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Behavioral analysis of airline scheduled block time adjustment

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ABSTRACT

Scheduled block time (SBT) is the time between gate departure and gate arrival assumed by airlines for use in published timetables and operations planning. SBT setting has critical impacts on airlines' operating cost and on-time performance. Air carriers regularly update their SBTs to respond to changing operating conditions and evolving business strategies. Most existing studies have focused on investigating the impact of SBT on on-time performance or predicting SBT based on historical performance and market characteristics. However, the dynamics of adjusting SBT, which may allow deeper understanding about the trade-offs airlines make between SBT and on-time performance, have been rarely studied. In this paper, we assume that SBT adjustment choices reveal preferences. Based on airlines' practice in setting SBT, hypothetical SBT scenarios and their corresponding on-time performance profiles are re-constructed to mimic the situations faced by airline schedulers. This enables us to infer how airlines trade-off between SBT, on-time arrivals, and earliness. By using correlated mixed logit models, we find that our five study airlines are willing to increase SBT from 0.38 to 0.54 min to increase on-time performance by 1%. We also find that both on-time performance and early arrival are valued by airlines, but the former is considerably more valuable. The estimated models can also be used to predict airlines' SBT adjustments in response to changes in operational performance.

1. Introduction

Schedule design continues to remain one of the most challenging planning activities for any airline (Barnhart and Cohn, 2004). A critical component of the scheduling activity is the setting of flight scheduled block time (SBT). SBT is the time duration between the scheduled (computer reservation system, or CRS) departure and scheduled (CRS) arrival time. Its realized counterpart is termed actual block time (ABT) which is the time duration between the actual departure time and the actual arrival time. Typically airline schedulers set SBT for a certain flight more than six months ahead of time (Deshpande and Arikan, 2012).

Maintaining consistent profitability requires that appropriate tradeoffs be made in setting SBT. Specifically, at the airline level, SBT has significant impact on operating cost and on-time performance. As illustrated by Hao and Hansen (2013) and Mayer and Sinai (2003a), a longer SBT may cause less efficient utilization of the aircraft (i.e. fewer scheduled flights for a fleet), higher flight crew cost (crews are paid based on the maximum of ABT and SBT), and more early arrivals (when actual

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arrival time is earlier than scheduled arrival time). This is in line with the findings of Zou and Hansen (2012) in which schedule buffer (a longer SBT) has been found to be an important airline cost driver. Moreover, from a passenger's point of view, shorter SBT would be generally preferred since it indicates less travel time. Hence, overestimating SBT might make one airline less competitive to other airlines. On the other hand, a longer SBT with more padding will guarantee less delay (against schedule) for flights, thus ensuring better on-time performance. According to the U.S. Federal Aviation Regulations (14 C.F.R. section 234.2) (FARs), a flight is counted as "on time" if it operated less than 15 min later the scheduled time shown in the carriers' CRS. This on-time performance metric is reported by the airlines and published by the FAA. Although airlines generally compete based on their fares, it is well known that flight on-time performance is a very important indicator of airline service quality, and also affects market share (Hsiao and Hansen, 2011; Britto et al. 2012). Furthermore, though early arrivals can sometimes induce cost (Deshpande and Arikan, 2012), based on our interview with one major U.S.-based airline, early arrivals increase customer satisfaction by providing extra buffer for connecting passengers, as well as generally "exceeding expectations." The common practice of cabin crew calling attention to early arrivals in their end-of-flight announcements supports this view. Therefore, airlines face a difficult set of trade-offs in setting SBT. They must balance their cost saving motive against their desire for good schedule adherence (Hao and Hansen, 2013).

Besides its profound impact on on-time performance or flight delays, SBT has also been found to reflect airlines' strategic responses to ABT predictability as measured by flight time standard deviation (Mayer and Sinai, 2003b) or flight time distribution percentiles (Hao and Hansen, 2014). In general, the less predictable the flight time, the longer SBT airlines tend to set. Therefore, studying airlines' behaviors in adjusting SBT could provide new insights in evaluating the predictability performance in the National Airspace System (NAS).

To this end, intensive efforts have been made to focus on evaluating the impact of SBT on flight delays, developing robust scheduling models through network optimization, and predicting SBT based on historical performance and market characteristics. However, the dynamics of adjusting SBT, which may allow deeper understanding about the trade-offs airlines make between SBT and on-time performance, have been rarely studied. These trade-offs can help predict how airlines respond to changes in operational performance, thus can be used in the benefit assessments of various initiatives and programs such as NEXTGEN, which, by increasing capacity under adverse weather, is expected to differentially impact the right tail of flight time distributions. It is important to know whether such a change will ultimately improve on-time performance, reduce SBT, or some combination of the two. Furthermore, through the monetization of SBT reduction, policy makers can also better evaluate potential economic benefit of new initiatives for the airline community. Finally, by revealing the preference structure that guides SBT setting, it is possible for management to assess the consistency between this structure and the higher level strategic goals and policies of the airline.

Therefore, the goal of this paper is to empirically investigate how considerations about SBT, on-time performance, and early arrivals influence SBT adjustment decisions, using the data of five major U.S.-based airlines. We assume that SBT adjustment choices are guided by the principle of utility maximization. Accordingly, discrete choice models are estimated in which different possible SBT adjustments constitute the choice set, and attributes of these alternatives are based on the on-time performance and earliness that would be expected to result, based on historical distributions of ABT. In order to obtain a starting point in selecting design variables, relevant industry practice of SBT settings and existing literature will be reviewed in Section 2. Section 3 covers data collection and preparation. In Section 4, statistical modeling strategies will be discussed in detail. Section 5 discusses the estimation results for five airlines. Summary and conclusions are presented in Section 6.

2. Literature review

Phone interviews with two major U.S.-based airlines' flight operators and managers were conducted to gain a detailed understanding about their SBT setting process. A consistent SBT setting process has been observed for these two airlines which are based on target block time reliability (BTR) and historical flight performance. BTR represents the proportion of realized flights that flew an ABT shorter than or equal to its SBT based on 3–5 years of historical flights categorized by quarter, origin–destination pair (OD), departure time-of-day window, and aircraft type (details of exactly how flights are grouped when determining BTR vary across airlines). By pre-specifying a target BTR, airlines can get the corresponding SBT for a particular segment of flights based on a historical flight ABT distribution. Target BTRs also vary across hubs and OD markets. Notably, gate delay is not considered by either airline in setting SBT. These findings are broadly consistent with the SBT setting process described by Hao and Hansen (2013) based on an interview with the block time scheduling group of a major U.S.-based airline. In the case of that airline, the network group works with the SBT provided by the block time group and gives feedback for SBT adjustment if they feel on-time performance will be unsatisfactory. In addition to historical performance, airlines sometimes also adjust SBT due to changes in schedule structure, for example implementing connecting complexes at a hub, or changes in airport layout or gate location. A more comprehensive review of how airlines set SBT could be found in Hao and Hansen (2013).

As mentioned before, academic literature on SBT can be classified into three streams: (1) evaluation of the impact of SBT on airline cost and productivity; (2) models of SBT setting based on historical performance and market characteristics; (3) robust scheduling strategies through system optimization of SBT.