The Effects of Capacity Discipline on Smaller U.S. Airports: Trends in Service, Connectivity, and Fares

by

Michael D. Wittman

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Signature redacted

Author ....
Department of Civil and Environmental Engineering
May 1, 2014

Signature redacted

Certified by ....
Peter P. Belobaba
Principal Research Scientist of Aeronautics and Astronautics
Thesis Supervisor

Signature redacted

Accepted by ....
Heidi M. Nepf
Chair, Departmental Committee for Graduate Students

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Abstract

After decades of growth in domestic flights, seats, and available seat-miles, airlines reduced capacity at airports across the United States from 2007-2012 in response to a global economic downturn and high and volatile fuel prices. Despite an economic recovery and more stable fuel prices, airlines continued to keep domestic capacity low relative to historical levels. This strategy, which has been referred to as "capacity discipline," has had widespread implications for the entire U.S. air transportation network.

This thesis examines the effects of capacity discipline on service availability, network connectivity, and fares in the U.S. air transportation network, particularly at smaller airports. We find that airlines cut flights at large airports by 8.8% from 2007-2012, as compared to a 21.7% reduction in flights at smaller airports over the same time period. As a result, some smaller airports may be particularly vulnerable to losing all network carrier service.

Capacity discipline also changed the mix of carriers that served smaller airports. In many cases, network carriers providing service from smaller airports to connecting hubs were replaced by ultra-low-cost carriers providing less-frequent service. We create an airport connectivity index to explore these effects of capacity discipline on airports' connections to the global air transportation network. The index model suggests that smaller airports lost more connectivity than larger airports in multi-airport regions.

Finally, we examine changes in airfares as a result of capacity discipline. We find that medium-sized airports saw the largest increases in airfares—11.9% on average—from 2007-2012. Additionally, while the presence of low-cost carriers is still associated with in a decrease in the average one-way fare at an airport, the effects of some LCCs such as Southwest Airlines have diminished over time.

Capacity discipline may be an unstable equilibrium when viewed in the game-theoretic context of the "prisoner's dilemma." With lower levels of connectivity and increasing fares, smaller airports in multi-airport regions will need to employ creative strategies to prevent passengers from leaking to primary hubs. Whether these airports can recover from service consolidation will also depend on how long this capacity discipline equilibrium remains in effect among U.S. airlines.

Thesis Supervisor: Peter P. Belobaba
Title: Principal Research Scientist of Aeronautics and Astronautics

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1 Introduction

1.1 Airline Attitudes About Capacity: Then and Now

Since the deregulation of the US airline industry in 1978, airlines have been able to compete for passenger traffic on the basis of both fares and frequencies they offer in each origin-destination market. Historically, since deregulation, airlines have often primarily competed by increasing frequencies in order to grow their market share in a given origin-destination (O-D) market. This is because there is a perceived and empirically-tested nonlinear relationship between frequency share and market share (Belobaba et al., 2009). As shown in Figure 1.1, this relationship is often modeled as an "S-curve" shape, such that airlines with more than 50% of the frequency share in a given market will gain a disproportionate fraction of market share.

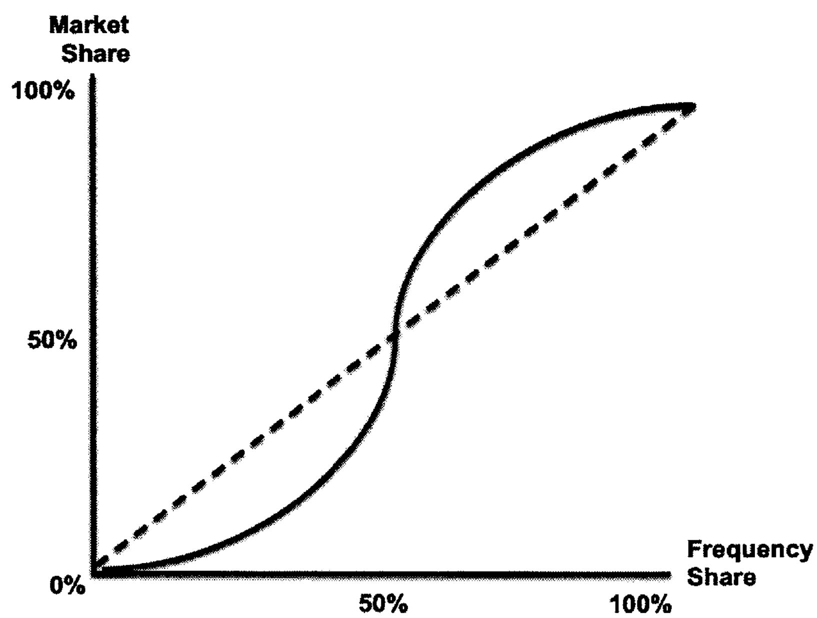

Figure 1.1: S-curve relationship between frequency share and market share

U.S. airlines have attempted to take advantage of this frequency share-market share relationship and achieve growth and profitability by focusing on expanding their networks (Oum et al., 1995). This is particularly true amongst large airlines that have adopted hub-and-spoke connecting networks—each additional frequency to a "spoke" airport in a provides allows airlines to leverage the economies of network size by allowing access to hundreds of new O-D markets for connecting passengers (Brueckner and Spiller, 1994). In the same fashion, growing an airline's network by adding a new destination can create many new possible connecting itineraries for the airline to sell. Given these advantages of network growth, it is not surprising that a 2007 Continental Airlines memo to investors stated that the airline "must...continue to grow its network to remain an effective competitor in the future." (Kellner and Smisek, 2007)

Indeed, many of the past 20 years of domestic aviation in the United States have been marked by growth in both traffic and capacity. Domestic available seat-miles (ASMs) have grown from about 552 million in 1992 to about 678 million in 2012, according to data from the U.S. DOT, with most years showing year-over-year growth rates of between 1% and 5%. Similarly, measures of passenger traffic such as revenue passenger-miles (RPMs) have also generally increased during the period, from about 344 million in 1992 to 565 million in 2012.

Using this historical precedent as a guide, official forecasts from the Federal Aviation Administration and other sources have often assumed that the future will bring continuing positive growth in ASMs, RPMs, and seat departures. Airport planners are thus encouraged to plan for both passenger-side growth in enplanements and airline-side growth in departures in both the short and long term (e.g. Goetz (1992); Humphreys (2003) and others).

In recent years, however, only one of these predictions has continued to be fulfilled. The number of passengers flying domestically in the United States has indeed continued to increase since 1992, with only limited interruptions during periods of economic slowdown or recession. On the other hand, since 2007, airline capacity levels have deviated from historical patterns. The period from 2007 to 2010 was marked by significant reductions in available flight departures and seat departures across the U.S. air transportation network as airlines coped with two sudden economic shocks: the rapid rise and instability in the price of jet fuel, and a burgeoning economic recession. Figure 1.2 shows the degree of the cuts in domestic departures and available seats from 2007-2010.

Yet since 2010, U.S. airlines have not grown available domestic capacity, despite economic growth and more stable (albeit higher) fuel prices. As Figure 1.2 shows, the period from 2008-2012 was marked by negative or flat yearly growth in both departures and available domestic seats (i.e., seat

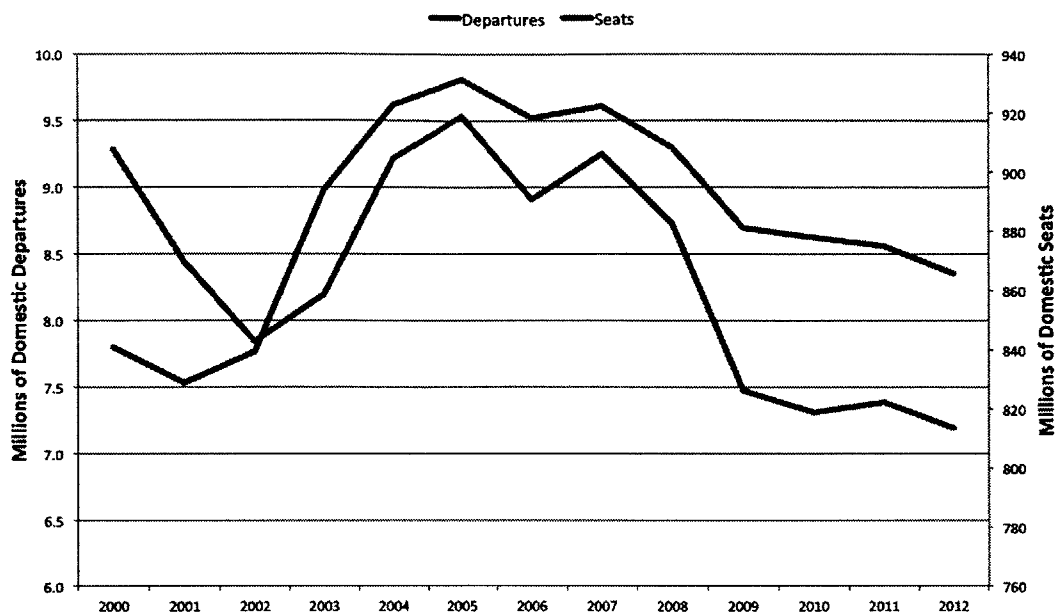

Figure 1.2: Domestic departures and available domestic seats, 2000-2012. Source: Diio Mi

departures). Importantly, this lack of growth continued despite an economic recovery and positive GDP growth from 2010-2012. The period from 2008-2012 was the first time in the last twenty years, and perhaps the first time in U.S. aviation history, that there has been five consecutive years of flat or negative growth in available domestic seat departures. We will define this pattern of restricted growth in domestic capacity despite strong economic fundamentals as **capacity discipline**.

There are several different ways that airlines have implemented capacity discipline in their networks. They include:

- **Ceasing all service on a route or at an airport.** This is the most extreme form of capacity discipline, yet it is also one of the least common. From 2007-2012, only 24 U.S. airports lost all of their network carrier service, out of nearly 500 primary commercial service airports in the United States.
- **Reduction of frequencies.** In most cases, airlines practiced capacity discipline by removing some frequencies on unprofitable routes while still maintaining some service on that route. The majority of losses in flights and seat-departures at U.S. airports were a result of airlines

cutting back on frequencies while still offering some service and connectivity.

- **Change of gauge**. In some cases, airlines changed the gauge of the aircraft that served small community airports. This was often done in tandem with a change in frequencies. For instance, two daily flights with a 50-seat CRJ-200 regional jet could be replaced by a single flight with a 76-seat CRJ-900 regional jet, leading to a 24% reduction in available seats and a 50% reduction in available flights.

Capacity discipline represents a new and important shift in airline strategic decision-making that has had tremendous repercussions throughout the industry. For instance, despite historically high inflation-adjusted fuel prices, the U.S. airline industry paradoxically posted several consecutive years of stable and record profits from 2011-2013. This profitability may have only been possible as a result of the simultaneous reduction in seat capacity and increase in load factors that were the hallmark of the domestic industry in the early 2010s. By restricting the amount of available capacity, airlines were able to carry a greater percentage of higher-fare passengers, increasing both yields and load factors simultaneously. Indeed, as a United Airlines executive remarked in August 2013, that airline's yield growth (and associated profitability) between 2007-2012 "would have been impossible without capacity discipline" (Jones, 2013).

Yet capacity discipline has had negative effects for U.S. airports and for the traveling public. The effects of capacity discipline were felt most strongly at smaller airports—those classified as medium-hubs, small-hubs, or non-hubs by the Federal Aviation Administration—in the form of fewer flight choices and higher fares. Thus, this thesis will attempt to examine capacity discipline through the lens of small community air service—a topic that has been somewhat neglected by past academic research.

1.2 The Need for Research on Small Community Air Service

Much of the academic literature regarding air transportation in the United States focuses on analyzing congestion, noise, delays, or flows at the very largest and busiest airports. Yet with nearly 500 primary commercial service airports[1] in the United States, this research agenda neglects hundreds of smaller airports that have not gotten their academic due. These airports are located throughout the country, and are as important to their communities as large airports are to theirs. Often, such airports provide the only economic and geographic link between a small community, the rest of the country, and the rest of the world.

To be sure, the patterns of air service at smaller airports are very different than those at larger airports. Service levels at smaller airports, as measured by available flights, seats, or ASMs, are much lower than those at larger airports. Small airports may have only a handful of daily flights to one or two destinations operated by regional affiliates of network carriers or, more recently, low-cost carriers. The 50-seat regional jet emerged as the most important aircraft for airports of this size, as it is small enough to be operated profitably in small markets. Figure 1.3 shows that nearly 300 U.S. airports received service from 50-seat regional jets in 2012, while nearly 100 airports were served by only 50-seat RJs, as shown in Figure 1.4.

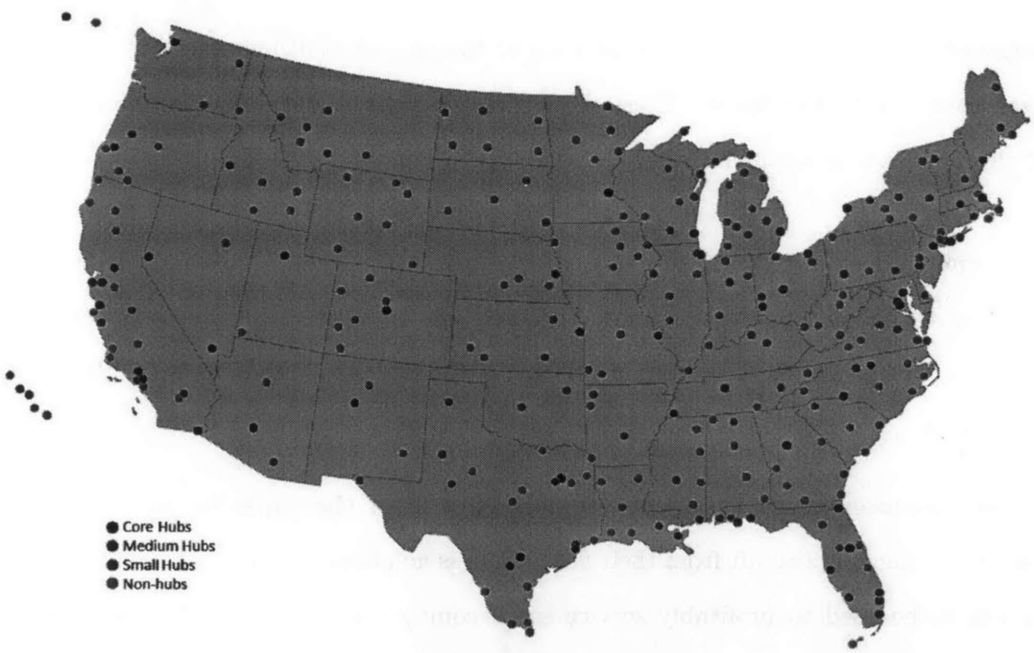

Figure 1.3: U.S. airports with 50-seat regional jet service in 2012. Source: Diio Mi

[1]A primary commercial service airport, as defined by the Federal Aviation Administration, enplanes at least 10,000 passengers in a given year

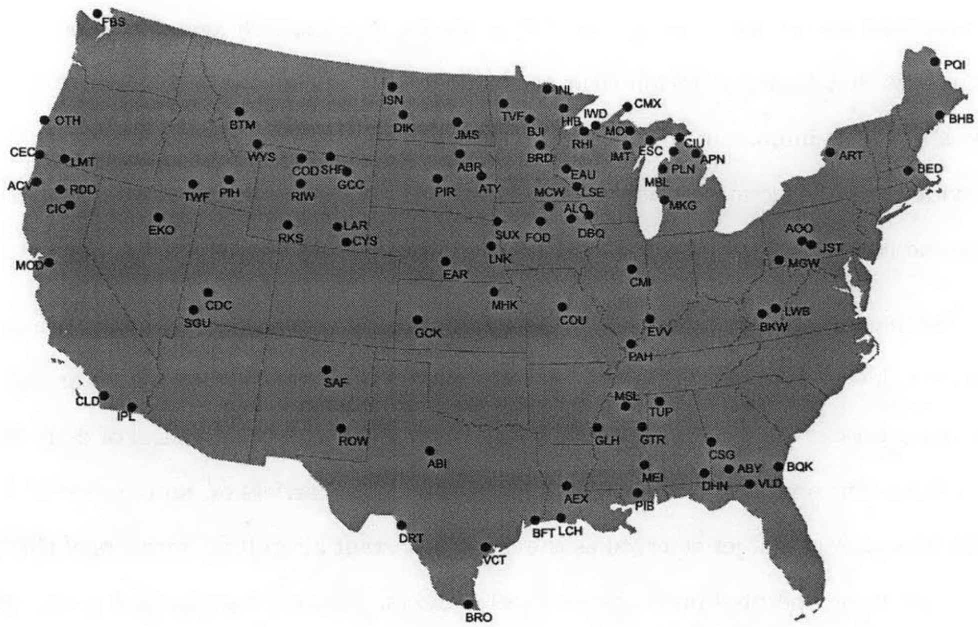

Figure 1.4: U.S. airports served only by 50-seat RJs or turboprops in 2012. Source: Diio Mi

The emergence of capacity discipline has highlighted the myriad challenges faced by small community air service in the United States. These challenges, which are shown in Figure 1.5 and discussed in detail throughout this thesis, include:

- **High fuel prices** that changed the economics of operating the 37-50 seat regional jets that often serve smaller airports. As these aircraft become more expensive to operate, airlines responded by cutting service at smaller airports or upgauging to larger aircraft, also at reduced frequencies.

- **No replacement for the 50-seat regional jet is in the pipeline**, so as more airlines start removing this aircraft from their fleet, there is no obvious choice of aircraft that is small enough to be used to profitably service small communities. The smallest new production aircraft from regional jet manufacturers like Bombardier, Embraer, and Mitsubishi are likely to contain at least 100 seats—too large to serve many small community markets.

- **Regional airline service at smaller airports continues to be cut** as a result of higher fuel prices and persistently low levels of demand at small community airports.

- **New regulations regarding flight time and duty time of regional pilots** have created fears of a pilot shortage among regional carriers, which could limit the amount of service offered at smaller airports.

- The **presence of low-cost carriers (LCCs) in primary catchment areas** has encouraged traditional network legacy carriers to exit smaller markets. While LCC service is often seen as valuable for passengers as it leads to lower average fares, the impacts of LCC and ULCC service on small airports' connectivity to the global air transportation network needs further evaluation.

- **Capacity discipline** and the associated profitability-focused airline management mentality may be the greatest challenge faced by small community airports. As long as airlines continue to maintain profitability using capacity discipline strategies, small airports may struggle to attract new service from network carriers.

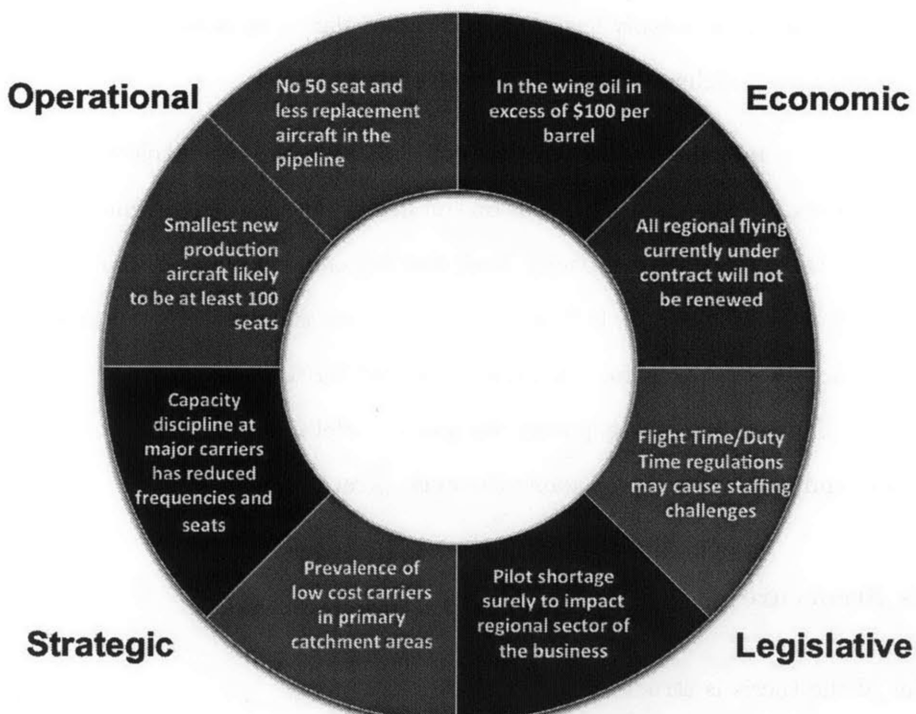

Figure 1.5: Challenges faced by smaller airports in the United States

Given these challenges, a thorough examination of service levels, connectivity, and airfares at small community airports is warranted in the context of the capacity discipline era. This thesis examines in detail the changes in these critical performance areas at over 450 airports in the United States from 2007-2012 with the goal of highlighting how capacity discipline and schedule rationalization have changed the role that small airports play in the U.S. air transportation system.

