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Supply-and-demand models for exploring relationships between smaller airports and neighboring hub airports in the U.S.

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ABSTRACT

Airport passenger leakage is the phenomenon of air passengers choosing to travel longer distances to access more extensive air services offered by airlines at an out-of-region hub (or, substitute) airport, instead of using their local airports. Airport leakage can cause further reduction in services offered by airlines at a local airport, thereby causing even further leakage, and so on, which can significantly impact an airport's role in the growth of the local economy. This paper explores the geographic and operational attributes of local-and-substitute airport pairs in the United States, explicitly accounting for the interactive feedback relationship between passenger volumes and air service characteristics that contribute to the onset, persistence, and exacerbation of airport passenger leakage. A two-stage least squares regression model of air passenger demand at small- and medium-sized airports is first presented, where local passengers may travel by vehicle to larger, out-of-region hub airports. The results confirm that airfare and passenger volume relationships exist between the local and substitute airport pairs included in the dataset, and that lower airfares at the substitute airport have a greater impact on airport choices made by larger travel groups. They also suggest the existence of positive feedback in that if an airport attracts increasingly smaller passenger numbers with fewer air services and fewer air services with fewer passengers, without external intervention airport leakage impacts may be irreversible and exacerbate over time. A conceptual market share equilibrium analysis is used to illustrate the mechanisms of a direct two-way feedback relationship between passenger volumes at a local airport and air service characteristics at both the local and substitute airports. With data, this quantitative framework can help guide airport planners in further assessing and verifying suspected passenger leakage issues at their airport. The results suggest that without intervention, airport leakage impacts may be difficult to reverse; further exacerbating the trend are technological advancements that make driving cheaper and easier (connected and autonomous vehicles). However, the results can also guide planners in choosing the types and degrees of infrastructure investments and airline incentives that may be used to expand or retain air services to attract passengers.

1. Introduction

Passengers at many small- and medium-sized U.S. airports are increasingly provided fewer flight options and higher airfares as a result of airline mergers, alliances, and various decisions made to cut operational costs and increase efficiency (Sharkey, 2014a, 2015), in addition to constraints on opportunities to expand infrastructure capacity. For instance, airlines are increasing their use of larger and more efficient jet aircraft over regional jets, which make hub airports more preferable for these airlines to operate from (Sharkey, 2014b). This in turn increases airline competition and decreases the concentration level of airlines at hub airport as measured by the Herfindahl–Hirschman Index (HHI) (Detzen et al., 2012; Lijesen and Rietveld, 2002), which may be associated with more airfare discounts (Stavins, 2001). As a result, passengers that would typically use their smaller local airports may respond by driving relatively long distances to larger out-of-region hub airports (termed substitute airports) in order to take advantage of better flight options, lower airfares, and other airport amenities. This phenomenon has been termed airport leakage (Elwakil et al., 2013; Fuellhart, 2007; Suzuki and Audino, 2003; Suzuki et al., 2004).

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As airports play an important role in connecting regions nationally and globally and supporting local economic development, the loss of passengers at these small- and medium-sized airports can have significant and long-term impacts (Ottawa Macdonald-Cartier International Airport Authority, 2012; De Neufville, 1995). It may contribute to increased traffic and congestion at substitute airports. A shrinking passenger base at the local airport makes that airport less attractive to airlines, eventually leading to fewer flight options (Pitfield et al., 2010), then fewer passengers and even fewer flight options, and so on – a positive supply-and-demand feedback, or the "vicious cycle of local air services" (Kanafani and Abbas, 1987). For instance, after airline deregulation, air carriers reduced their services at Meadows Field Airport in Bakersfield, California, encouraging a large portion of travelers in the Bakersfield area to drive approximately 110 miles to Los Angeles International Airport (LAX). The shrinking market and revenues at Meadows Field resulted in fewer air carriers and flight options, which further drove local passengers to LAX (Kanafani and Abbas, 1987). Without incentive programs (Ryerson, 2016), other investments by local governments, or the benefits of external economic forces, passenger losses may be difficult to reverse (Sharkey, 2014b). It is important to have some quantitative insights into the mechanisms driving passenger leakage at these local airports to major out-of-region hub airports, with respect to the service characteristics of these airports, and vice versa, in order to gauge the need for (and degree of) investments that may help to stem this passenger leakage.

