ARTICLE IN PRESS

Economics of Transportation xxx (2017) 1–11

Contents lists available at ScienceDirect

Economics of Transportation

journal homepage: www.elsevier.com/locate/ecotra

How much do consumers really value air travel on-time performance, and to what extent are airlines motivated to improve their on-time performance?

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ARTICLE INFO

JEL classification:
codes: L93
L13

Keywords:
Airline on-time performance
Commercial aviation

ABSTRACT

This paper estimates the value consumers place on air travel on-time performance (OTP), and the extent to which airlines are motivated to improve their OTP. We find robust evidence that consumers value OTP and are willing to pay to avoid delays. Airlines can invest to improve OTP, but would independently choose to do so only if on-time performance improvement leads to increases in profitability. Using a methodology that does not require having actual cost data to draw inference on cost changes associated with improvement in OTP, we analyze airlines' optimal OTP-improvement investment choice. The modeling framework allows us to provide estimates of OTP-related marginal investment costs per minute of improvement necessary to achieve specific percent reductions in arrival delay minutes from the current levels of arrival delay minutes observed in the data.

1. Introduction

Punctuality is certainly a key performance indicator in the airline industry, and carriers with excellent on-time performance (OTP) record use it as a marketing tool by prominently displaying it on their websites. Given increased competition that followed deregulation of the airline industry in 1978, many carriers have resorted to product quality differentiation as a key to long-term profitability. Although airlines generally compete based on pricing, flight OTP is a very important component of airline service quality, which drives customer satisfaction and loyalty. For example, in the 1990's American Airlines ran ads calling itself “The On-Time Machine.”[1] Likewise, airlines that produce excessive flight delays receive a great deal of negative publicity.

In 1987, the U.S. Congress passed the flight on-time disclosure rule amidst chronic air traffic delays that stirred public outcry and media coverage. The disclosure rule made it mandatory for airlines with at least one percent of all domestic traffic to publish flight-by-flight delay data. Airlines are required to track and report five segments of travel time for each of their flights to the Federal Aviation Administration (FAA): *i)* departure delay, *ii)* taxi-out, *iii)* air time, *iv)* taxi-in, and *v)* arrival delay.

Remarkably, even with the flight on-time disclosure rule of 1987, the industry's OTP is still far below satisfactory levels. A report from the U.S. Department of Transportation's (DOT) Office of Aviation Enforcement and Proceedings[2] revealed that the most prevailing consumer air travel complaint in the year 2000, stems from flight problems namely cancellations, delays and missed connections. In fact, 1 out of 4 flights was either delayed, canceled or diverted (Rupp et al., 2006). According to Mayer and Sinai (2003), in year 2000, flights that arrived at their destination within 15 min of their scheduled arrival time and without being canceled or diverted, accounted for less than 70 percent. Even more recently, the Bureau of Transportation statistics (BTS) showed that 23.02% of U.S. domestic flights were delayed[3] in year 2014, an increase from 14.69% in year 2012. The BTS maintains an archive of monthly and yearly OTP data that is also accessible through the Internet.[4] Thus, passengers' most common source of frustration is flight delay.

In the midst of these delay statistics, airlines often claim that air traffic delays are out of their control, placing the blame on adverse weather or air traffic control as the most common culprits.[5] A good portion of delay can be attributed to extreme weather, air traffic control and security checks (U.S. DOT, 2015). In June 2003, the Air Carrier On-Time

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[1] Boozer et al. (1990).
[2] US Department of Transportation Office of Aviation Enforcement and Proceedings (USDTOAEP) Feb. 2001 p. 34.
[3] A flight is considered delayed if it arrived at (or departed) the gate 15 min or more after the scheduled arrival (departure) time.
[4] The BTS archived data are located at http://www.transtats.bts.gov/homedrillchart.asp.
[5] http://www.washingtonpost.com/lifestyle/travel/what-to-do-when-airlines-blame-flight-problems-on-circumstances-beyond-our-control/2015/02/12/7298b264-a57f-11e4-a7c2-03d37af98440_story.html.

https://doi.org/10.1016/j.ecotra.2018.01.003
Received 9 June 2017; Received in revised form 4 December 2017; Accepted 30 January 2018
Available online xxxx

Please cite this article in press as: Gayle, P.G., Yimga, J.O., How much do consumers really value air travel on-time performance, and to what extent are airlines motivated to improve their on-time performance?, Economics of Transportation (2017), https://doi.org/10.1016/j.ecotra.2018.01.003

Reporting Advisory Committee defined five broad categories for the cause of any flight delay[6]:

1 ***Air Carrier***: The cause of the cancellation or delay was due to circumstances within the airline's control (e.g. maintenance or crew problems, aircraft cleaning, baggage loading, fueling, etc.).
2 ***Extreme Weather:*** Significant meteorological conditions (actual or forecasted) that, in the judgment of the carrier, delays or prevents the operation of a flight (e.g. tornado, blizzard, hurricane, etc.). Weather delays are also included in the National Aviation System and late-arriving aircraft categories.
3 ***National Aviation System (NAS)***: Delays and cancellations attributable to the National Aviation System that refer to a broad set of conditions—non-extreme weather conditions, airport operations, heavy traffic volume, air traffic control, etc.
4 ***Late-arriving Aircraft:*** A previous flight with same aircraft arrived late, causing the present flight to depart late, and
5 ***Security:*** Delays or cancellations caused by evacuation of a terminal or concourse, re-boarding of aircraft because of security breach, inoperative screening equipment and/or long lines in excess of 29 min at screening areas.