1.3 Thesis Objectives

The emergence of capacity discipline in the early 2010s has had tremendous ramifications for the U.S. airline industry, U.S. airports, and domestic passengers. For airlines, capacity discipline has been a road to collective profitability despite the unclear stability of the strategy as a competitive equilibrium. For airports, capacity discipline has locked-in the capacity cuts that were instituted during the 2007-2009 economic recession, resulting in large reductions in service and connectivity—particularly at secondary and tertiary airports in multi-airport regions. And for domestic passengers, the restriction of available supply has resulted in fuller planes, reduced availability of departure times, and, in many cases, higher inflation-adjusted airfares.

This thesis examines the impacts of capacity discipline on each of these stakeholders in the U.S. air transportation network, with a particular focus on smaller airports. Using a blend of traditional and new methodologies, we examine how capacity discipline has affected the level and types of domestic service available, the connectivity of U.S. airports to the global air transportation network, and inflation-adjusted domestic airfares for the period from 2007-2012. We conclude with a discussion of the competitive framework of the capacity discipline model and the stability of the strategy in the medium-term and long-term from a game theoretic perspective.

1.4 Thesis Structure

The remainder of the thesis is structured as follows:

- **Chapter 2** introduces and carefully defines the periods of schedule rationalization (2007-2009) and capacity discipline (2010-2013), focusing specifically on the causal factors that heralded the beginning of each period and the effects of these periods on U.S. airports.

- **Chapter 3** discusses how these market forces have affected levels of available domestic service at 462 U.S. airports, as well as broader industry trends in aircraft and airline mix. A taxonomy system for small community airports is also proposed to identify airports that may be at risk to lose some or all of their scheduled passenger air service over the next five years.

- **Chapter 4** introduces the Airport Connectivity Quality Index (ACQI), an intuitive model to quantify an airport's level of connection to the global air transportation network based on both the quantity and quality of available service. ACQI scores are computed for each of the airports profiled in Chapter 3, and trends and case studies are discussed in relationship to capacity discipline and schedule rationalization.

- **Chapter 5** analyzes trends in domestic airfares as a result of capacity discipline, and examines how changes in airline networks and available service have affected average fares at U.S. airports. A simple regression analysis is used to investigate how the effects of low-cost carriers like Southwest Airlines and JetBlue Airways, as well as so-called "ultra low-cost carriers" like Allegiant Air and Spirit Airlines, have affected average fares at U.S. airports, and how those effects have changed in response to capacity discipline.

- Finally, **Chapter 6** summarizes the trends examined in Chapters 2-5, explores the government reaction to capacity discipline, and discusses the short-term and long-term stability of capacity discipline as the "new normal" for domestic air service.

Note: Modified versions of chapters 3, 4, and 5 were previously published as MIT International Center for Air Transportation white papers 2013-ICAT-02, 2013-ICAT-05, and 2013-ICAT-07.

2 Evolution of U.S. Domestic Capacity Strategies: From Rationalization to Capacity Discipline

This chapter defines the term "capacity discipline" and discusses capacity discipline in the context of historical trends in the U.S. domestic air transportation industry since 1990. The forces driving the "schedule rationalization" period from 2007-2010 are also discussed, and the transition between rationalization to capacity discipline is explored. We also briefly discuss some of the aggregate effects of capacity discipline on the U.S. air transportation system and on smaller airports; these trends are discussed in more detail in Chapters 3, 4, and 5. Finally, a game theoretic model of capacity discipline is proposed to explain why this strategy remained in equilibrium for at least four years—from 2010 through 2013.

2.1 Historical links between capacity growth and economic growth

Traditionally, close parallels have been drawn between growth in domestic airline capacity and regional economic growth, as measured by gross domestic product (GDP), gross national product (GNP), or per-capita income. This is because broader economic growth (in per-capita income, for instance) is thought to increase the demand for air transportation (Jorge-Calderón, 1997; Jiang, 2005; Grosche et al., 2007). Indeed, past empiricists have shown links between passenger demand for air transportation (measured in revenue passenger miles (RPMs)) and GDP (Graham, 2006; Borenstein, 2011). In the past, airlines have largely responded to these increases in demand by increasing the amount of available capacity (measured in flights, seat departures, or available seat-miles (ASMs)) in the system.

Figure 2.1 shows the close historical relationship between year-over-year growth in RPMs, ASMs, and GDP in the United States from 1991-2012. As the figure shows, years in which the domestic U.S. economy grew also typically experienced growth in both demand (RPMs) and supply (ASMs). The Pearson's correlation coefficient between year-over-year growth in ASMs, RPMs, and GDP are very high: 0.8108 between RPM growth and GDP growth, and 0.8259 between ASM growth and GDP growth. This helps explain the traditional use of GDP-based forecasts of passenger demand

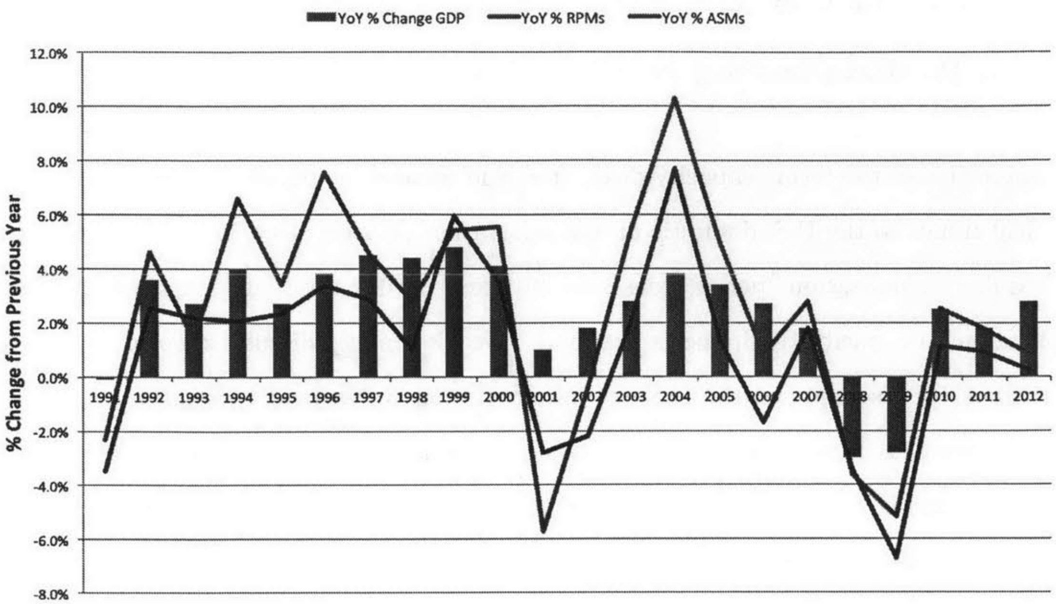

Figure 2.1: Year-over-year growth in U.S. domestic RPMs, ASMs, and GDP. Source: Diio Mi and Bureau of Economic Analysis

and airline capacity, such as the Federal Aviation Administration's yearly Terminal Area Forecast.

Since capacity growth is highly correlated with GDP growth, we would expect a similar pattern for growth in available domestic seats (or *seat-departures*). Indeed, Figure 2.2 demonstrates that year-over-year growth in available domestic seats in the U.S. has been also strongly correlated with GDP growth. The Pearson's correlation coefficient between these two metrics is 0.7704, suggesting a strong positive correlation.

Note that during the 2001-2002 U.S. economic downturn, available seats fell as airlines contracted in the wake of the terrorist attacks of 9/11. It should not be surprising, then, that in the midst of the 2007-2009 economic recession airlines also cut available seats. In 2008 and 2009, when the U.S. economy contracted, airlines also reduced the amount of seats they made available by as much as 6.0% year-over-year. This is to be expected; an economic recession would suggest depressed demand for air transportation, and airlines would have been expected to respond by cutting capacity.

However, a closer examination of Figure 2.2 reveals a possible break in the pattern in recent years. In particular, note the growth in available domestic seats from 2010-2012. In these years, the U.S.

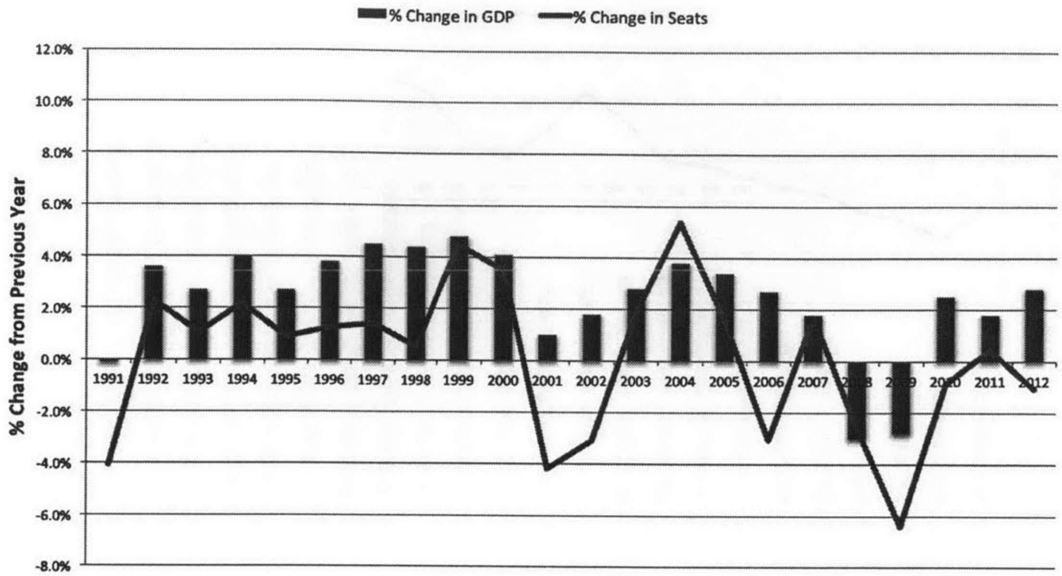

Figure 2.2: Year-over-year growth in U.S. available domestic seats and GDP. Source: Diio Mi and Bureau of Economic Analysis

economy grew by year-over-year rates of approximately 2-3%, yet growth in available domestic seats was anemic or negative. In fact, the years from 2010-2012 represent the first time in the last twenty years (and possibly the first time since deregulation) that we observed flat or negative growth in airline capacity despite economic growth. Indeed, growth in available domestic seats was negative or flat in the five year period from 2008-2012.

This pattern becomes clearer through an examination of the absolute number of available domestic seats from 1991-2012. Figure 2.3 displays this trend, as well as the yearly average domestic load factor over the same period. Note that the number of available domestic seats barely changed from 2010-2012 following significant reductions in 2008 and 2009. By 2012, the number of available domestic seats in the U.S. had fallen to the lowest level since 1995, down over 100 million seats from the peak in 2004. All the while, average load factors continued to increase, from about 65% in 1995 to about 83% in 2013. That is, while historically low levels of seats were being provided by U.S. airlines, many more of those seats were being filled by passengers than in the past.

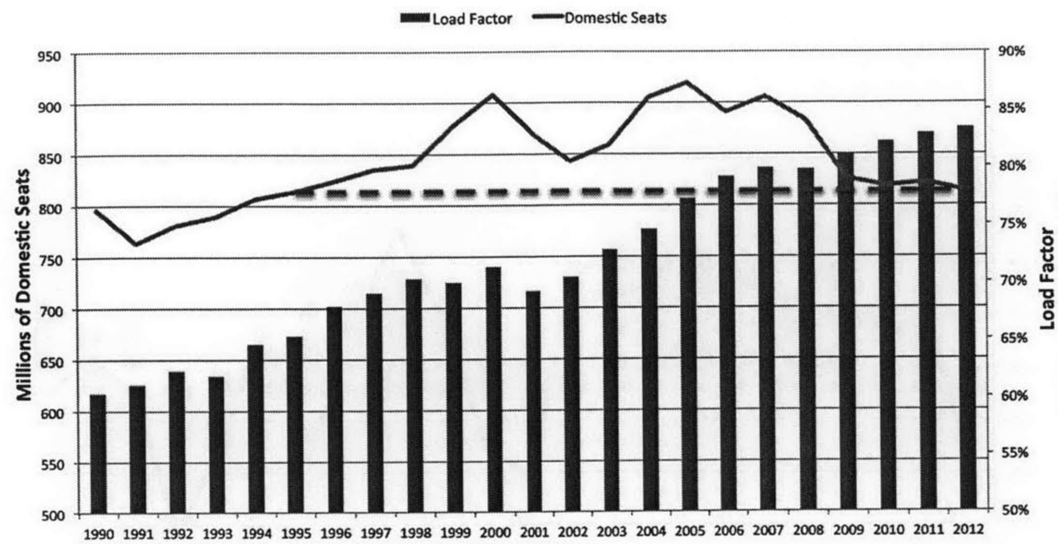

Figure 2.3: Available U.S. domestic seats and load factors. Source: Diio Mi and BTS T-100

2.2 Defining schedule rationalization and capacity discipline

The nuances in the patterns of growth and contraction in capacity are more visible when examining disaggregate trends of individual airlines. Figure 2.4 shows year-over-year percent changes in available domestic seats from 2005-2013 broken down by individual airlines. When appropriate, airlines were combined to represent mergers and acquisitions. For instance, the data for US Airways (US) and America West Airlines (HP) were combined in Figure 2.4, as were the data for Delta Air Lines (DL) and Northwest Airlines (NW); United Airlines (UA) and Continental Airlines (CO); and Southwest Airlines (WN) and AirTran Airways (FL). In all, nine major domestic airlines are represented in Figure 2.4, representing more than 80% of the available domestic seat capacity in 2013.

As shown in Figure 2.4, we propose that capacity strategies in the U.S. domestic airline industry from 2005-2013 can be broken down into three epochs:

- The period from 2005-2007 can be seen as the **previous "status quo."** In the status quo period, U.S. airlines—many of whom were struggling with bankruptcies or going through mergers—made capacity decisions independently based on the status of each individual airline.

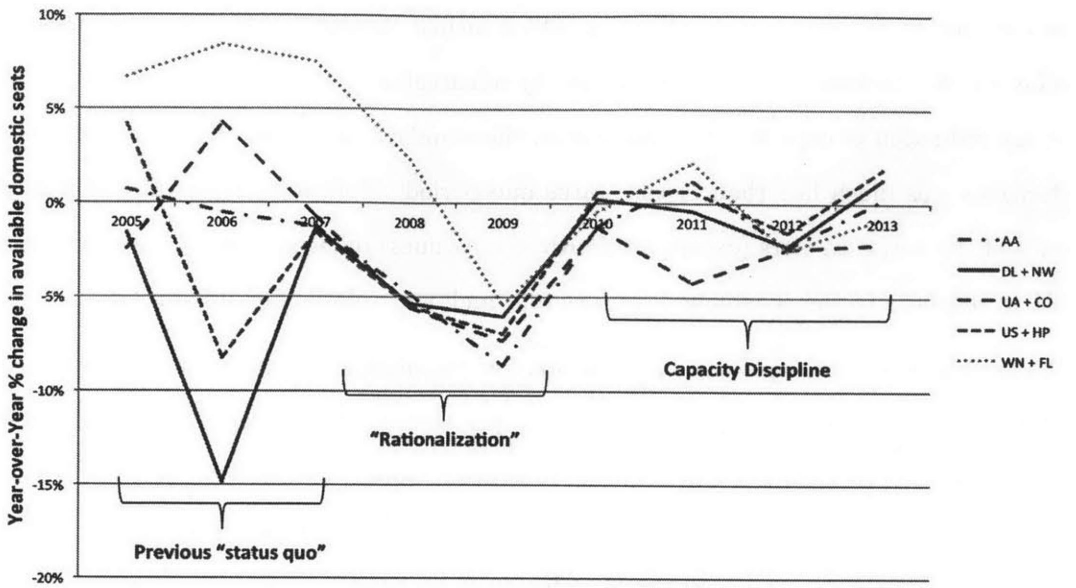

Figure 2.4: Year-over-year % change in available domestic seats by airline. Source: Diio Mi

This led to a wide range of capacity growth and contraction decisions. For instance, in 2006, year-over-year domestic capacity growth varied from nearly 8% for fast-growing Southwest Airlines to nearly -15% for Delta Air Lines and Northwest Airlines, which were going through bankruptcy.

The status quo period was marked by widely divergent strategies of capacity growth. This can be seen in Figure 2.4, where the variation amongst carrier capacity growth was larger in the status quo period than in any other period. In this period of relatively inexpensive fuel and general economic growth, airlines were prone to expand their networks in an attempt to gain market share and increase profits.

- In 2008 and 2009, the U.S. airline industry was hit with a pair of contemporaneous economic shocks: a domestic economic recession in the United States, and a sudden spike in the price of fuel. In response to these shocks and a number of other factors, which are discussed in detail in the next section, airlines began quickly moving in lock-step to restrict capacity by removing unprofitable or duplicate frequencies while reducing the size of their networks. This period can be called **schedule rationalization**.

In contrast to the status quo period, in which airline capacity strategies varied widely, the schedule rationalization period was marked by remarkable similarity among the major carriers in the reduction of capacity. In other words, the standard deviation between airline capacity decisions was much less than in the status quo period. Note from Figure 2.4 that in 2008, each of the major carriers (except for Southwest Airlines) reduced capacity by almost exactly 6% in response to the economic downturn and high and volatile fuel prices.

While this coordination of capacity decisions might suggest collusion among airlines, recall that airlines often signal their capacity strategies through press releases and other industry documents. In this way, if a first mover provides a capacity reduction benchmark (of -6%, say) through a press release, other airlines may be more likely to folllow suit, creating the appearance of collusion without direct airline coordination.

- In 2010 and later years, the domestic U.S economy started to recover from the recession and fuel prices started to stabilize, albeit at a higher level. The U.S. economy posted four years of GDP growth from 2010-2013. Based on historical patterns, we would have expected U.S. airlines to increase capacity in this period of economic growth to meet this increased demand for air transportation. However, Figure 2.4 shows that this is not the case. Instead of increasing domestic seats, U.S. airlines made only small adjustments to their networks—on the order of ± 2% per year. It is this period of limited capacity growth that we will refer to as **capacity discipline**.

  Like the schedule rationalization period, the capacity discipline period was marked by airlines setting very similar levels of capacity growth. The variation between airline capacity decisions in 2010 and 2012 was even smaller than that of the schedule rationalization period, in part because Southwest Airlines had joined the network legacy carriers in restricting capacity growth. The decisions of Southwest Airlines during the capacity discipline period had tremendous ramifications for smaller airports; this airline will be discussed in more detail in the following sections.

