

Dissertation Proposal

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A Structural Analysis of Sharing Economy Leveraging Location and Image Analytics Using Deep Learning

The global sharing economy, e.g., Airbnb and Uber, is projected to generate roughly \$335 billion by 2025. The rise of sharing economy has drawn enormous attention from academia and led to policy intervention debates. However, the existing work on sharing economy largely focused on studying the impact of sharing economy on their incumbent counterparts. Three questions that are essential to a better understanding of sharing economies remain unanswered: 1) can we identify, from unstructured data such as images, the key dimensions that affect consumers' choices, as well as provide guidelines for improving sharing economy platforms, and 2) what is the optimal policy for Airbnb to target its heterogeneous hosts for providing them property images that give an optimal "misrepresentation" of the properties, so as to maximize the platform's profit, and 3) are there demand interactions/externalities that arise across sharing economies to provide policy implication. This dissertation contributes to the relevant literature by filling the gap. To achieve this objective, I apply economic theory to a data on a large scale leveraging advanced machine learning techniques in computer vision, natural language processing, and deep learning models.

In the first chapter, we investigate the economic impact of images and lower-level image factors that influence property demand in Airbnb. Using Difference-in-Difference analyses on a nine-month Airbnb panel dataset spanning 8,211 properties, we find that units with verified photos (taken by Airbnb photographers) generate approximately 7% more demand, or \$4,141 per year on average. Leveraging computer vision techniques to classify the image quality of more than 380,000 photos, we show that 52.5% of this effect comes from the high image quality of verified photos. Next, we identify 12 image attributes from photography and marketing literature to further quantify (using computer algorithms) and characterize unit images to evaluate the economic impact of these human-interpretable attributes. The results suggest that these attributes have a direct impact on demand even after controlling for many observables and thus there is significant value in optimizing images in e-commerce settings. From an academic standpoint, we provide one of the first large-scale empirical evidence that directly connects systematic lower-level and interpretable image attributes to demand. This contributes to, and bridges, the photography and marketing (e.g., staging) literature, which has traditionally ignored the demand side (photography) or did not implement systematic characterization of images (marketing). Lastly, these results provide immediate insights for housing and lodging e-commerce managers (of Airbnb, hotels, realtors, etc.) to optimize product images for increased demand.

In the second chapter, we aim to provide Airbnb an optimal policy to target the specific group of hosts and offer them an optimal image-improvement-solution of their properties. Despite the importance of property images, a large number of Airbnb hosts use low-quality photos—even Airbnb offered the professional photography program for free. This is because consumers use the observed property attributes (image quality) to infer the unobserved ones (service quality). Hence high-quality images come with a risk of setting a high expectation on the delivered lodging experience for the guests and then bringing down the guests' review scores if the expectations are not met. A host may not want to have (free) high-quality images, if his marginal cost of hosting a guest with high-quality service (e.g., respond to guest promptly) is high. An optimal policy for Airbnb is then to target hosts who are more receptive to image quality in their demand functions and have low marginal costs of delivering high-quality service. To achieve this goal, we build a structural model on both the demand and the supply side of the platform. On the demand side, consumers have heterogeneous preferences on a set of product attributes in choosing lodging alternatives. Following BLP frame work (Berry et al. 1995), we estimate the random-coefficient logit-model using aggregate market-share data. On the supply side, in each period a host set a pair of image quality and property price to maximize his expected profit, conditional on his marginal cost of providing a service quality that matches the image quality. That is, the image quality and the property price, are equilibrium outcome of rational hosts in each period. The estimated marginal costs, combined with the hosts' self-demand-image elasticities, allow us to simulate policy counterfactuals, which provide an optimal improvement in the image quality for each heterogeneous host, given the expected increase in their property demand and the delivered service quality.

In the third chapter, we examine how ride sharing services such as Uber/Lyft affect the demand for home sharing services such as Airbnb. Our identification strategy hinges on a natural experiment—Uber and Lyft exit Austin in May 2016—that introduced a significant increase in the transportation costs in Austin. Applying Difference-in-Difference approach on a nine-month balanced longitudinal data spanning 7,300 Airbnb properties across seven US cities, we find that the exit of Uber/Lyft leads to a decrease of 9.6% in the Airbnb property demand, equivalent to a decrease of \$6,482 in the annual revenue to the host of an average property unit. We further find that the exit of Uber/Lyft reduces the (geographic) demand dispersion on Airbnb. The demand gets more concentrated in areas with access to better public transportation services. Further, the properties farther away from downtown experience greater decrease in their demand in the absence of Uber/Lyft. The negative effect of Uber/Lyft's exit for the low-end properties is 2.17 times greater than the effect for high-end properties in the same areas. Our research effort is a first step toward understanding the positive externalities between sharing economies and provides policy implication.