This paper explores the operational attributes of local-and-substitute airport pairs in the United States. We explicitly account for the interactive feedback relationship between passenger volumes (demand) and air service characteristics (supply) that contribute to the onset, persistence, and exacerbation of airport passenger leakage. We first present a two-stage least squares regression model of air passenger demand at small- and medium-sized airports, where local potential passengers may travel by vehicle to larger, out-of-region hub airports. The results confirm that airfare and passenger volume relationships exist between the local and substitute airport pairs included in the dataset, and that lower airfares at the substitute airport have a greater impact on airport choices made by larger travel groups. After confirming the existence of this relationship, we then present a conceptual market share equilibrium analysis to illustrate the mechanisms of a direct two-way feedback relationship between passenger volumes at a local airport and air service characteristics at both the local and substitute airports. They also suggest the existence of positive feedback in that if an airport attracts increasingly smaller passenger numbers with fewer air services and fewer air services with fewer passengers, without external intervention, airport leakage impacts may be irreversible and exacerbate over time.

The contributions of this paper include the confirmation of relationships between airport leakage and explanatory factors such as travel group size and airport enplanement, and explicit consideration of the interaction between demand and supply in both the empirical model and the equilibrium analysis. Most importantly, this paper proposes a quantitative framework that can help guide airport planners in further assessing and verifying suspected passenger leakage issues at their airport. If an airport suspected of passenger leakage to an out-of-region hub airport exhibits characteristics similar to those in the regression model dataset, data collection to estimate and populate the proposed feedback model may be justified. The model results can be used, in turn, to quantitatively verify or refute the existence and severity of leakage. Analysis results can be used by local jurisdictions and airport planning authorities to gauge what types of, and to what degree, infrastructure investments and incentive programs should be considered in expanding or retaining air services to attract passengers back to the airport in question. More specifically, the results can provide some indication of how impactful intervention decisions may be in disrupting the positive feedback of air passenger leakage and service cutbacks, such that appropriate types and levels of investment can be applied.

2. Literature review

The study of airport passenger leakage implicitly assumes that air travelers within a certain distance of an airport, or within a defined region in which the airport is located, are expected to use that airport when flying (Fröhlich and Niemeier, 2011). These travelers presumed to be in the catchment area of that airport may "leak" to a larger airport for which they are not expected to be in the catchment. This phenomenon can be categorized as an airport passenger competition problem (Fuellhart, 2007; Lieshout, 2012). Although airport competition and passenger choice has been extensively studied for multi-airport regions (MARs), it has received far less attention in the context of airports experiencing expected passenger loss to larger, out-of-region hub airports. The passenger leakage problem has been studied using the same analysis methods applied to MARs problems, insofar as both deal with understanding the mechanisms that determine how airports attract (and compete for) passengers with two or more airport options. Differences arise as the geographic scope of the leakage problem is interregional, while that of the multi-airport region problem is within a single metropolitan area. The service characteristics of these airports differ, as do the factors that influence passengers' airport choice.

Despite that interregional air passenger leakage is considered to be an issue of significance (Lian and Rønnevik, 2011; Jang, 2010; Sharkey, 2014b), it has not been studied as much as the MARs problem due to a number of reasons. Firstly, it is often the case that the local metropolitan planning organization (MPO) collects various transportation data within the region it oversees. These agencies are not typically easily able (or willing) to collect data – particularly the disaggregate survey data required for discrete choice models – beyond their jurisdictions. Coordinated data collection by multiple regional authorities is difficult due to institutional structure and therefore happens very rarely (Miller, 2004). As a result, most past studies on airport leakage have been based on data collected specifically to study the problem by the airports experiencing the leakage (Suzuki et al., 2003; Fuellhart, 2007; Kimley-Horn and Associates, Inc., 2012). Secondly, although airports and regions that experience passenger leakage may have anecdotally identified the issue, without an investment in data collection, it may be more difficult to determine whether the issue is severe enough to warrant further infrastructure investments and how much.

Interregional air passenger leakage is also relevant within the context of the Essential Air Service (EAS) program (Grubesic and Matisziw, 2011). Passenger retention at small community airports in the EAS program, as well as overall program efficiency, has been studied by several researchers (Kaemmerle, 1991; Zhang and Xie, 2005; Grubesic and Wei, 2012). Consistent with conclusions from airport leakage studies, it has been found that the quality and quantity of air services at small community airports, as well as the distances between them and other larger airports, are very important in retaining passengers at these EAS airports (Kaemmerle, 1991; Zhang and Xie, 2005). A study indicates that