  Recall that the capacity discipline period occurred after airlines had already removed a great deal of excess or unprofitable capacity from their networks. Therefore, not only did capacity discipline restrict the growth of airline capacity in response to economic growth, it also "locked-in" capacity at lower, rationalized levels. That is, airports that were negatively affected by capacity cuts through the rationalization period saw flight levels continue to remain low throughout the capacity discipline period. While capacity discipline was not a period of further widespread cuts in service, it still created problems for smaller airports because of this maintainance of previously reduced levels of service.

Thus, to recap, we can define schedule rationalization and capacity discipline as follows:

- **Schedule rationalization** is an *active reduction of available seat capacity* as a result of macroeconomic shocks to the airline industry, including a domestic recession and high and volatile fuel prices.
- **Capacity discipline** is a *restriction of seat capacity growth* by large U.S. carriers, even as the U.S. domestic economy started to recover and fuel prices stabilized.

The next two sections will examine these two periods in detail, describing why each period began as well as the competitive forces that defined and perpetuated each period.

2.3 Why and how did U.S. carriers implement schedule rationalization?

While high fuel prices and the economic recession of 2008-2009 were two of the most important reasons that U.S. carriers began schedule rationalization, there were other competitive forces at play during this period that had a significant impact on how rationalization was implemented. This section examines in detail the causes and effects of schedule rationalization and the resulting changes to the U.S. air transportation system.

2.3.1 High and volatile fuel prices

Perhaps even more than the economic downturn's depressive effect on passenger demand, the sudden increase in fuel prices fom 2007-2008 provided one of the greatest pressures for airlines to rationalize their networks. Figure 2.5 plots the price that airlines paid per gallon of fuel "in the wing" from 2004 to 2012, as well as the number of domestic flights scheduled in each of those years.

Note that these two metrics are highly correlated—year in which fuel was above $2.00 per gallon were marked by significant restrictions in the number of flights scheduled.

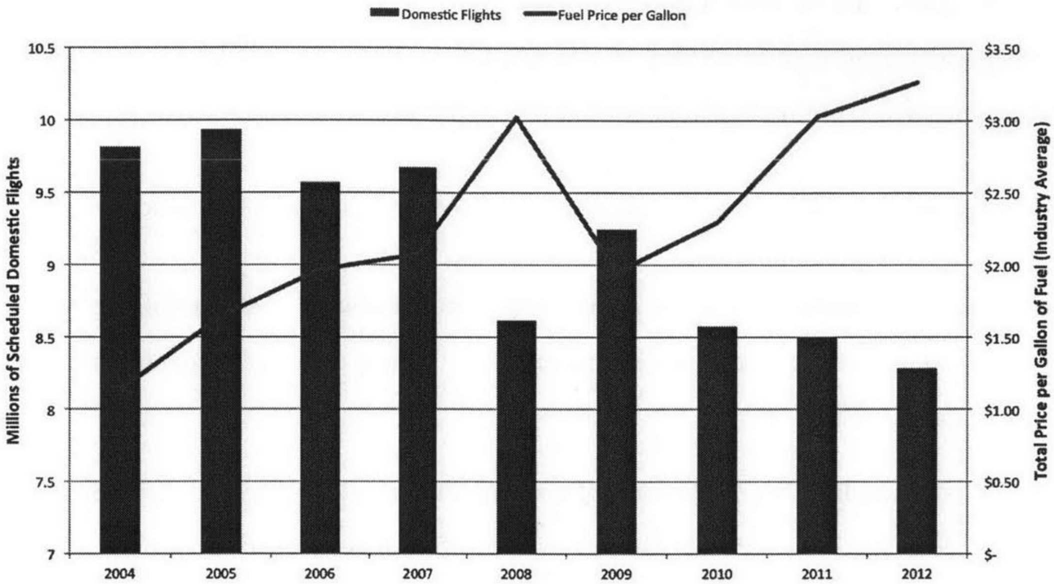

Figure 2.5: Fuel price per gallon and domestic scheduled flights. Source: Diio Mi and MIT Airline Data Project

Fuel is one of the major operating costs for air transportation, and the rising price of fuel have increased its importance to the industry. In 2004, fuel made up 19% of total airline expenses (excluding transport related expenses) according to the MIT Airline Data Project; this had increased to 35% by 2012.

As fuel prices increased, the economics of operating some types of aircraft and routes began to change. Specifically, the strategy of operating many short-haul flights using small regional jet aircraft like the Embraer ERJ-135 family and the Bombardier CRJ-200 family, which seat between 37-50 passengers, became unsustainable as the unit costs of operating these types of aircraft increased significantly with higher fuel prices.

As a result, airlines began removing short-haul service from their networks. As shown in Figure 2.6, from 2007-2012, airlines reduced scheduled short-haul (less than 500 nautical miles) service by 16%, as compared to a 9% reduction in medium-haul (500-1500 miles) service and a 7% reduction in long-haul (1500 miles or more) service. This increase in average stage length helps explain why

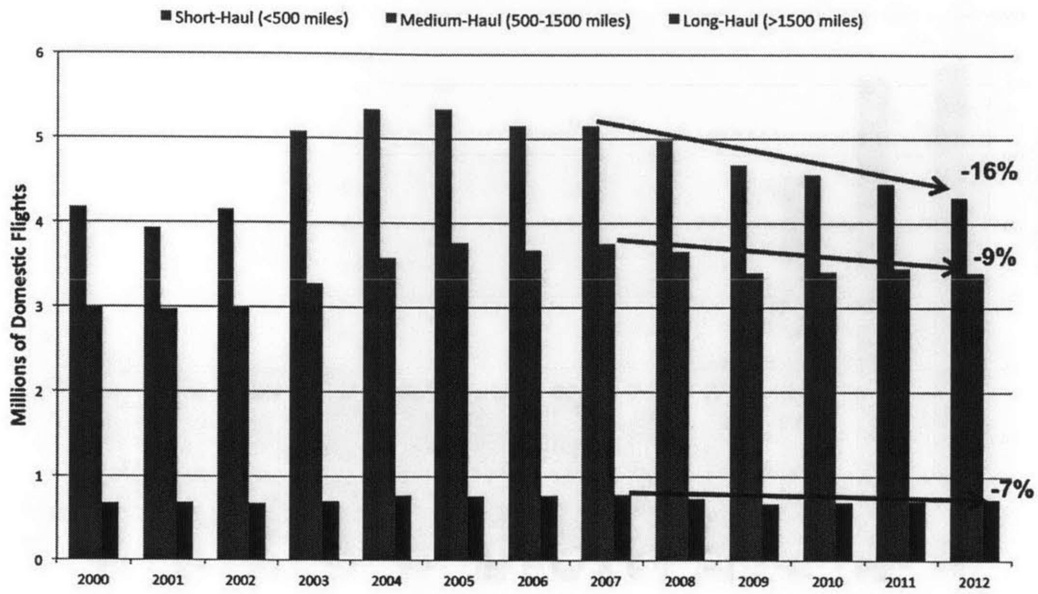

Figure 2.6: Reductions in short-haul, medium-haul, and long-haul domestic flights. Source: Diio Mi

there was modest growth in available seat-miles (ASMs) from 2010-2012 even as airlines limited growth in available seat departures.

At the same time, airlines also began to draw down on the use of smaller regional jets in this period. As shown in Figure 2.7, average seats per domestic departure increased by 3.7% from 2007-2012 as airlines started replacing smaller 50-seat regional jets with larger 76-seat regional jets. Upgauging represents a trade-off for smaller airports; as airlines increase the size of the aircraft that serve smaller airports, they often reduce the number of frequencies per day, harming these airports' connectivity and level of service. This trend is discussed in detail in Chapter 3 and 4.

2.3.2 Depression of air transportation demand

Many scholars (Ito and Lee (2005); Ritchie et al. (2010); Franke and John (2011), and others) have studied the links between recessions and air transportation demand. In all cases, internationally and domestically, recessions were associated with reductions in demand for air transportation. Indeed, as Figure 2.8 shows, the number of enplaned domestic passengers decreased by 8.6% from its peak

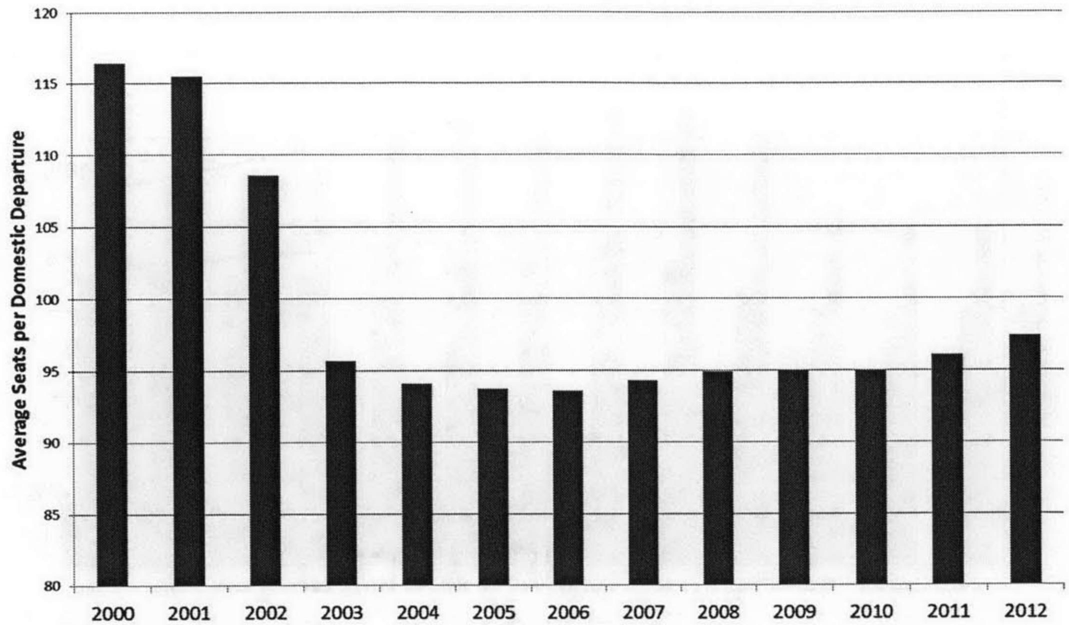

Figure 2.7: Average seats per domestic departure. Source: Diio Mi

in 2007 to the trough of the recession in 2009, from about 686 million passengers to about 628 million passengers. The same pattern occurred following the 2001-2002 U.S. domestic recession and in the aftermath of the September 11, 2001 terrorist attacks.

Given the reduction in passenger demand that follows a recession, it is not surprising that airlines would cut available seats during the same period to avoid decreases in load factors. This can help explain some of the initial cuts in capacity during the recession in 2008 and 2009, although it is worth noting that passenger demand rebounded following the recession much faster than did available domestic airline capacity.

2.3.3 De-hubbing and consolidation of capacity

As will be discussed in detail in Chapter 3, the capacity cuts during the schedule rationalization period were not applied evenly across the entire air transportation network. Instead, airlines largely focused on consolidating or increasing service at selected large hubs while reducing service at secondary or tertiary hubs. Airports like Cincinnati/Northern Kentucky International Airport (CVG),

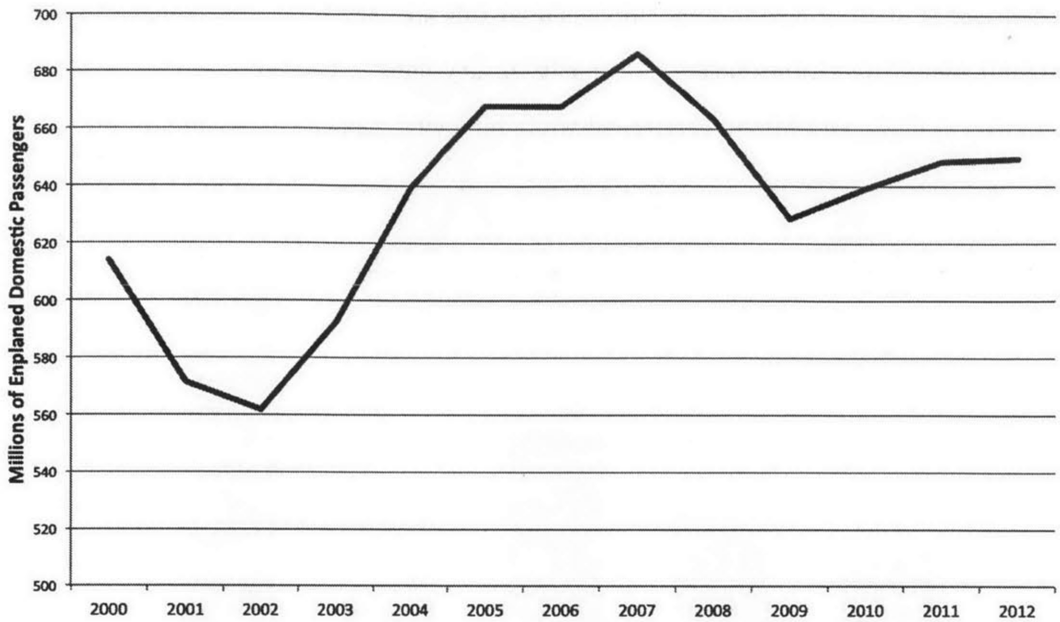

Figure 2.8: Enplaned domestic passengers, 2000-2012. Source: Diio Mi and BTS T-100

Pittsburgh International Airport (PIT), and Cleveland-Hopkins International Airport (CLE)—hubs for Delta Air Lines, US Airways, and United Airlines, respectively—saw tremendous cuts in service during schedule rationalization as airlines pulled out of many markets.

This process of closing secondary or tertiary hubs like CVG, PIT, and CLE has been referred to as *de-hubbing* (Redondi et al., 2012; Tan, 2012). The argument for why de-hubbing would increase airline profitability is roughly as follows: consider, for instance, a small airport with daily flights on Delta Air Lines to CVG and Hartsfield-Jackson Atlanta International Airport (ATL). Passengers from the small airport can connect through the Delta hubs at CVG and ATL to other destinations in the Delta network. Suppose that each destination served from CVG is also served from ATL. In this case, the elimination of flights from the small airport to CVG would only affect local origin-destination traffic to Cincinnati, since the other connecting destinations can still be reached over Atlanta.

Therefore, if local demand is weak at these connecting hubs (which was the case at hubs like CVG, PIT, CLE, and Memphis International Airport (MEM)), airlines were able to contract their networks by removing service to these hubs without hurting connectivity across their networks.

Figures 2.9 and 2.10 show how airlines implemented this strategy during schedule rationalization between 2007 and 2010; airlines bolstered capacity at key hubs in Charlotte (CLT), San Francisco (SFO), Denver (DEN), and Miami (MIA), all while removing capacity at secondary hubs.

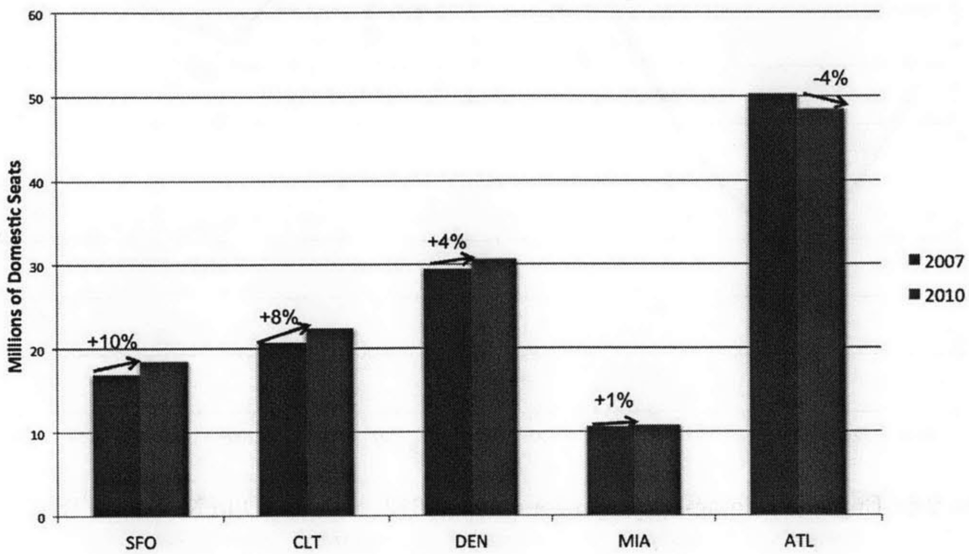

Figure 2.9: Available domestic seats at key NLC hubs, 2007-2010. Source: Diio Mi

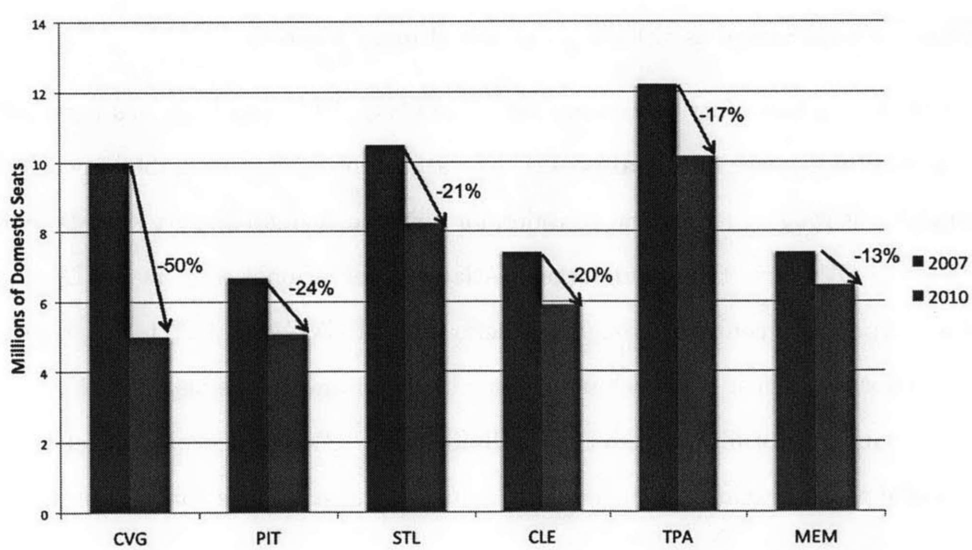

Figure 2.10: Available domestic seats at secondary and tertiary NLC hubs, 2007-2010. Source: Diio Mi

The de-hubbing process was not limited to network legacy carriers. Southwest Airlines, an airline that was known for serving secondary and tertiary airports in multi-airport regions while avoiding larger airports in those regions (Vowles, 2001; Boguslaski et al., 2004), surprisingly joined the network legacy carriers in consolidating service at larger airports. Southwest Airlines entered two new large-hub markets—Boston (BOS) and Minneapolis-St.Paul (MSP)—from 2007-2010, all while increasing service at large-hubs Denver (DEN), Fort Lauderdale (FLL), and San Francisco (SFO). This movement of Southwest into large-hub airports is shown in Figure 2.11.

