. However, the current modeling of these new mobility markets is limited in its understanding of: (1) the underlying factors the influence the growth of the ATS market; (2) the competition of ATS and TTS markets; (3) pricing in the ATS market; (4) system wide tools to understand the impacts of the market. This dissertation will address these gaps by using original large scale datasets to characterize disruptive changes in mobility, understand strategic behaviors of stakeholders, and formulate system dynamics. The overarching goal of this dissertation is to address four fundamental processes of taxi system, ranging from demand generation, supply generation and exiting, dynamic pricing generation, and vehicle-passenger matching over road network.

This dissertation develops various modeling structures and estimation methods, motivated from statistical, econometric, machine learning, and stochastic approaches. First, we adapt multiple econometric models for demand, supply, and platform-exiting (offline) behaviors, including mixture model of spatial lag and Poisson regression and mixture model of spatial lag and panel regression. It is apparent that all proposed econometric models should be corrected with spatial lag due to significant spatial autocorrelations. The results indicate effectiveness of dynamic pricing in controlling demand, however, almost it also shows no impacts on driver's online and offline behaviors. Then a dynamic pricing generation problem is formulated with multi-class classification. This model is empirically validated for the impacts of demand and

supply in dynamic price generation and the significant spatial and temporal heterogeneity. Last, we propose a queueing network consisting of taxi service queues for vehicle-passenger matching and road service queue for vehicle movements at homogeneous spatial units. The method captures stochasticity in vehicle-passenger matching process, and more importantly, formulates the interactions with urban road traffic.

In summary, the thesis provides a holistic understanding of fundamental processes that govern the rapid rise in ATS markets and in developing fundamental tools to model the system wide impacts of this evolving taxi markets. Taken together, these tools are transformative and useful for city agencies to make various decisions in the smart mobility landscape.