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Modeling taxi drivers' decisions for improving airport ground access: John F. Kennedy airport case

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ABSTRACT

Taxi service is an important component of airport ground access, which affects the economic competitiveness of an airport and its potential positive impact on the surrounding region. Airports across the globe experience both taxi shortages and excesses due to various factors such as the airport's proximity to the city center, timing and frequency of flights, and the fare structure. Since taxi drivers are independent entities whose decisions affect the taxi supply at airports, it is important to understand taxi drivers' decision mechanisms in order to suggest policies and to maintain taxi demand and supply equilibrium at the airports. In this paper, New York City (NYC) taxi drivers' decisions about airport pick-ups or cruising for customers at the end of each trip is modeled using logistic regression based on a large taxi GPS dataset. The presented approach helps to quantify the potential impacts of parameters and to rank their influence for policy recommendations. The results reveal that spatial variables (mainly related to proximity) have the highest impact on taxi drivers' airport pickup decisions, followed by temporal, environmental and driver-shift related variables. Along with supplementary information from unstructured taxi driver interviews, the model results are used to suggest policies for the improvement of John F. Kennedy (JFK) airport's ground access and passenger satisfaction, i.e. the implementation of taxi driver frequent airport server punch cards and a time-specific ride share program.

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1. Introduction

Airports provide national and international connectivity for cities and economic benefits to the surrounding region (Chmura Economics and Analytics, 2008). The airport travel modal share for taxis ranges between 6% and 35% for major airports in the U.S., the U.K. and Japan (Tam and Lam, 2005; Gosling, 2005). Taxi trips to or from the airport represent 5% of all taxi trips in New York City (NYC-TLC, 2014). In terms of airport travel, taxis carry 39% of all airport bound passengers from Manhattan to NYC airports. 35% and 23% of air passengers arriving at La Guardia Airport (LGA) and John F. Kennedy Airport (JFK) respectively utilize taxis. The 2014 Taxi Fact Book (NYC-TLC, 2014) states that taxis serve an average of 26% and 10% of all passengers arriving to or departing from LGA and JFK respectively. Moreover, there has been an increasing trend in taxi use (Schaller Consulting, 2006). The number of taxis dispatched from JFK increased by 68% from 1996 to 2005 (Schaller Consulting, 2006). In 2010, close to 3 million taxis were dispatched from JFK (Conway et al., 2012). Briefly,

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taxis represent one of the major access modes for airports. In the case of multiple airports serving a region, Gelhausen (2011) shows that airport ground accessibility affects travelers' airport choice decisions. Airport choice, in turn, may affect the airline choice as companies mostly consolidate their operations in certain airport hubs. In these respects, taxi service is an important component of airport ground access from the perspectives of both the public and commercial airline companies.

Taxi regulations vary considerably from city to city, as well as between different airports serving the same city, e.g. specific provisions pertaining to taxi pickups from the airports. The demand for taxis at the airport and in the city affect each other (Santani et al., 2008), based on the relative attractiveness between the airport and the citywide areas, due to airport passenger volume, distance to the city center, fare structure, and potential driver revenue outside of the airport. Some airports can take advantage of the airport attractiveness (limited accessibility options, high demand, distance to the city, lucrative fares) and charge a fee to support the airport operations (Kamga et al., 2013). Cases of taxi supply excess (Chmura Economics and Analytics, 2008; Skok and Martinez, 2010; Lukic, 2007) and shortage (Tiwari, 2005; Lam et al., 2006; Lukic, 2007; Barrett, 2010; Jung et al., 2013; Costa and Neufville, 2012) are reported for airports throughout the world. In NYC, taxi shortages are experienced, especially during inclement weather conditions at JFK airport in NYC as taxi drivers prefer cruising in the city rather than picking up passengers from the airport (Conway et al., 2012; Kamga et al., 2011). The opposite case is observed at Dallas Forth-Worth, Portland, and San Francisco airports where taxis mainly provide service to the airport but do not adequately serve the city (Tiwari, 2005; Lam et al., 2006). Adjusting the taxi supply does not guarantee better service or satisfaction (Darbera, 2010; Yang et al., 2010). Changes in taxi regulations are politically challenging due to multiple stakeholders. Besides airport passengers and taxi drivers, the stakeholders in NYC include (1) The New York City Taxi & Limousine Commission (TLC), which is responsible for licensing and regulating New York City's taxis (also called medallion or yellow taxis), (2) The Port Authority of New York and New Jersey (PANYNJ), which is responsible for airport taxi operations, and (3) airline companies, which are potentially affected by their customers' satisfaction levels with the land-side travel experience. In brief, identifying and mitigating sources of delay and discomfort for taxi customers positively affect multiple parties involved in the process. Since taxi drivers work independently, the decisions about when to work and where to make pickups are solely based on their personal preferences, thus it is important to understand their decision mechanisms in order to provide incentives to attract them to and relieve their shortage at airports.

In these respects, this paper aims to: (1) identify and quantify the factors that affect taxi drivers' airport pick-up decisions, and (2) provide policies to enhance airport ground access, which in turn are expected to increase passenger satisfaction and enhance airport/airlines competitiveness. Emerging taxi GPS trip datasets provide the opportunity to extract important patterns for a particular region, to create sound models and to help determine policies for improving the quality of airport ground access. The current study moves in this direction and models taxi drivers' airport pick-up decisions for JFK airport in New York City. In addition to the model outcomes, unstructured taxi driver interviews are also used to fine-tune the suggested policies. The existing airport taxi policy and operations are defined by the NYC Taxi & Limousine Commission (TLC) and the Port Authority of New York & New Jersey (PANYNJ). The current open system policy allows only NYC medallion taxis to make airport pick-ups after following airport specific operational procedures. This study provides policies that can be implemented within the existing NYC regulatory framework.

The developed model is based on the consecutive taxi trips made by each driver in the database. For each passenger drop-off, the origin of the next trip is categorized as either JFK (which implies an airport pickup based on GPS coordinates), or a non-airport, "regular" pickup. Hence, the actual decision of a taxi driver to make an airport pick-up (which is a 0/1 binary variable) is recorded along with spatio-temporal, weather and driver-specific variables associated with that particular trip. Then, binary logistic regression is used to model the drivers' decision to go to JFK for a passenger pick-up and get a guaranteed flat fare (as is the case for JFK taxi operations), or to keep on cruising in the city (particularly Manhattan) for a random fare. The model's independent variables include the drop-off location, time and date, weather conditions, drivers' anticipated monetary gain with an airport pick-up, and some other additional variables. Considering the higher market penetration of GPS devices in taxis (and for-hire vehicles in general), and the increasing availability of taxi GPS data around the world, the proposed methodology has the potential to be replicated elsewhere. As a matter of fact, such data driven approaches have been adopted by researchers to model taxi drivers' customer search process behavior (Szeto et al., 2013; Wong et al., 2014a, 2014b; Liu et al., 2009).

The outline of the paper is as follows. First, the literature review on role of taxis in airport ground access is presented along with the specific taxi regulations in NYC and JFK. Second, the details of the utilized data are given, followed by the discussion of variables that were included in the taxi driver decision model. Then, the binary logistic regression results are presented. The model results are used to suggest policies to improve the taxi supply at JFK. Lastly, the conclusions are presented.

2. Literature review

Tsamboulas and Nikoleris (2008) argue that, as the ground transportation modes compete with each other, high levels of service (e.g. better accommodating passengers with luggage) become important and affect the willingness to pay for airport ground access time savings. Studying the San Francisco Bay Area, Pels et al. (2003) find that access time is generally more important than the access cost (especially for business travelers) and access time plays a very important role in the

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