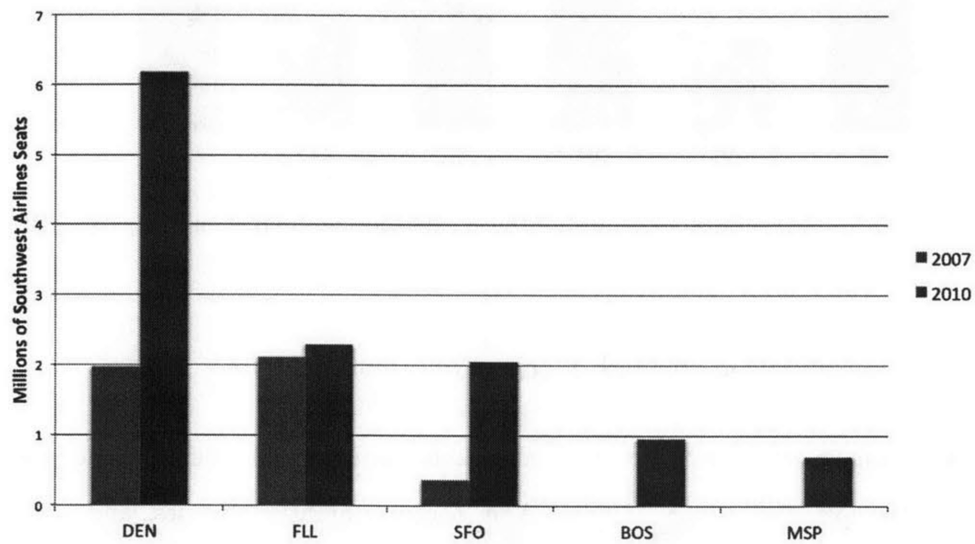

Figure 2.11: Available domestic seats from Southwest Airlines at Large Hubs, 2007-2010. Source: Diio Mi

During the schedule rationalization period, Southwest also cut capacity at many of the medium-sized airports at which it maintained a significant presence. Many of these airports, which are shown in Figure 2.12, were heavily reliant on Southwest Airlines for passenger traffic. For instance, Southwest cut available seats by 27% at LA/Ontario International Airport (ONT), by 25% at Manchester-Boston Regional Airport (MHT), and by 25% at Oakland International Airport (OAK) from 2007-2010. With lower levels of available service from Southwest, these airports struggled mightily to attract passengers, as they saw network connectivity fall and fares rise. These airports are discussed in more detail in the following chapters.

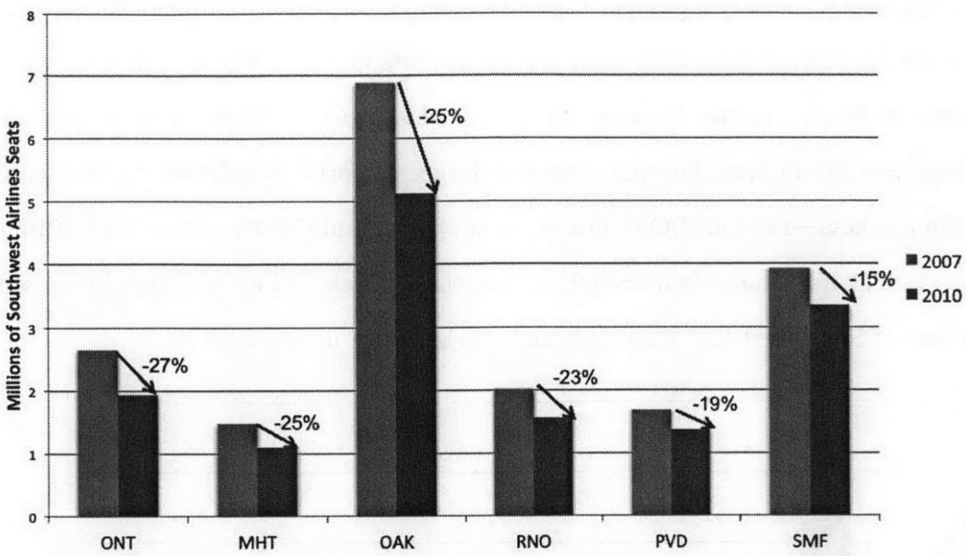

Figure 2.12: Available domestic seats from Southwest Airlines at smaller hubs, 2007-2010. Source: Diio Mi

2.3.4 Airline consolidation through mergers and bankruptcies

The schedule rationalization period occurred contemporaneously with several airline mergers and bankruptcies. For instance, Aloha Airlines, ATA Airlines, Frontier Airlines, and Sun Country Airlines all filed for bankruptcy in 2008, and Delta Air Lines and Northwest Airlines completed their merger during the schedule rationalization period. This period was preceded by a merger of US Airways and America West Airlines, and the bankruptcies of both Delta Air Lines and Northwest Airlines in 2005. United Airlines and Continental Airlines merged just after the schedule rationalization period in 2011, as did Southwest Airlines and AirTran Airways.

Figure 2.13 annotates Figure 2.4 with many of the mergers and bankruptcies that occurred from 2005-2013. As Figure 2.13 shows, mergers and bankruptcies have been correlated with cuts in that airline's available service. This makes sense intuititively—one of the purposes of merging is to take advantage of economies of scale by combining the two carriers' networks, and one way to exit bankruptcy is to remove unprofitable flying through capacity-cutting.

This empirical analysis is in contrast to some theoretical papers (e.g. Richard (2003)) who suggest that a merged carrier would operate more flights in a market than the two seperate carriers would individually, but agrees with empirical work by Borenstein and Rose (2003) and Ciliberto and Schenone (2012) who find that "bankrupt airlines permanently downsize networks, flight frequency, and market capacity." Given the sheer number of mergers and bankruptcies between 2005 and 2012, it is not surprising that so much capacity was removed from the system during the schedule rationalization period.

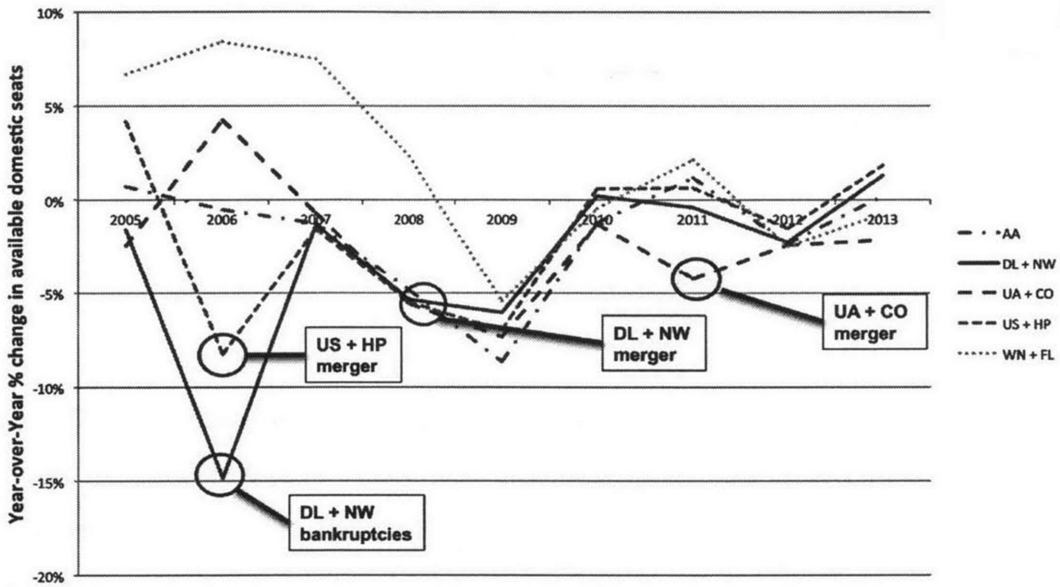

Figure 2.13: Capacity changes as a result of selected mergers and bankruptcies, 2005-2013. Source: Diio Mi

2.3.5 Convergence of unit costs

Much attention has been given to the differences in unit costs between the network legacy carriers and the low-cost carriers (LCCs), such as Southwest Airlines and jetBlue Airways. Traditionally, these carriers were able to maintain significant cost advantages over the legacy carriers due to the use of a single unified fleet family, low labor rates and pension responsibilities, fuel hedging, leaner operations, and younger staff. In the context of capacity, the low-cost carriers were seen as a competitive counterweight to the network legacy carriers. That is, as the NLCs cut capacity due to their higher costs, LCCs like Southwest could take advantage of their lower costs to increase service and gain market share.

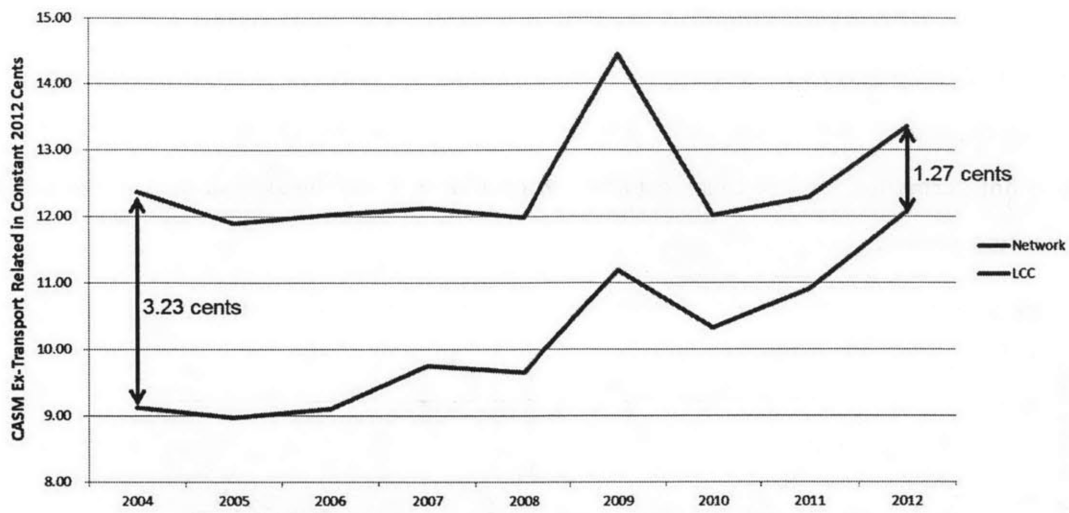

Figure 2.14: Convergence of NLC and LCC CASM ex-transport related. Source: MIT Airline Data Project

However, the cost gap between network legacy carriers and LCCs has continued to shrink (Tsoukalas et al., 2008). As Figure 2.14 shows, the gap between ex-transport related CASM for NLCs and LCCs fell from 3.23 cents in 2004 to 1.27 cents in 2012, adjusting for inflation. As LCCs, and particularly Southwest, became more mature airlines, they lost the labor cost advantages of younger, nimbler competitors with less-senior staff. Additionally, in an era of persistently high fuel prices, the advantages of Southwest Airlines' fuel hedge, which helped the airline acheive profitability even as fuel prices were spiking in 2008, started to evaporate. LCCs like Southwest were no longer making significant increases in capacity when NLCs pull out of markets, contrary to regulators' assumptions in prior years.[2] Indeed, Southwest itself started to act like a NLC, cutting capacity to smaller markets by 10% from 2007-2012.

[2]Some other LCCs, like JetBlue Airways, Spirit Airlines, and Allegiant Air, continued to grow capacity throughout the capacity discipline period, but each of these airlines control less than 5% of the available seats in the U.S. domestic airline industry. Therefore, their growth was overshadowed by capacity cuts by the NLCs and by Southwest.

2.4 The transition to capacity discipline

2.4.1 Capacity discipline and airline profitability

The transition of airlines to capacity discipline is somewhat surprising in the context of some academic literature that suggests that airlines have "over-invested" in capacity, even in the midst of economic downturns. For instance, even in the midst of the schedule rationalization period, Hanekc (2009) asked the question "Will there be an airline capacity glut by 2012?" as orders for new aircraft continued to increase in other parts of the world. Furthermore, Wojahn (2012) suggests that "capacity reduction is a public good that must be provided privately and is thus underprovided, and the result is a war of attrition where even profitable carriers hold on to their capacity." Yet it is clear in retrospect that in the United States, this market behavior is no longer in place. Contra Wojahn (2012), airlines were indeed able to enter into a market equilibrium in which unprofitable capacity was removed from the system and kept at lower-than-expected levels.

It could be argued that this transition to capacity discipline was a result of a shift in airline management strategy from a focus on market share to a focus on profitability. Elementary microeconomics would suggest that restricting capacity (by moving the supply curve in and to the left) would result in higher prices, assuming the demand for the good remains the same. In practice, airlines realize this increase in average fare by using modern revenue management techniques to sell fewer lower-fare seats by protecting seats for higher-fare passengers. That is, as the number of available seats is reduced, revenue management systems close lower fare classes while leaving higher fare classes open.

Closing lower fare classes may price some passengers with low willingness-to-pay out of the market. On the other hand, some passengers may decide to buy up to higher fare classes if low-fare seats are not available. In either case, as capacity is restricted, the average price paid by passengers would increase. This would lead to an increase in average yield on each flight, since fewer low-fare "discount" passengers are unable to purchase a ticket at a price at or below their willingness-to-pay and high-fare passengers are less likely to be able to buy down to a lower fare class.

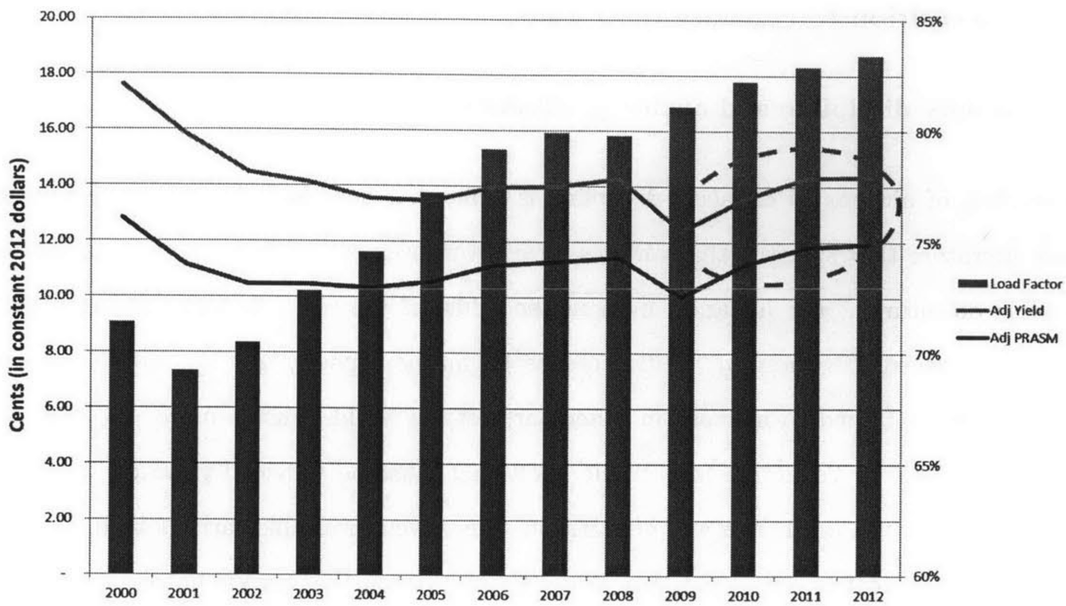

Figure 2.15: Inflation-adjusted yield, PRASM, and load factors, 2000-2012. Source: BTS, MIT Airline Data Project, BLS CPI

At the same time, since the demand for air transportation remains unchanged, the restriction of capacity through capacity discipline would lead to an increase in load factors. In other words, since the same number of passengers are filling fewer available seats, the number of empty seats on any given flight would likely decrease. Therefore, the restriction of supply (through capacity discipline or other means) is a capacity strategy that results in an increase in both yield and load factor.

Figure 2.15 demonstrates that airlines were indeed able to achieve gains in both yield and load factor as a result of schedule rationalization and capacity discipline. Adjusting for inflation, both yield and passenger revenue per available-seat mile (PRASM) showed modest increases from 2009-2012 as airlines kept capacity low, while average load factors increased by about two percentage points from 81% to 83%. While these increases in yield are modest, they allowed the U.S. airline industry to post positive profits throughout the capacity discipline era, as shown in Figure 2.16. This is particularly impressive given that, adjusting for inflation, fuel prices during this period remained at record highs.

Given these stable levels of profitability achieved during the capacity discipline era despite high fuel prices, airline executives began to talk about capacity discipline as a key to profitability.

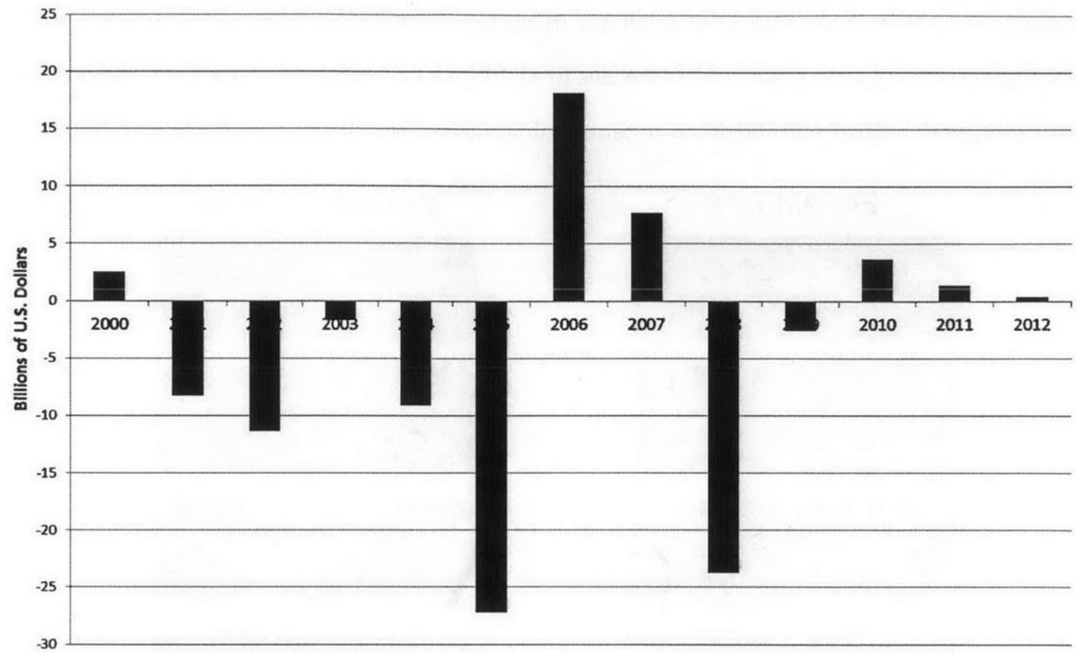

Figure 2.16: Profitability of the U.S. airline industry, 2000-2012. Source: BTS

As one senior executive for United Airlines said in a 2013 interview, the yield growth that the industry experienced from 2007-2012 "would have been impossible without capacity discipline" (Jones, 2013). The outspoken nature of airline executives about capacity discipline serves in part to explain to investors one of the causes of the industry's newfound profitability, but also serves as a signal to other competitors that the airline will continue to keep its capacity at disciplined levels. Since airlines cannot directly cooperate in setting capacity levels without violating antitrust laws, subtle signals like these allow airlines to communicate about their capacity decisions to each other. However, they also risk drawing the attention of regulators who worry about the upward pressure capacity discipline places on airfares and the negative effects of capacity discipline on airports and consumers.

2.4.2 The effects of capacity discipline on airports and passengers

While the capacity discipline era has been a boon for U.S. airlines, some U.S. airports and travelers have felt negative effects from the airlines' decisions to keep capacity at rationalized levels. Figure

2.17 summarizes some of the effects of capacity discipline for both airlines and airports. Note that the airline effects are mostly positive—increases in yield and load factors (along with the completion of several mergers) helped the industry regain profitability after the financial crisis of 2008-2009.