Although some of these factors are uncontrollable, airlines still have a substantial level of control over their OTP. An airline can schedule a longer flight time to absorb potential delays on the taxiways, or choose a longer layover on the ground to buffer against the risk of a late incoming aircraft (Mayer and Sinai, 2003). Fig. 1 shows declining shares of flight delay caused by weather and air traffic control (NAS) over time, while over the same time period, the shares of delay caused by late-arriving aircraft and air carrier, continue to rise. Figs. 1 and 2 suggest that OTP improvement potential within the reach of airlines is significant.

The objective of this paper is twofold. First, we examine the monetary value that consumers place on OTP. In order to make our case about consumers valuing improved OTP, we estimate a discrete choice demand model, which allows us to quantify the opportunity cost of delays to consumers. Thus, incorporating OTP into our demand model affords us the advantage of measuring how much OTP matters to consumers. In essence, we estimate how much consumers are willing to pay to avoid each minute of delay.

Second, if consumers do value OTP, to what extent may airlines benefit from improving their OTP? How does improved OTP affect airlines' variable profits in an oligopoly market structure, a strategic environment where few firms are competing with each other? One way to answer these questions is by examining how airlines' price-cost markup and demand for air travel respond to changes in OTP. To facilitate this part of the analysis we specify a supply-side of the model assuming that multiproduct airlines set prices for their differentiated products according to a static Nash equilibrium. The supply-side of the model is first used to generate estimates of product-level price-cost markups and airline-level variable profits, and then used to conduct counterfactual exercises to assess the extent to which improvements in arrival delay (i.e. improvements in OTP) influence variable profits of airlines. The variations in airlines' variable profit due to counterfactual improvements in OTP are used to assess the incentive a given airline has to improve OTP.

The rationale for using variable profit changes as measures of airlines' incentive to improve OTP is that airlines care about their bottom line, and if improving OTP leads to increases in variable profits, then improving OTP might be a worthwhile proposition for airlines. In addition, because variable profit is a function of price-cost markup and demand level, we are able to decompose the changes in variable profit into changes in its components and examine how these components drive the changes in variable profits.

Over the last three decades, empirical studies on air travel have neglected to explicitly incorporate OTP measures of service quality into air travel demand estimation. De Vany (1975) is among the first to incorporate service quality, proxied by flight frequency, in a demand model. Anderson and Kraus (1981), Ippolito (1981), Abrahams (1983) and De Vany (1975) estimated air travel demand models with schedule delay[7] as a measure of service quality. Our present paper contributes to this literature.

A novel feature of this study is that we model demand based on passenger origin-destination[8] markets rather than flight segments within a broader origin-destination market. Previous demand studies that are based on origin-destination markets have not incorporated flight delay,[9] and studies that have incorporated delay (Abrahams, 1983; Anderson and Kraus, 1981; De Vany, 1975; Douglas and Miller, 1974; Ippolito, 1981), model demand based on flight segments rather than passenger origin-destination markets. Since much of air travel from passengers' origin to their destination use several flight segments rather than a single non-stop flight, it is reasonable to model demand within an origin-destination framework, which captures the imperfect substitutability between non-stop and intermediate-stop products within an origin-destination market. In fact, our dataset shows that only 17.6 percent of itineraries are non-stop flights from the relevant passengers' origin to destination. Travelers typically demand air transportation between a directional origin and destination pair rather than segment-by-segment flights. Our focus on origin-destination markets not only helps to predict passengers' behavioral intentions, but provides a more realistic structure for the measurement of consumer welfare effects of flight delay.

Several conclusions emerge from the empirical analysis. First, other things equal, consumers value OTP and are willing to pay for it. Our demand estimates show that consumers are willing to pay $1.56 per minute late to avoid delay. Second, we find that, a 10% reduction in arrival delay minutes (improved OTP) results in an increase in variable profit by a mean 3.95 percent. Furthermore, we find that it is the increase in demand levels, as compared to increase in markup, that accounts for most of the increase in variable profits.

Given the finding that reductions in arrival delay minutes (improved OTP) yield increases in variable profits, we are able to use the model to recover estimates of the cost per minute of delay improvement that rationalizes the level of delay minutes we observe in the data. The model predicts that a 2.39% increase in OTP-related marginal investment cost per minute of improvement is necessary to achieve a 10% reduction in arrival delay minutes below their current levels.

The remainder of the paper is organized as follows. The next section provides a review of the literature. Section 3 describes the data used for analysis. Section 4 describes variables used for estimation. Section 5 discusses the research methodology and estimation procedure used to analyze the OTP effects. Results are presented and discussed in Section 6, while concluding remarks are gathered in Section 7.

2. Literature review

Researchers have written extensively on airline flight delays. The literature on flight delays abounds in both operations management and economics. The operations management literature uses models that attempt to explain flight delays from an operational standpoint of running an airline. Shumsky (1995) contributed to the literature of airline scheduling performance analysis by examining U.S. air carriers' response to the on-time disclosure rule of 1987. The rule creates incentives for carriers to improve their OTP by either reducing the amount

[6] http://www.rita.dot.gov/bts/help/aviation/html/understanding.html.

[7] Defined as the sum of frequency delay and stochastic delay. Frequency delay is the gap between one's desired and the nearest offered departure time while stochastic delay is time lost due to the nearest offered departure being unavailable.

[8] Tickets are issued for the entire itinerary, which may include intermediate airport(s).

[9] Origin-destination passenger data contain no information on routings' on-time performance.