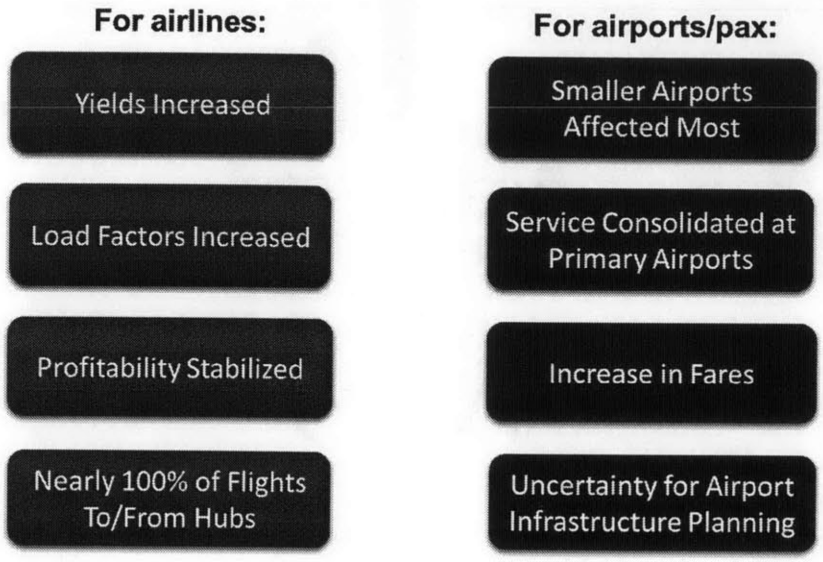

Figure 2.17: The effects of capacity discipline on airlines, airports, and passengers

However, for smaller U.S. airports, the effects have been less positive. This is because, as discussed previously, many of the service cuts as a result of schedule rationalization and capacity discipline have come at the expense of smaller airports, as airlines de-hubbed and concentrated service at large airports. Similarly, the increase in airline yields reflects a similar increase in average airfares. This makes economic sense—as capacity is constrained, microeconomic theory would suggest that average prices would increase if demand remains unchanged.

Yet airline passengers and consumer activist groups are often unhappy with the increases in average airfares that resulted from capacity discipline. Airport connectivity at smaller airports was also hurt from capacity discipline; as airlines eliminated service on some routes, the quality of airports' connections to the rest of the global air transportation network was reduced. The impact of capacity discipline on connectivity is discussed in detail in Chapter 4.

One less obvious result of capacity discipline was the degree of uncertainty it introduced to planners and operators of small airports with regards to infrastructure planning. Through capacity discipline, small airports experienced first hand how the capacity decisions of one or two airlines can make or break the level of service available an airport. Network carriers that pulled out of small airports in many cases left these airports without any scheduled commercial air service, causing the airports to have to open their checkbooks to attract service by the means of revenue guarantees or other incentives.

Capacity discipline thus introduced additional volatility to the operating forecasts of smaller U.S. airports. It is difficult to plan for future passenger volumes at a small airport (to justify the construction of a new piece of infrastructure, for instance), if an airline could decide to cut capacity and leave the airport without any service at all. Some airports, such as Salt Lake City (SLC), spent millions of dollars in the years just prior to the capacity discipline era to construct additional infrastructure intended to increase airport capacity (such as new runways or new terminals), only to see passenger traffic fall as airlines cut 10-20% or more of the previous levels of scheduled service. Current planners are left to guess how long the capacity discipline era will continue as they plan for future infrastructure investments and passenger volumes.

2.5 Capacity discipline as an infinitely repeated prisoner's dilemma game

Given the profitability that capacity discipline brought the U.S. airline industry, it is not surprising that the largest U.S. airlines each "agreed" (although not explicitly) to restrict capacity growth for four consecutive years, from 2010-2013. However, the stability of the capacity discipline equilibrium is perhaps more surprising when considered in a game theoretic context. In a non-cooperative game, players choose from a set of strategies (such as increasing capacity or restricting capacity growth). Each player's result (or *payoff*) depends on not only that player's action, but also on the actions of other players in the game. Yet each individual player has limited information about the other players' strategy sets and choice of action, and cannot directly influence those actions. This framework is ideal for examining the airline industry, in which airlines' payoffs are closely tied to the decisions of other competitors, yet airlines are carefully monitored such that they cannot collude to achieve a positive outcome.

Let us model capacity discipline as such a non-cooperative economic game. Suppose that an airline knows that its competitors will be keeping disciplined levels of capacity throughout their networks over the next time period. Rationally, that airline should decide to respond by growing capacity, thus capturing valuable market share away from their competitors' artificially shrunken networks. Since each airline has the same incentive to grow capacity in response to capacity discipline, game theory would predict that capacity discipline itself would be an unstable equilibrium—this is a classic *prisoner's dilemma* game.

	Capacity Discipline (D)	Increase Capacity (G)
Capacity Discipline (D)	+ / +	-- / ++
Increase Capacity (G)	++ / --	- / -

Figure 2.18: Payoff table for the capacity discipline game

Consider the payoff table in Figure 2.18. In this example, we are modeling the capacity game between two airlines operating similar networks: Airline 1 and Airline 2. Note that each airline has two strategic options in each period: they can choose either to practice capacity discipline (D) or to grow capacity (G). If both airlines pick strategy D, they each enjoy the efficiencies of eliminating unprofitable capacity and shrinking their networks. This outcome (D, D) is the capacity discipline scenario that we observed from 2010-2013, and it has been shown empirically in the previous sections to contribute to robust profitability for both airlines.

However, consider what would happen if one airline decided to "defect" from the capacity discipline outcome and instead grows their capacity. In the (G, D) outcome, the airline that plays G captures a majority of the frequency share and market share from the airline that plays D. This provides the

G airline with increased profitability, while leaving the D airline in a inferior competitive position in the future. Yet if both airlines decide to play G, the (G, G) outcome is one in which there is too much capacity in the system, leading to lower load factors, lower yields, and reduced levels of profitability. The (G, G) outcome is similar to the U.S. airline industry in 2007, a year marked by significant delays and congestion.

Yet since the payoffs from playing G strictly dominate the payoffs from playing D in all cases, it is in each airline's best interest to always play G and grow their networks. Therefore, the only Nash equilibrium[3] from this game would be (G, G), in which both airlines have grown their networks too much and remain unprofitable. This is a classic outcome to the prisoner's dilemma game; each player's individual incentive to defect from the mutually beneficial outcome leads to an equilibrium that is not optimal for either player.

How, then, can capacity discipline have existed as an equilibrium for four straight years? The key to understanding this behavior is that airlines play this prisoner's dilemma game of capacity-setting not once, but multiple times over the course of a day, week, month, and year. Thus, we should examine the capacity discipline game not as a single instance, but as a repeated prisoner's dilemma game.[4]

There is a wealth of economic literature that has examined repeated prisoner's dilemma games. The literature broadly divides repeated games into two categories: finitely repeated games and infinitely repeated games. In a finitely repeated game, the game is played over and over for a fixed number of periods T. T is known to both players at the start of the game. It can be shown that as long as both players know how many rounds the game will last, the Nash equilibrium from the finitely repeated game is identical to that of the single game (Church and Ware, 2000). That is, a finitely repeated capacity discipline game would result in an equilibrium in which both players grow their networks; the (D, D) equilibrium could never be sustained.

However, given the number of times in which airlines interact in setting capacity in markets, the infinitely repeated game framework is more appropriate when modeling capacity discipline.

[3]A Nash equilibrium is a set of strategies from which no player has the incentive to deviate, even if they have perfect information about the other player's strategies

[4]Thanks to Daniel Fry for this insightful suggestion.

Osborne and Rubinstein (1994) suggest that an infinitely repeated game framework is appropriate when players believe that they will continue to keep playing the game indefinitely (or at least for one more period following the current one). Since no airline assumes that they will go bankrupt (thus ending the game), it is plausible to assume that capacity-setters at each airline plan for indefinite continuation of the prisoner's dilemma game.

Unlike the finitely-repeated game, the infinitely-repeated prisoner's dilemma can result in equilibria in which both players cooperate indefinitely (Church and Ware, 2000). These games are often modeled using a discount rate δ that players use to discount future winnings. It can be shown that as long as the discount rate is sufficiently high (implying the that the players are "patient," placing value in the future), players choosing certain strategies can "agree" to cooperate for many periods.

Consider, for instance, a strategy in which a player decides to play D until its opponent decides to grow its own network (G), after which point the original airline decides to play G for all future periods. This strategy is often called the "grim trigger," since the decision of an opponent to defect (or play G) "triggers" the incumbent player to also defect. It can be shown that the grim trigger strategy is a successful deterrent to defection; that is, sufficiently-patient players that play the grim trigger strategy can reach an equilibrium in which all players cooperate (Church and Ware, 2000).

Is the airline industry sufficiently "patient" such that the grim trigger equilibrium could explain why capacity discipline remained in place for at least four years? It is arguable that this is indeed the case. Airlines engage in planning over a variety of time periods: short-term, medium-term, and long-term. There is also a delay in how quickly an airline can respond by adding capacity; schedules are often set six months or more in advance, and adding a new spoke or frequency takes time.

Despite this, there is a clear first-mover advantage to breaking with capacity discipline; the airline that makes the first move to expand capacity gains the first competitive foothold in each market it enters, setting the airline up well for a future market environment in which capacity is no longer restricted. However, airlines may be patient enough to continue to cooperate in the infinitely-repeated capacity discipline game into the near future.

2.6 Conclusion: An end to capacity discipline in sight?

In response to the economic downturn of 2008-2009 and high and volatile fuel prices, airlines began rationalizing their networks to remove duplicate or unprofitable service. Meanwhile, airlines were merging and able to realize some of the network efficiencies from exiting bankruptcies. Taken together, these two actions led U.S. airlines in 2010-2013 to mark four years of consecutive profitability, all in the midst of the highest fuel prices the industry has ever seen. The capacity discipline era, in which airlines kept capacity at rationalized levels to take advantage of the economic efficiencies of smaller networks in the midst of high fuel prices, certainly contributed to the airlines' profitability.

While the capacity discipline era was a net positive for the airline industry, it had less positive effects for some airline passengers and smaller airports. These effects are examined in detail in the reamining chapters of this thesis: Chapter 3 more closely examines some of the trends in airline upgauging and schedule changes as a result of rationalization and capacity discipline and proposes a system for identifying airports that might be at risk of losing future service should capacity discipline continue. Chapter 4 examines the effects of schedule rationalization on airport connectivity, and Chapter 5 explores whether average airfares rose as a result of capacity discipline, as economic theory would predict. Taken together, these chapters form a more complete picture of the competitive position of smaller airports vis-à-vis larger ones in the capacity discipline era.

As mentioned in the previous section, examining capacity discipline through the lens of a "repeated game" framework can help explain why a break from capacity discipline had not yet occurred as of 2013. However, as of 2014, some airlines appeared to be making some market entry decisions that could signal the end of capacity discipline. Chapter 6 also considers which airlines might be the first to break with capacity discipline, and what the result of these airlines' actions would be in setting up the competitive position of the U.S. domestic airline industry in the latter half of the 2010s. Chapter 6 also considers the regulatory response to capacity discipline, and how the actions of the U.S. Department of Justice in the American Airlines–US Airways merger case may affect the way that airlines view capacity discipline in relation to other capacity strategies.

3 Trends and Market Forces Shaping Small Community Air Service in the United States

While Chapter 2 focused on the aggregate industry trends that precipitated the capacity discipline era, this chapter focuses on the effects of capacity discipline and rationalization on smaller U.S. airports. Many smaller airports felt the brunt of capacity reductions as a result of the removal of duplicate connecting service through secondary hubs. Additionally, capacity discipline at Southwest Airlines, which had traditionally focused its network on smaller markets, also disproportionally affected smaller airports. Finally, changes in the usage patterns of the regional jets that typically serve smaller airports resulted in reductions in flights at those airports.

This chapter first examines some of the macro-level trends of air service at smaller U.S. airports from 2007-2012. Service levels are examined at 462 U.S. airports, and capacity decisions by network carriers, LCCs, ULCCs, regional carriers, and ultra-regional carriers are each explored in detail. We then construct an airport classification system to identify airports that might be at risk of losing all commercial air service in the future. Through a taxonomy analysis of the 24 airports that lost network carrier service from 2007-2012, we identify several risk factors for airports that may lead to further cuts in service. Finally, we conclude by exploring the regulatory and legislative risks to small community air service in the 2010s.

3.1 Data Sources and Methodology

3.1.1 Classification of airports into airport hub types

The Federal Aviation Administration (FAA) regularly identifies which U.S. airports are designated as primary commercial service airports. Primary airports are those with at least 2,500 commercial passenger enplanements per year. As part of its National Plan of Integrated Airport Systems (NPIAS), the FAA also assigns a hub identifier to each of the primary airports in the United States. Airports are classified into four categories: large-, medium-, small-, and non-hub. Note that the FAA's use of the word "hub" merely suggests that the airport is an important node within the U.S. air transportation system, and does not imply that the airport is a connecting hub for a major U.S. carrier. For instance, the FAA classifies Indianapolis International Airport (IND) as a medium-hub airport, even though IND is not a connecting hub for any major U.S. carrier.

The division of airports into hub types is based on the previous year's enplanements at that airport as a percentage of the total number of enplanements in the United States:

- **Large-hub** airports enplaned at least 1% of the U.S. total in the previous year (e.g. Hartsfield-Jackson Atlanta International Airport)
- **Medium-hub** airports enplaned between 0.25% and 1% of the U.S. total in the previous year (e.g. Indianapolis International Airport)
- **Small-hub** airports enplaned between 0.05% and 0.25% of the U.S. total in the previous year (e.g. Syracuse Hancock International Airport)
- **Non-hub** airports enplaned at least 10,000 passengers in the previous year, but no more than 0.05% of the U.S. total (e.g. Columbia (Mo.) Regional Airport)

Table 3.1 shows the number of airports classified into each hub category as of February 1, 2013:

Hub Type	# of Airports
Large Hub	29
Medium Hub	35
Small Hub	74
Non-Hub	249

Table 3.1: U.S. airports by FAA Hub Type. Source: FAA National Plan of Integrated Airport Systems 2013-2017

Additionally, some airports that are too small to be labeled "non-hub" are also included in the analysis due to their participation in the Essential Air Service (EAS) program, which provides federal subsidies to support consistent air service for smaller U.S. communities. While some EAS airports are contained in the "non-hub" category, as many as 80 additional airports are too small to be assigned a hub status. These airports are included in this chapter under an "EAS" category.

In all, 462 of the 499 primary commercial service airports in the United States are analyzed in this chapter.

3.1.2 Description of Data Sources

The data analyzed in this report is sourced from the Diio Mi Market Intelligence portal, which uses Innovata LLC's Schedule Reference Service (SRS) data product. Created in coordination with IATA, the Diio Mi schedule data covers the schedules of nearly every commercial airline in the world and is updated on a daily basis.

To verify the accuracy and robustness of the Diio Mi data, spot checks were made with the FAA's Aviation System Performance Metrics (ASPM) data product. The ASPM schedule data are another industry-standard data set for measuring commercial air service performance, including schedules and operations. Spot checks resulted in very close similarity between the Diio Mi data and the ASPM schedule data, confirming the robustness of the data set used in this analysis. The Diio Mi data includes the following information for each origin/destination (O/D) airport-pair with nonstop commercial service at some point from January 2007 and December 2012:

- Marketing airline
- Origin
- Destination
- Aircraft type
- Number of scheduled flights
- Number of scheduled seats
- Number of scheduled ASMs

Data was aggregated for full years (January through December) from 2007-2012. Flights that were scheduled fewer than 12 times per year (i.e. less than once monthly) for each year of the study period were treated as extraneous and removed from the data set.

Note that airline flight data were aggregated based on the *marketing* carrier for each flight, not the *operating* carrier. That is, flights that were operated by a regional affiliate of a large network carrier were attributed to the network carrier, not the regional carrier. Since the network carrier often makes the route and fleet decisions for its regional partners, aggregating data on the marketing carrier level provides a better picture of how the competitive strategies of the larger U.S. carriers changed from 2007-2012. Additionally, some regional carriers operate flights for multiple network carriers; hence, aggregating data on an operating carrier basis would lead to some confusion as to which regional flights were operated on the behalf of each mainline carrier.

3.2 Analysis of Service Trends at Small Community Airports

3.2.1 Airlines have consolidated air service around the nation's largest airports

Figure 3.1 shows the aggregate number of annual scheduled domestic departures from U.S. airports from 2007-2012. Departures are divided into two categories: those flights that depart from large-hub airports are shown in the lower portion of each bar, and those that depart from smaller airports are shown in the upper portion.

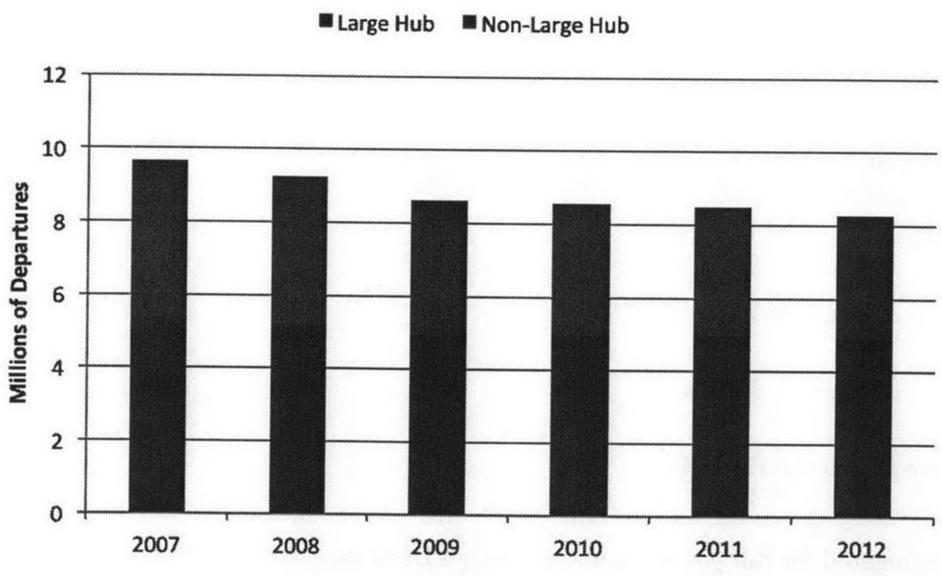

Figure 3.1: Scheduled domestic departures from all U.S. airports. Source: Diio Mi

As a result of the schedule rationalization and capacity discipline periods discussed in Chapter 2, about 1.4 million yearly scheduled domestic flights were cut from the U.S. air transportation system from 2007 to 2012. Also of note is the changing distribution of flights between larger airports and smaller airports. In 2007, scheduled domestic departures from large-hub airports made up 55.8% of the total—by 2012, this percentage had grown to 59.4%. This reveals a pattern of airlines reducing service in smaller markets while retaining or bolstering service in some of their largest markets. In other words, airlines consolidated service at the nation's largest airports while cutting back on service to small- and medium-sized airports.

3.2.2 Smaller airports have suffered significant capacity reductions

While the large-hub airports were spared from much of the brunt of airline service reductions, smaller airports saw a much more severe decline in service. Table 3.2 shows that scheduled domestic departures from smaller U.S. airports decreased by 21.3% from 2007-2012, compared to a decrease of 8.8% at large-hub airports over the same time period.

Airport Type	% change in domestic departures
Large Hub	-8.8%
Medium Hub	-26.2%
Small Hub	-18.2%
Non-Hub	-15.4%
Essential Air Service (EAS)	-5.0%
All Smaller Airports	-21.3%
All Airports	-14.3%

Table 3.2: Percent change in scheduled domestic departures by airport hub type, 2007-2012

Furthermore, as Table 3.2 shows, reductions in service were not applied equally across the entire U.S. air transportation network. In fact, medium-hub airports—not the small-hub or non-hub airports—saw the largest decrease in departures as a percentage of total from 2007-2012 at 26.2%. Small-hub airports saw 18.2% of their domestic flights cut on average between those years, and domestic flights at non-hub airports were cut by 15.4%. However, Essential Air Service[5] (EAS) airports, whose levels of service are mandated by the federal government, lost only 5.0% of their scheduled domestic departures. Figure 3.2 shows the relative proportion of flights operated from medium-hub, small-hub, non-hub, and EAS airports during the study period.

[5]Essential Air Service is a federal subsidy program that funds flights to small airports in isolated communities that would not otherwise receive commercial air service.

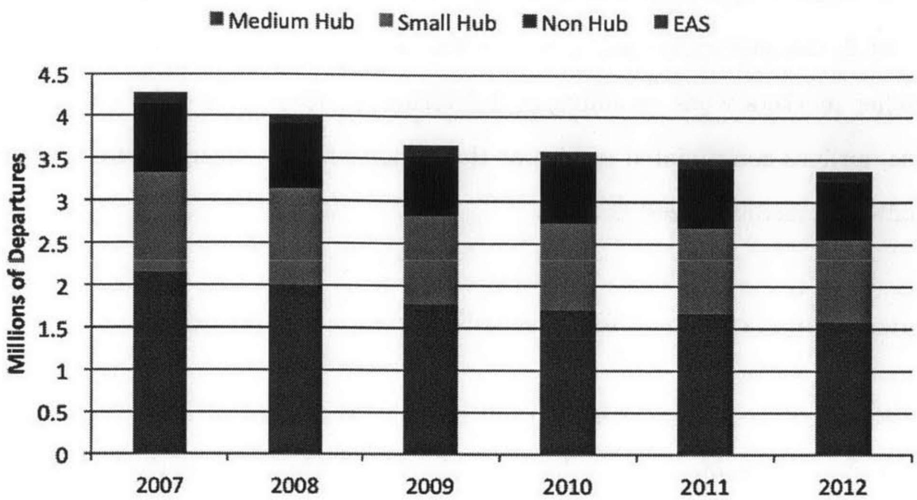

Figure 3.2: Scheduled domestic departures at smaller U.S. airports. Source: Diio Mi

Note that most of the reductions in departures at medium- and small-hub airports were on routes to other smaller airports. That is, while passengers in Boise, ID, could still reach Reno, NV, on commercial air service, previously existing direct flights were cut and replaced by connecting service through Salt Lake City, UT, for instance. The frequency of large-hub service from smaller airports was also reduced.

The medium-hub airport category includes Oakland, CA (OAK), Providence, RI (PVD), and Love Field in Dallas, TX (DAL)—airports that Southwest Airlines targeted in the early stages of its development to serve as alternative options for passengers wishing to avoid the crowded airports of competing airlines. In response, network carriers started to cut service to these secondary airports in the face of stiff competition from Southwest on both frequency and price. In many instances, these medium-hub airports can be found in metropolitan areas with multiple airports. During the capacity discipline period, network and low-cost carriers alike consolidated their service offerings at one airport in a metro area instead of offering a wider distribution of service among many airports serving the same metropolitan area.

Specifically, as operating costs at Southwest rose, the nation's largest low-cost carrier started to undertake the capacity discipline strategies also practiced by larger network carriers. Southwest cut nearly 10% of its domestic departures from smaller airports between 2007-2012. On the other hand, Southwest increased flights at large-hub airports by 6% over the same period. This left some medium-hub airports in a precarious position—with both network carriers and Southwest cutting service, these "secondary airports" were often no longer able to compete on service or price with larger, nearby hubs. As such, many of the medium-hubs in multi-airport regions in the United States saw the biggest reductions in service from 2007-2012.

Some of the smallest U.S. airports, such as Oxnard, CA, and Bullhead City, AZ, lost all of their commercial air service over the study period. However, only 24 airports that had network carrier air service in 2007 lacked such service in 2012—even through record-high fuel prices and an economic recession, only a small proportion of the country's primary commercial service airports "went dark" completely. At many smaller airports, network carrier air service was quickly replaced by other commercial service from a new class of "ultra-low cost carriers" (ULCCs) such as Allegiant Air and Spirit Airlines.

Often branding themselves as vacation providers and offering extra-low base fares with higher-than-average ancillary fee structures, ULCCs typically entered airports that had been abandoned by network legacy carriers to provide infrequent direct service to vacation destinations such as Orlando, FL, or Las Vegas, NV. For instance, after US Airways and Northwest Airlines ended service from Arnold Palmer Regional Airport (LBE) near Latrobe, PA in 2011, Spirit Airlines entered the airport to provide service to Ft. Lauderdale, FL, Orlando, FL, and Myrtle Beach, SC.

The replacement of traditional network legacy carrier service with ULCC service to vacation destinations may have helped some smaller airports survive a temporary discontinuation of commercial flights. However, is infrequent service to vacation destinations as valuable to residents of a community as frequent network carrier service to a hub airport, from which connections can be made to other destinations throughout the country and the world? Chapter 4 addresses this question by proposing a connectivity model with which airports can be compared not just based on their levels of service, but also on the quality of their connections to the global air transportation network.

3.2.3 Network carriers (and Southwest) drove the capacity reductions at smaller airports

Most of the capacity reduction at small- and medium-sized U.S. airports was due to decisions made by network carriers, not LCCs. As Figure 3.3 shows, network carriers decreased the number of scheduled domestic flights they operated from smaller U.S. airports by 27.3% from 2007-2012. While Figure 3.4 shows that some low-cost carriers such as JetBlue Airways, Frontier Airlines, and AirTran Airways increased flights from these airports during the study period, this addition of service by the low-cost and ultra-low cost carriers was not enough to fully make up for the cuts in service from the legacy carriers.

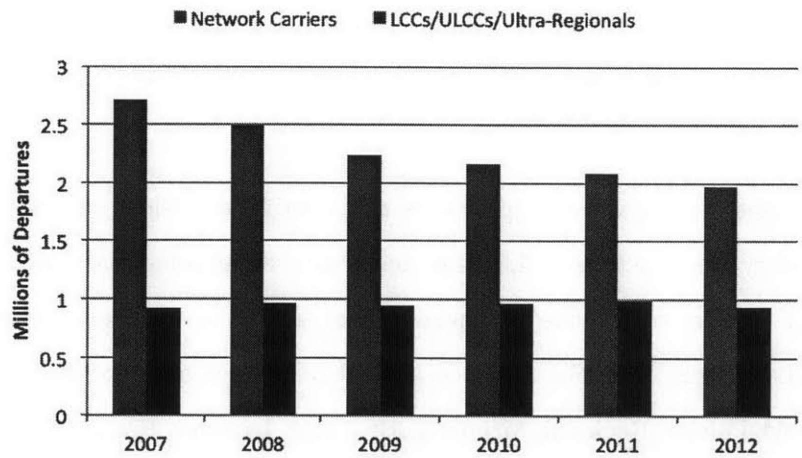

Figure 3.3: Scheduled domestic departures from smaller U.S. airports by marketing carrier type. Source: Diio Mi

The schedule data also highlight one of many ways in which Southwest Airlines, previously hailed as a paragon of a low-cost carrier, started to behave more a network legacy carrier from 2007-2012. While other LCCs and ULCCs increased flights and showed some growth in smaller markets, Southwest Airlines cut scheduled flights in many of the smaller markets it helped establish, as shown in Figure 3.5. Southwest cut 9.8% of its scheduled domestic flights from smaller airports from 2007-2012, as opposed to a 21.3% increase in scheduled flights at these airports by LCC competitor JetBlue Airways. While Southwest did not cut flights as severely as the network legacy carriers in smaller markets, the airline's capacity discipline should be worrying to smaller airports—

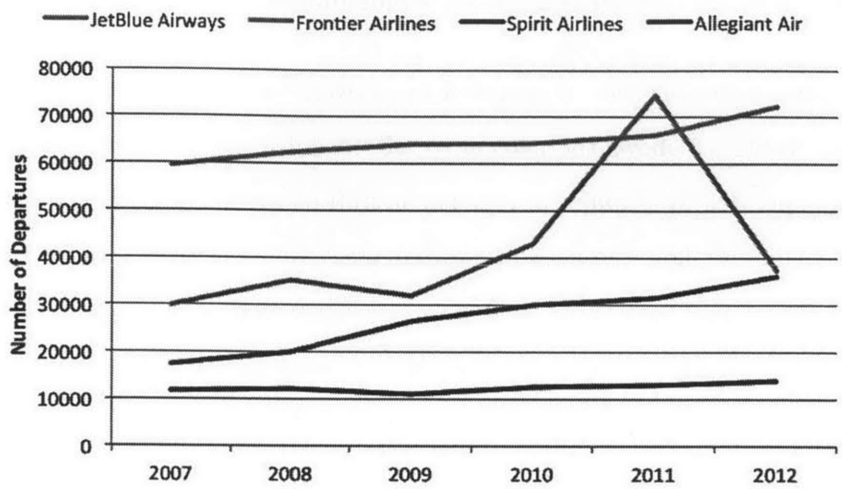

Figure 3.4: Low-cost/Ultra-low cost carrier scheduled domestic departures from smaller U.S. airports. Source: Diio Mi

particularly medium-hubs—whose previous growth was fueled largely by new Southwest service.

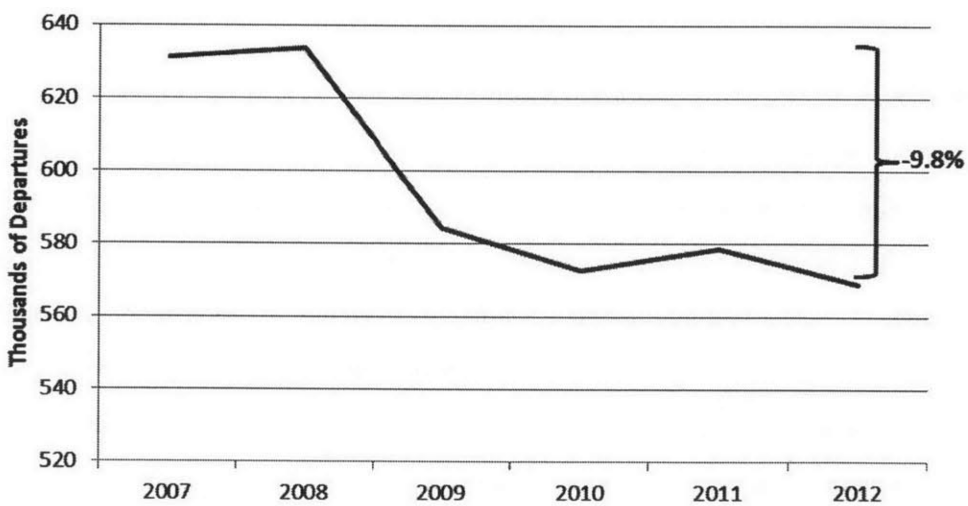

Figure 3.5: Southwest Airlines scheduled departures from smaller U.S. airports, 2007-2012. Source: Diio Mi

3.2.4 Network carriers shifted remaining small-market service to regional affiliates

Domestic small community air service operated by network carrier mainline aircraft has become increasingly rare. Table 3.3 shows the percentage of scheduled domestic departures from smaller airports that were operated by mainline or regional aircraft for several large U.S. airlines in 2007 and 2012. The table highlights how the network carriers chose different strategies for the deployment of their regional fleets, and that those strategies continued to shift throughout the period. For instance, Delta Air Lines held the proportion of small community air service operated by mainline aircraft and regional aircraft relatively constant from 2007-2012.

Airline	2007		2012	
	% Mainline	% Regional	% Mainline	% Regional
American	30.8%	69.2%	31.2%	68.8%
Delta/Northwest	24.9%	75.1%	25.9%	74.1%
United/Continental	21.0%	79.0%	12.5%	87.5%
US Airways/America West	26.3%	73.7%	19.5%	80.5%

Table 3.3: Percentage of mainline/regional domestic departures from smaller U.S. airports

On the other hand, United Airlines started to shift operations at smaller airports to their regional partners over the same time period. Note that even though the percentage of service provided by United regional carriers increased from 2007-2012, this does not imply that United was adding regional capacity. Instead, the airline cut mainline domestic service at these airports by a greater percentage than domestic regional service, leading to a greater fraction of flights operated by regional aircraft.[6] Some of the differences in trends between carriers are due to unique features of each airline's scope clause that may limit the number of regional aircraft that can be flown per the collective bargaining agreement. Potential changes in scope clauses as a result of the American Airlines/US Airways merger may continue to change the mix of mainline/regional aircraft for that combined carrier.

[6]Nearly seven out of every eight United flights from smaller U.S airports in 2012 were operated by a regional aircraft

3.2.5 The players are changing in Essential Air Service (EAS) markets

The Essential Air Service program is a federal air subsidy program intended to ensure that a "minimal level of air service" is provided at selected small and rural airports in the United States. Airports that receive EAS subsidies must be at least 70 miles from any medium- or large-hub airport. Subsidies vary by airport, but require operating airlines to provide direct service to a nearby medium- or large-hub airport such that passengers can connect to the domestic and international air transportation network. The stipulations of the EAS contracts limit the ability of carriers to exit the markets without arranging for replacement service to be provided by another airline. As of October 2012, 120 airports in the contiguous United States received a total of nearly $225 million dollars per year in EAS subsidies.

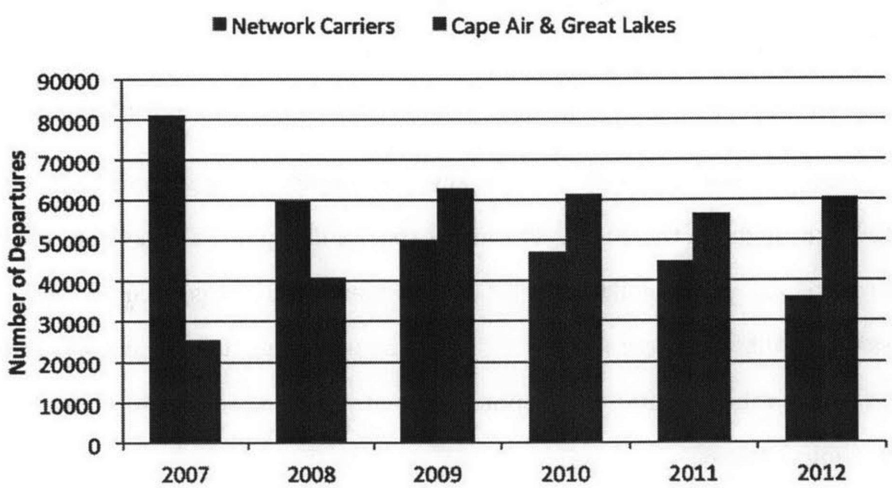

Figure 3.6: Essential Air Service (EAS) scheduled departures by marketing airline type. Source: Diio Mi

One of the most significant trends in small community air service is the extent to which the network carriers exited Essential Air Service markets from 2007-2012. Service that was previously provided by regional affiliates of network carriers transitioned to being operated by a small handful of "ultra-regional" carriers: Great Lakes Airlines and Cape Air are the major players in these markets. These ultra-regionals operate fleets of mostly small Cessna or Beechcraft aircraft with 8-19 seats that lack some amenities, but provide service from the smallest U.S. communities to nearby airports. The ultra-regionals operate under a different business model than the network carriers—for instance, Cape Air opens regional ticket offices in the small cities they serve to target local commuting passengers instead of relying on web distribution alone.

Passengers departing from airports served by these ultra-regional carriers do not receive amenities like flight attendants and a multiple-class cabin, but on the whole showed support for this type of service as both Cape Air and Great Lakes continued to grow both their frequencies and destinations served from 2007-2012. New entrant Silver Airways may also make a play for many of these markets, particularly as network carriers continue their swift exit.

While these airlines provide interline service to major hubs at which passengers can connect to network carrier service, it is also interesting to note that the ultra-regionals were some of the few carriers operating service *between* smaller airports. For instance, as of March 2013, Cape Air provided service from Albany, NY, to Massena International Airport in upstate New York—this type of service would not have been provided by a network carrier in the capacity discipline era.

These ultra-regional airlines are likely to be a key component of small community air service in the United States throughout the 2010s. Through capacity discipline, the network carriers showed a clear desire to exit the very smallest markets; their planes are not gauged correctly for the low volume of passengers that fly these routes. Instead, the ultra-regional carriers will likely continue their path of growth as they assume the responsibility of providing service to many of the smallest airports in the United States.

3.2.6 The swan song of the 50-seat regional jet?

The 2000s may very well be recorded in aviation history as the decade of the regional jet. Fueled by consumer preferences and compelling operating economics, network carriers started in the early 2000s to replace small turboprop airplanes with 37-50 seat regional jets (RJs) to serve smaller markets. The Embraer ERJ-135/140/145 and the Canadair CRJ-100/200 series by Bombardier were two of the most popular variants of RJs to start serving these smaller routes, and the number of regional jets in commercial service in the United States quickly increased from the 1990s to the early part of the 2000s (Mozdzanowska, 2004).

However, the trend of strong growth in 37-50 seat RJ service at smaller U.S. markets started to sharply reverse following the spike in fuel prices during 2007-2008. With higher fuel prices, the jet-powered RJs no longer were as attractive economically to provide frequent service in short-haul markets. Even after fuel prices began to stabilize, capacity discipline kept the amount of regional jet service in the United States low as airlines kept frequencies at rationalized levels. Since rationalization and capacity discipline was mainly applied to smaller airports that were more likely to be served by small regional jets, RJ service was disproportionally affected. Figure 3.7 shows the extent of the decline of 37-50 seat RJ service in smaller markets from 2007-2012.

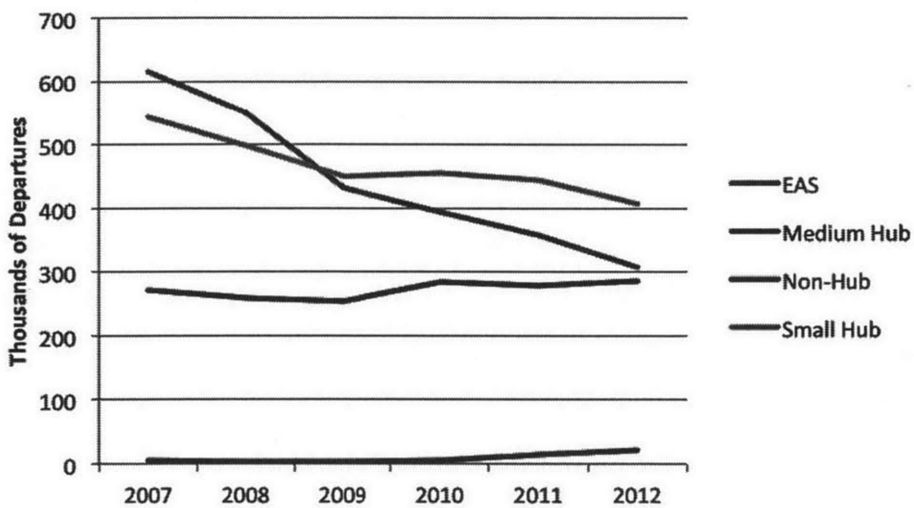

Figure 3.7: 37-50 seat RJ scheduled domestic departures at smaller U.S. airports. Source: Diio Mi

Much attention has been paid to this reversal of fortune in the small regional jet market segment. Widespread industry wisdom would hold that as the primary aircraft of choice for the smallest U.S. markets, smaller RJs would be removed from the non-hub markets first in reaction to unattractive fuel economics and curtailed domestic demand. However, Figure 3.7 shows that this was not the case. In fact, 50-seat RJ departures from non-hub markets actually increased slightly from 2007-2012. Instead, smaller RJs were removed at a rapid pace from medium- and small-hub airports. SkyWest Airlines, a large regional carrier that operates flights on the behalf of several network carriers, led the charge in moving small RJs to the very smallest markets, even deploying 50-seat regional jets in some small Essential Air Service markets.

There are several factors that could explain this trend. The first is simply a broader pattern of schedule rationalization—just as network carriers began to cut domestic service across their network, particularly at medium- and small-hub airports, so too should we expect to see a proportional decline in smaller RJ service at these smaller airports. It is also possible that airlines began reallocating their smaller RJ fleet to their smallest markets (non-hubs) in an effort to "right-gauge" their fleet across their entire networks; since there was no alternative small aircraft to serve these markets, it may have been more cost-effective to operate 50-seat RJs at non-hubs instead of parking the aircraft or exiting the markets entirely.

Some of the smaller RJ service at medium-hub airports may have also been replaced by larger, 76-seat regional jets, which were more efficient to operate during times of high fuel prices. As the next section shows, this pattern of upgauging regional jet service in medium-hubs did exist from 2007-2009. However, the trend later flattened as a result of capacity discipline; instead of replacing two 50-seat RJ flights with two 76-seat RJ flights, airlines instead replaced that service with just a single 76-seat regional jet flight. This behavior is one of the most important driving factors behind the significant reduction in flights at medium-hub and small-hub airports since 2007.

3.2.7 The 76-seat regional jet picked up some of the slack

Some of the capacity previously provided by 50-seat regional jets was replaced by 51-76 seat regional jets such as the Bombardier Canadair CRJ-700 and the Embraer E-175. These aircraft proved popular during the capacity discipline period—scheduled domestic flights operated by these larger RJs from smaller airports increased by 19.2% from 2007-2012. In many markets, the opportunity to replace two 50-seat RJ flights by a single 76-seat RJ flight operating at a higher load factor proved to be an attractive one for airlines. However, the 76-seat RJ was not deployed equally across all market types.

Figure 3.8 shows the changes in large RJ departures at smaller airports from 2007-2012. Larger regional jets were introduced in medium-hub markets to replace some of the smaller RJ service that had been removed, but the rate of substitution slowed over time. Small hub markets saw limited introduction of larger RJs, while non-hub and EAS airports saw almost no use of the 76-seat RJ.

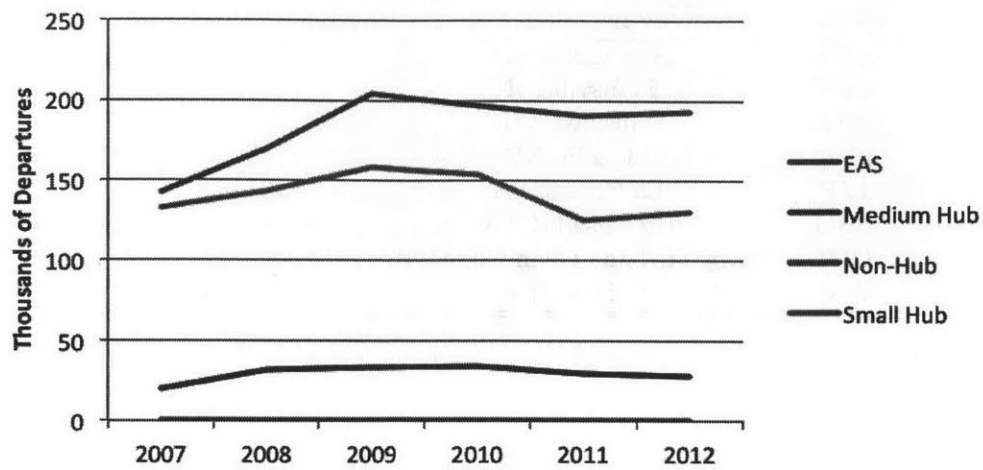

Figure 3.8: 51-76 seat RJ scheduled domestic departures at smaller U.S. airports. Source: Diio Mi

An important consideration for aviation planners is the identification of characteristics that indicate whether a given airport can support 76-seat regional jet service. Airports that fit this categorization might be able convince airlines to replace aging or inefficient 50-seat regional jets with (perhaps less frequent) 76-seat RJ service and retain their connectivity to key connecting hubs.

However, there is no easy answer as to which markets can support larger RJ service. Airports with 76-seat RJ service are on average larger than those that have only 50-seat RJ service. Airports with 76-seat RJ service enplaned about 70,000 passengers on average in 2011, whereas those with only 50-seat RJ service enplaned only about 40,000 passengers in the same year. Airports with both 50-seat and 76-seat RJ service in 2012 enplaned about 95,500 passengers on average in the previous year.

Airports with above-average enplanement levels and only 50-seat RJ service might be good candidates for 76-seat regional jet service in the future. Table 3.4 summarizes some airports that had enplanement levels over the 76-seat category average in 2011, but were served by only 50-seat regional jets in that year.

Of course, enplanements are only one measure of the economic strength of a given airport, and other demographic and local economic considerations need to be taken into account before the correct gauge for the market can be computed. The variation in the types of airports served by

Airport	Location	2011 Enplanements
AEX	Alexandria, LA	188,286
EVV	Evansville, IN	169,426
CWA	Mosinee, WI	135,965
LNK	Lincoln, NE	135,647
LSE	La Crosse, WI	102,958
BRO	Brownsville, TX	85,244
CMI	Savoy (Urbana-Champaign), IL	83,731
ABI	Abilene, TX	80,434

Table 3.4: Selected airports served only by 50-seat regional jets with above-average enplanements

only 50-seat regional jets highlights the challenges faced by airlines in selecting the correct aircraft for a given market.

3.3 A taxonomy of small-community airports: which airports may be at risk of future service loss?

Before examining which small community airports might be at risk of future service loss, it is first worthwhile to consider why a passenger would choose to fly out of a smaller airport instead of a large hub. Figure 3.9 summarizes some of the tradeoffs passengers face when choosing between departing from a small or large airport.

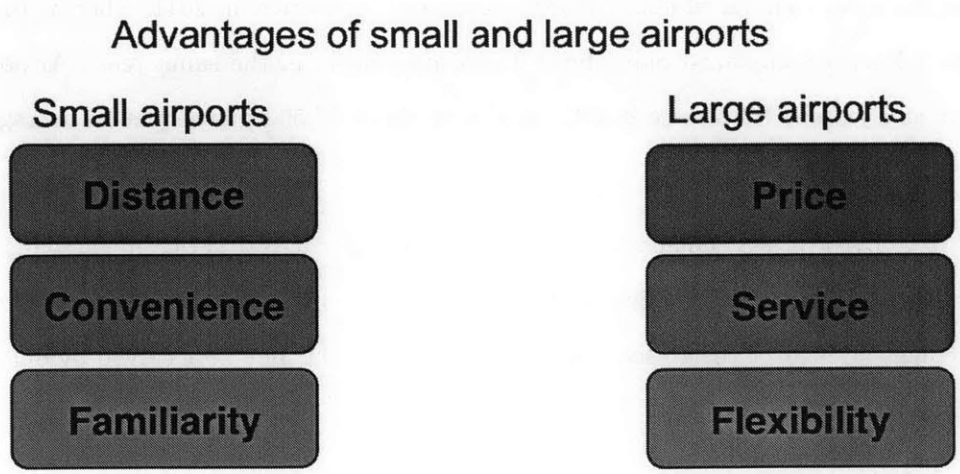

Figure 3.9: Advantages for passengers at small and large airports

Passengers who choose to fly from small airports often do so to take advantage of a sense of convenience: perhaps the smaller airport is closer to home, offers shorter security or check-in lines, or a smaller terminal footprint that is easier to navigate. Conversely, passengers who choose larger airports often do so because these airports may have a larger range of flights and connections from which to choose, lower fares, and more flexibility to reschedule itineraries during periods of delays, cancellations, or other irregular operations. Passengers in multi-airport regions evaluate each of these factors when weighing which airport to use for departure, and airport managers often attempt to influence the choice through advertising touting their airport's ease of use (for smaller airports) or range of options and amenities (for larger airports).

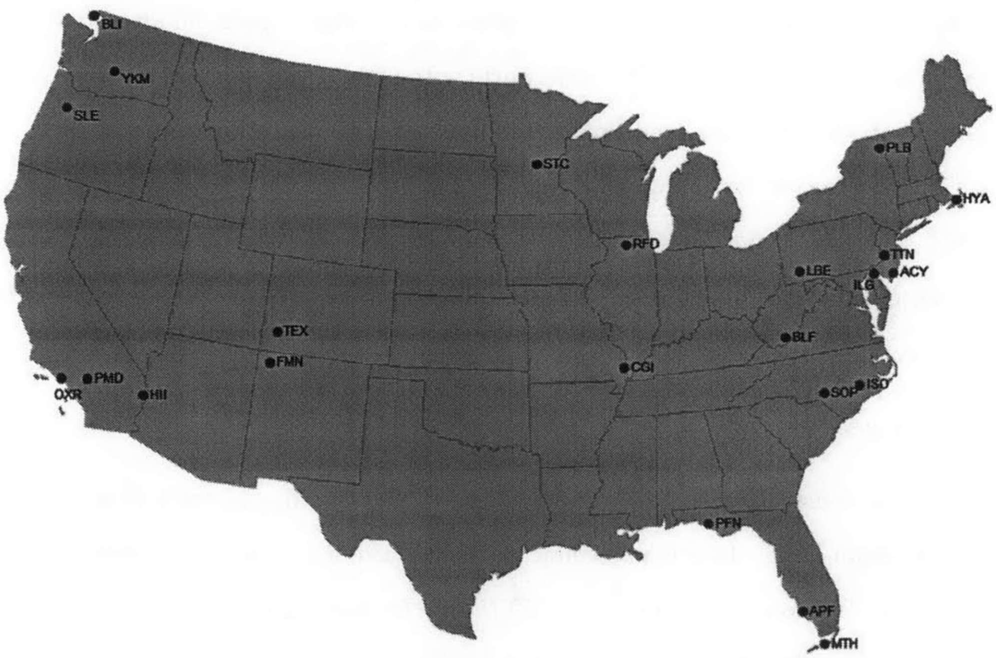

Figure 3.10: Airports that lost all network carrier service from 2007-2012. Source: Diio Mi

Examining the schedule data reveals that some small airports did a better job of conveying their benefits to potential travelers than others. Some of the least successful airports had lost all network carrier service entirely by the end of 2012. These airports spanned the entire country and served communities of different sizes, as shown by the map in Figure 3.10. Just as we can divide airports into categories based on their size, levels of service, and amenities, so too can we categorize airports that lost all network carrier service into several groups. This taxonomy exercise aims to help small airports identify if they may be at risk for total network carrier service loss in the future.

There are at least three categories into which the 24 airports that lost network carrier service from 2007-2012 can be classified:

1. Lack of local demand

The most typical cause of network carrier service loss is a lack of local demand to support the service. These airports, such as Four Corners Regional Airport (FMN) in Farmington, NM, often have a limited population with low household income in their immediate catchment areas. The airports are generally located in rural areas that are a significant distance from the nearest hub airport, but the average network carrier fares at the smaller airports are often several hundred dollars higher than average fares at the nearest hub. While airports with little local demand may have significant general aviation activity, there are traditionally limited network airline operations—these airports had been historically served by one or two network carrier flights per day before those carriers decided to exit. This group of airports is likely a good candidate for Essential Air Service support, as they are located far from other larger airports but lack the local demand to attract frequent network carrier service at reasonable prices.

2. Proximity to nearby hub

Some smaller airports may have lost their network carrier service due to their close proximity to other large or medium-hubs. This is particularly true for airports along the eastern and western seaboards, such as Trenton Mercer Airport (TTN) in Trenton, NJ. Even though airports like Trenton have large populations with high household incomes in their catchment areas, they are so close to large hub airports with greater service options that supporting limited network carrier frequencies can become difficult. For instance, Trenton is only 42.8 miles away from Philadelphia International Airport (PHL), a large-hub in Philadelphia, PA. Compared to this large hub, Trenton offered only limited options for nonstop service. However, due to their dense catchment areas, this group of airports still may have room to revive: Trenton itself signed a deal in 2013 with Frontier Airlines to provide nonstop service to more than ten new destinations from TTN.

3. Presence of ULCCs

A third category of airports that lost all network carrier service can be identified by the presence of ultra-low cost carrier (ULCC) service. The timing of ULCC entry into these markets can vary—at some airports, ULCCs arrive before network carriers exit, while at other airports ULCCs move in to fill a void in commercial service. These airports with ULCC service generally have a moderate level of population and household income in their immediate catchment area, and are fairly close to other hub airports. There may be geographic advantages at these airports that can attract ULCC service—for instance, Bellingham International Airport (BLI) in Bellingham, WA, is located less than 50 miles from Vancouver International Airport across the Canadian border. This has allowed Allegiant Air to market Bellingham as an alternative gateway airport for Canada. In these markets, there is enough demand to support infrequent ULCC service, but the network carriers are unable to compete in terms of either volume or price.

Taking these characteristics into account, it is possible to form a general picture of smaller airports that may be at risk of losing all network carrier service in the near future. These "at-risk" airports typically have service from only one network carrier, and have seen one or more network carriers with significant frequency share recently exit the market. There may or may not be the presence of one or more LCCs or ULCCs providing frequency or price competition to the remaining network carrier service. These airports are also likely located in close geographic proximity to a major hub airport.

Toledo Express Airport (TOL) in Toledo, OH, is one example of an airport that fits this categorization and may be at risk for future loss of all network carrier air service. Toledo is located 50 miles from Detroit, MI, and after Delta acquired DTW as a hub following its merger with Northwest Airlines, the airline saw no reason to continue its historically frequent service to TOL. There were 6,317 scheduled network carrier departures out of TOL in 2007, of which 2,118 were Delta flights. Yet in 2012, there were only 1,345 scheduled network carrier departures out of TOL, all of which were American Airlines service to Chicago O'Hare. Given its close proximity to DTW, Toledo may be at risk of losing this American Airlines service despite the significant population size of the Toledo metropolitan area. Allegiant Air, perhaps smelling the blood in the water, entered TOL to provide service to three destinations in Florida and attempt to hasten American's exit.

Using the historical patterns of service described above, a taxonomy of smaller airports in the United States can be created; it is shown in Figure 3.11. In this classification system, airports that fall in categories highlighted in red may be at risk of future commercial air service loss throughout the capacity discipline period, whereas those in categories highlighted in green may see growth in service as airlines switch to larger regional jets or as ULCCs and ultra-regional carriers like Cape Air, Great Lakes Airlines, and Silver Airlines begin to make a bigger impact in the small community air service market.

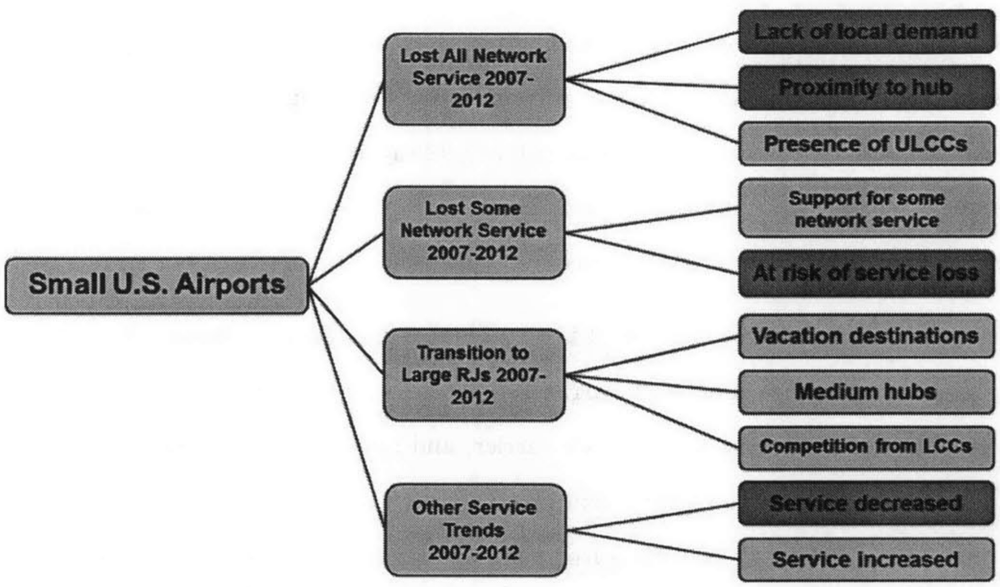

Figure 3.11: A taxonomy of small community airports in the U.S.

Despite a challenging economic climate and changing airline capacity strategies, it is still relatively rare for a small airport with commercial service to "go dark" completely for an extended period. The story of Arnold Palmer Regional Airport (LBE) in Latrobe, PA—at which network carrier US Airways exited the market only to be replaced by Spirit Airlines service—is likely to repeat itself dozens of times throughout the country throughout the capacity discipline period. The ultra-low cost carriers will provide the same growth opportunities to the small-hub and non-hub airports in the capacity discipline period as Southwest Airlines did for the current medium-hub airports in the 1990s and early 2000s. Airports should take into account, however, that service provided by a low-cost carrier to a vacation destination does not offer the same level of connectivity to the global air transportation network that network carrier service to a large hub would provide.

At the end of the day, the airlines' profitability on individual routes will continue to decide which airports are served and which are not. Financial incentives may attract service for several months, but only economically viable routes will survive. Airlines have shown less patience for achieving route success at small community airports in recent years; many case studies exist of an airline cutting all flights to a newly served airport after less than one year of trial service. Accurately judging the correct-sized airplane to service routes involving small communities will be critical to ensuring continued profitable commercial air transportation at these airports.

3.4 Conclusion: Regulatory threats to small community air service

As of early 2013, at least three legislative and regulatory hurdles presented further threats to regional air service in the United States. A new federal rule requiring newly hired pilots at U.S. airlines to have at least 1,500 hours of flight time caused some airlines and analysts to warn of an impending pilot shortage. Regional carriers may be disproportionally affected, as those regional pilots with enough flight time may begin migrating to larger network carriers as older pilots retire, leaving gaps that some regional carriers may find challenging to fill. The 1,500-hour rule will affect each regional carrier in a different way, and may give rise to a new round of regional carrier consolidation as carriers with a shortage of pilots struggle to maintain service levels. New pilot rest rules also put upward pressure on staffing levels, and were blamed for disruptions in airline service following a stretch of cold weather in the northeastern United States in January 2014 (Lavery, 2014).

Additionally, federal sequestration threatened to affect the ability of small U.S. airports to provide manned control towers for commercial air service. In March 2013, the Federal Aviation Administration released a list of 149 small community airports at which air traffic control towers would be closed, and outgoing Transportation Secretary Ray LaHood warned of disruptions in air service should sequestration cuts persist. While intervention from Congress kept these towers open in 2013, budget cuts should serve as an ongoing worry to small airports. There have been instances of airlines leaving airports due to deficient air traffic control facilities—in 2012, Allegiant Air cited the lack of a control tower as a primary reason for ceasing service at Fort Collins–Loveland Municipal Airport in Colorado, which the airline had served for nearly a decade. Furthermore, for the many small airports currently without commercial air service at which control towers are set to close, the potential lack of ATC infrastructure may discourage commercial carriers from entering these markets at all.

Finally, potential changes to the structure or budget of the Essential Air Service program could cause many small communities to lose their EAS subsidies. In many cases, the loss of an EAS subsidy would result in the end of commercial service at a small airport. Airports with strong economic fundamentals to support service may continue to see air service provided by Cape Air, Great Lakes, Silver Airlines, or another ultra-regional carrier. Hence, EAS airports will need to continue to pay careful attention to Washington.

The effects of these exogenous regulatory shocks on small community air service are difficult to predict. However, some of this proposed or existing legislature is likely to enhance losses in commercial aviation service at the nation's smallest airports. Combined with the merger of major carriers US Airways and American Airlines, the future of small community air service continues to remain dynamic, and will likely be tied closely to the duration of the capacity discipline period.

While this chapter examined overall trends in capacity discipline using schedule data, looking at changes in flights and seats alone does not provide full information about the effects of capacity discipline on smaller airports. For instance, if a network carrier flight from a small airport to a large hub was replaced by an ultra-low-cost carrier flight to a vacation destination, the number of available flights and seats at that airport may remain unchanged. However, a passenger's available connections from that airport to other airports in the system may be adversely affected as a result of this shift in destination quality. Therefore, the next section evaluates how schedule rationalization and capacity discipline changed U.S. airports' levels of connectivity to the global air transportation network.

4 Modeling Changes in Connectivity at U.S. Airports: A Small Community Perspective

4.1 Introduction

As described in Chapter 3, the U.S. air transportation system underwent a series of changes in response to the financial crisis of 2007-2009, high fuel prices, and a new wave of profitability-focused capacity discipline airline management strategies. More than 14.3% of yearly scheduled domestic flights were cut from the U.S. air transportation network from 2007-2012, mostly due to actions of the network carriers. Smaller airports were disproportionally affected by the cuts in service, losing 21.3% of their scheduled domestic flights as compared to an 8.8% decline at the 29 largest U.S. airports.

However, simply examining gains or losses in flight volumes does not provide a complete picture of the strength of commercial air service at an airport. For instance, many smaller airports lost service from network carriers from 2007-2012 but saw new service from ultra-low cost carriers (ULCCs) like Allegiant Air or Spirit Airlines. These ULCCs typically serve vacation destinations and offer limited connecting service to other U.S. airports or the global air transportation network. The small airports that lost network carrier service only to receive replacement service from ULCCs may not have seen significant decreases in flight volumes, but their connectivity was likely adversely affected.

An airport's connectivity to the global air transportation network is challenging to measure because it cannot be observed directly through published statistics. There currently exists no industry-standard metric to measure airport connectivity. Any such connectivity metric should be easy to compute and understand, but robust enough to measure changes in the airport's quantity or quality of service. Previous attempts at defining connectivity metrics have often not taken into account the quality of connecting destinations, been too complex for non-technical audiences to understand and adopt, and have often included no analysis of connectivity at smaller airports.

In this chapter, we propose a new, intuitive model of gauging an airport's level of connectivity to the global air transportation network that attempts to correct for these limitations in the current practice. In contrast to existing models, the Airport Connectivity Quality Index (ACQI) metric introduced in this chapter takes into account the relative value of flights to large connecting hubs vis-à-vis flights to smaller destinations. The ACQI also allows for comparison of airports across categories such as geographic region or airport size. It also allows for time-series analysis of a single airport to measure the impacts of changes in airline network strategies on connectivity.

After introducing the goals of the ACQI model and proposing a model formulation, we then compute these ACQI connectivity scores for 462 U.S. airports on a yearly basis from 2007-2012. The analysis in this chapter pays particular attention to connectivity at smaller U.S. airports rather than focusing exclusively on the largest airports. We provide four case studies of how connectivity changed over the study period for an airport in each of the FAA airport hub types. The ACQI scores for each of the 462 airports are also available in an appendix. As a final step, we also conduct a sensitivity analysis to examine how airport connectivity rankings shift in response to changes in model parameters.

The remainder of the chapter is structured as follows: first, a literature review is conducted to examine the current state of the practice in connectivity and accessibility modeling. The goals of the Airport Connectivity Quality Index are then introduced, followed by the model specification. Connectivity scores are computed for 462 U.S. airports for the years 2007-2012. Results are discussed by airport size group, and the relationships between capacity discipline and recent changes in connectivity are explored. We then examine how connectivity has changed at the primary and secondary airports in U.S. multi-airport regions. Finally, we discuss the limitations and extensions of the ACQI model for future work.

4.2 Review of Existing Connectivity Literature

When examining the airport service quality literature, it is important to draw a distinction between models that examine accessibility versus models that examine connectivity. As Jenkins (2011) suggests, connectivity can be thought of as a supply-side measure that defines how well-integrated a specific airport is into a larger network. On the other hand, accessibility can be seen as a demand-side measure that captures how easily passengers in a specific region are able to access air transportation, as well as the quality of the service that can be accessed from a specific location. For instance, a connectivity model might look at an airport's level of service to the global air transportation network, whereas an accessibility model might examine the air transportation choices for a passenger in a particular census tract. In some ways, accessibility models might be seen as geographic extensions of connectivity models.

This literature review will examine past work and recent advancements in both accessibility and connectivity modeling.

4.2.1 Accessibility modeling

A common argument for the use of demand-side accessibility models instead of supply-side connectivity models is that connectivity models include itineraries that are too expensive or cumbersome for passengers to actually purchase. Therefore, instead of schedule data, accessibility models often rely on passenger data from airline global distribution systems (GDS) or the U.S. Bureau of Transportation Statistics DB1B ticket sample database to complete their analyses.

Work by Grubesic and Zook (2007) is an example of this type of analysis, as the authors use data about schedules, fares, and available itineraries collected from a GDS to construct accessibility indices based on the quality of service (e.g., non-stop vs. connecting) and average fares. However, since the authors use GDS data instead of passenger booking data to collect available itineraries, they likely overstate availability of expensive or onerous itineraries since the GDS data contains all possible legal combinations of flights, regardless of the cost or travel time. Additionally, the GDS data used in this study was collected only for a seven day period in 2004, leading to an analysis that does not consider the changes in fares or available itineraries that often occur over time.

In contrast to Grubesic and Zook (2007), which use GDS data on schedules and availability, Jenkins (2011) uses actual passenger booking data from the BTS DB1B ticket sample database to compute a Path Quality Index (PQI) for several hundred U.S. airports. The PQI captures the quality of each origin-destination (O/D) pair in the DB1B data by weighting the percentage of non-stop, one-stop, and two-stop itineraries taken by actual passengers between those two airports. While this model considers only the routes that passengers actually flew and measures relative service quality on each of those itineraries, it does not assess the relative quality of the destination and may miss possible itineraries that customers do not fly simply due to low demand (for instance, a potential connecting itinerary between two very small airports).

A seminal study of geographic locational accessibility to air transportation in the United States was conducted by Matisziw and Grubesic (2010). Using airline schedule data, the authors computed accessibility for individual census tracts based on the distance to the nearest airports and the number of connections necessary to reach a destination from each airport. They mapped accessibility for each of 64,855 U.S. Census tracts and 431 commercially served airports. This model incorporates distance and other important geographic considerations and creates a valuable list of most and least accessible U.S. counties, allowing for analysts to consider variations in accessibility between geographic regions. However, the relative quality of connecting destinations was again not taken into account in the Matisziw and Grubesic model—that is, an additional flight to a small, poorly-connected airport was assumed to be as equally valuable as a flight to a well-connected hub airport.

Unlike the connectivity literature described below, the accessibility literature has spent a great deal of attention on the availability of commercial air service at small communities. A recent series of papers by Grubesic and Matisziw (2011); Matisziw et al. (2012); Grubesic et al. (2012) and Grubesic and Wei (2012) has examined accessibility in small community air service in the United States, with a specific focus on the Essential Air Service (EAS) program, which provides federal subsidies to induce commercial air service in selected small communities in the United States. This series of papers provides a valuable geographic perspective on the factors that influence flight performance at EAS airports, the efficiency of the EAS program, and the identification of potentially redundant EAS airports that could be cut from the subsidy program.

4.2.2 Connectivity modeling

Recent attempts to model airport connectivity can be divided into roughly three categories of research approaches: network theory models that rely on relatively more complex mathematical methodologies; temporal sensitivity models that build itineraries using schedule data to take into account minimum connection times and circuity; and more simple models that Arvis and Shepherd (2011) refer to as "intuitive metrics."

Network Theory Models

As a network with well-defined nodes (airports) and arcs (flights), it is intuitive to model the air transportation system using topology and mathematical graph theory. Some of the earliest approaches to connectivity modeling have done exactly that. In one of the first attempts at gauging the connectivity of the U.S. air transportation network, Ivy (1993) constructed origin-destination matrices and used graph theory concepts and linear algebra to measure the connectivity for the largest hub airports in the United States. Later work by Guimerà et al. (2005); DeLaurentis et al. (2008); Xu and Harriss (2008); Wang et al. (2011) and Arvis and Shepherd (2011) have also used graph theory to construct topological networks of the global air transportation system and measure the mathematical qualities of these networks in various countries.

The Arvis and Shepherd (2011) paper, published by the World Bank, received some significant attention from the academic community. Arvis and Shepherd use flight schedule data and gravity modeling—a traditional form of transportation modeling that takes into account the relative size of origin and destination points and their abilities to attract traffic—to carefully construct an Air Connectivity Index (ACI). However, some of the results of the Arvis and Shepherd ACI analysis are unusual: for instance, the United States, which is arguably the country with the most developed and connected air transportation network, is given what the authors describe as a fairly low ACI score.

This is because the Arvis and Shepherd (2011) model is most focused on international connections, and not domestic connections. To meet the global policy goals of the World Bank, the ACI measures only how well connected individual countries are to the global air transportation system. It would be desirable to apply some of the concepts from the Arvis and Shepherd model to measure the connectivity of individual airports within a country.

These papers typically analyze the air transportation network as a theoretical mathematics problem, often failing to account for the competitive forces within the airline industry that can give rise to different patterns of connectivity. Due to the complexity of the network theory metrics or high data requirements, these papers also generally provide connectivity scores for only a single year, making it challenging to examine how connectivity has changed over time.

Temporal Sensitivity Models

Arguably the most robust method to examine air transportation connectivity is to examine only those connections that are reasonable or feasible for a passenger to take. In other words, potential itineraries that involve lengthy layovers or unreasonably short connection times should be excluded in the computation of any connectivity metric, if possible. However, to actually exclude these unreasonable itineraries requires detailed schedule data and an algorithm for constructing feasible passenger trips.

The temporal sensitivity models of Bootsma (1997); Veldhuis (1997); Burghouwt and de Wit (2005), and others use time-of-day schedule data and minimum connection time rules to construct itineraries for passengers at individual airports. The quality of the available itineraries is then compared across airports to compute that airport's connectivity score. The approaches for constructing itineraries vary across these papers; in a thorough literature review, Burghouwt and Redondi (2013) provide a more detailed overview of many temporal sensitivity models. Redondi et al. (2013) have also applied a temporal sensitivity model to compute the change in travel time (and associated monetary cost) of closing small airports in Europe.

While the temporal sensitivity models appear to be a more robust method of computing connectivity as compared to models that use daily or weekly schedule data, these models do have some downsides. Constructing feasible itineraries requires the use of much more detailed datasets, making these models harder to generalize across hundreds of airports in a country, or across multiple years of schedule data. Airline schedules change frequently, making it unclear which days or weeks to select for the itinerary construction. Additionally, it is unclear whether the additional effort to construct feasible itineraries with time-of-day schedule data leads to a more informative metric than using aggregate schedule data that only includes the count of scheduled departures on a route; the latter approach may include some infeasible itineraries, but the effect of these itineraries on final connectivity scores is likely minimal.

"Intuitive Metrics"

A final category of connectivity metrics falls into a group that Arvis and Shepherd (2011) refer to as 'intuitive metrics." These models are often simpler than the network theory and temporal sensitivity metrics, but possess some attractive features. Using a simpler model reduces the data requirements necessary for computing connectivity, making it easier to create connectivity scores for many airports across a number of years. The models are also easier to understand for readers without mathematical training, and can make more sense when viewed in the context of the strategic decisions made in the airline industry.

Two appealing intuitive metrics are those created by Pearce (2007) and Reynolds-Feighan and McLay (2006). Both of these metrics contain an essential characteristic that is missing in most network theory models: they measure not only the quantity of available service and destinations, but also the quality of those destinations. In other words, an additional flight to Hartsfield-Jackson International Airport (ATL) in Atlanta, GA, should be weighted as more valuable than an additional flight to a small airport, all else equal. This is because more connections can be made from Atlanta than the smaller airport to other points in the air transportation network, and because Atlanta is a comparatively more important economic destination for commercial air service.

Most of the previously described models would treat these two destinations as equal, but both the Pearce and Reynolds-Feighan/McLay models include weighting terms that increase connectivity for airports that serve many valuable or highly served destinations. These models are computed by calculating the product of some capacity measure (such as available seats per week) and a weighting term for each destination, and then by summing up the scores for all destinations served from a specific airport.

While the simplicity and elegance of the intuitive metrics is appealing, the models by both Pearce and Reynolds-Feighan/McLay have an important limitation: they consider only an airport's non-stop destinations when computing connectivity, neglecting connecting itineraries entirely. While this approach might make sense in limited contexts (as in the Reynolds-Feighan/McLay paper, where the authors compute connectivity for airports in Britain that are only served by ultra-low cost carriers on which passengers generally fly only point-to-point), the advantages of nonstop service to a hub airport are lost when connecting traffic is not considered.

Moving Forward: A New Intuitive Metric

This chapter aims to improve on the current state of the practice by developing a new intuitive metric for connectivity that takes into account the possibility of connecting itineraries. The model retains the benefits of the existing intuitive metrics, as it is easy to compute and apply across many airports and many years of data. Destinations are also weighted by quality, meaning that an additional flight to a smaller airport is worth comparatively less than a flight to a large hub airport. Since the metric does not rely exclusively on mathematical graph theory when computing connectivity, it is more likely to inform the policy debate.

Furthermore, the analysis of the model in the following sections is completed in the context of broader airline industry trends, helping to better explain the changes in connectivity at certain airports. Unlike much of the research described above (with the exception of the work by Jenkins (2011), Redondi et al. (2013), and the many papers by Grubesic et al.), this chapter focuses specifically on the changes in connectivity at smaller airports instead of exclusively analyzing the largest hub airports in the U.S.

4.3 Introducing the ACQI Model

4.3.1 Model goals

We will first construct a simple air transportation network and consider what changes to the network structure would be expected to increase or decrease an airport's level of connectivity. For instance, consider the network in Figure 4.1. We wish to measure the connectivity of airport A, which currently has two flights per day to a small airport G and two flights per day to a large hub airport H. Connecting service is available from H to four additional small airports, labeled 1-4.

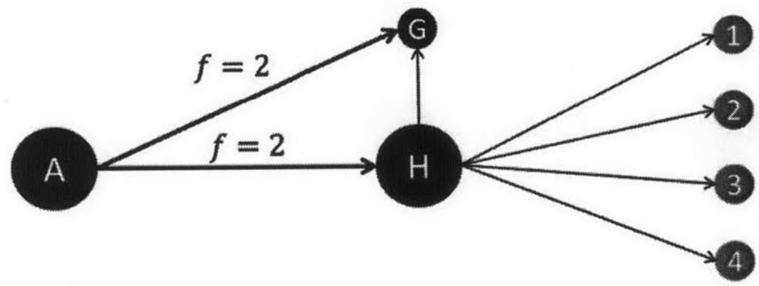

Figure 4.1: A simple air transportation network

What changes to the network should increase the connectivity of airport A? Clearly, if an airline increases the number of flights per day to one of the destinations that airport A already serves, A's connectivity should increase because passengers now have more time-of-day options to reach that destination. For instance, in Figure 4.2, the number of flights from airport A to airport H has increased from two to four. This should increase airport A's connectivity score.

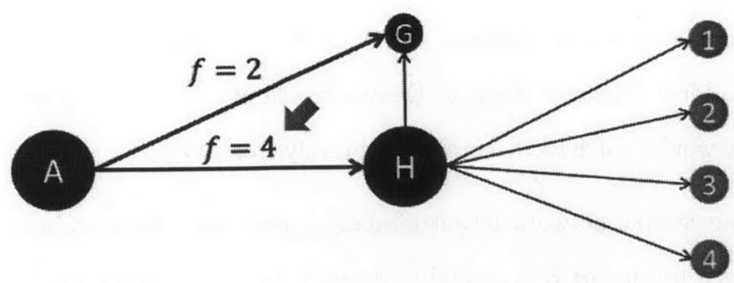

Figure 4.2: Increasing connectivity by increasing flights to existing destinations

Connectivity at airport A should also increase if more connecting destinations are available in the network. For instance, if an airline introduces service from the hub H to an additional small connecting destination (labeled 5 in Figure 4.3), Airport A's connectivity should increase. This scenario is shown in Figure 4.3. Note that the magnitude of the increase in connectivity should depend on the quality of the new destination. For instance, new connecting service to London should be worth more to an airport than new connecting service to a small U.S. city. In this case, the new destination in Figure 4.3 is a small airport, so the connectivity gains for airport A would be relatively minimal.

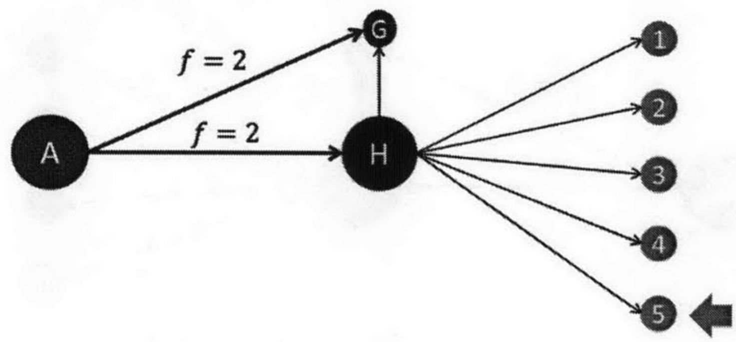

Figure 4.3: Increasing connectivity by adding a one-stop destination

Finally, connectivity would increase if service to a new nonstop destination is introduced from airport A. Once again, the magnitude of the increase would be related to the quality of the destination and the number of daily flights serving the new destination. It is possible that a new non-stop destination will also allow the possibility of connecting flights to airports that were not previously available. For instance, consider the potential gains in connectivity for a small airport that previously had non-stop United Airlines service to Newark, NJ, if a new United Airlines flight to Denver, CO, was added. The new flight to Denver would allow for connections to many smaller west coast cities that would not have been served directly from Newark.

Figure 4.4 extends our simple network by introducing a new daily flight to large airport K. Note that connecting service to airport 5 is available through the new destination K. Yet in this case, no net connecting destinations are added, since airport 5 is already served via connecting service from hub H.

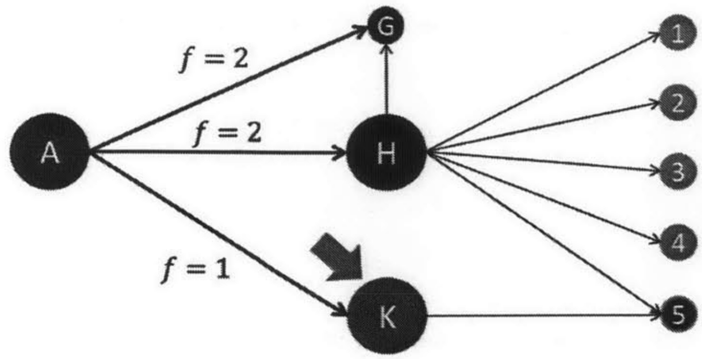

Figure 4.4: Increasing connectivity by adding a new non-stop destination

To summarize, we propose that an airport's connectivity should increase if:

- More flights per day are offered to an existing destination (as in Figure 4.2);
- The connecting opportunities from current nonstop destinations increases (i.e., more connecting service is available from an existing destination, as in Figure 4.3);
- The number of non-stop destinations increases (as in Figure 4.4); or
- The quality of destinations increases (for instance, a flight to a new Large Hub destination should be more valuable than a new flight to a small, Essential Air Service airport).

The Airport Connection Quality Index proposed in the following section was constructed such that any of the changes listed above to an airport's level of service would increase that airport's connectivity score.

4.4 Model definition

We will first define some notation. Let A be a set of origin airports and H be a set of airport types. For instance, the set of airport types might include large hub, medium hub, small hub, non-hub, Essential Air Service, and international airports.

Then the Airport Connectivity Quality Index (ACQI) score for an airport $a \in A$ is:

$$ACQI_a = \sum_{h \in H} f_{a,h} d_{a,h} w_h + \alpha \sum_{h \in H} d'_{a,h} w_h$$

where:

- $f_{a,h}$ is the average number of daily scheduled flights per destination from airport a to airport type h.
- $d_{a,h}$ is the number of nonstop destinations of type h served from airport a.
- $d'_{a,h}$ is the number of online or codeshare[7] connecting destinations of type h served from airport a
- w_h is a weighting factor based on the quality of airport type h
- α is a scaling factor that weights the importance of nonstop destinations vs. one-stop destinations.

In words, the connectivity score can be represented as:

$$ACQI_a = \text{(Quality of nonstop service)} + \text{Scaling Factor} * \text{(Quality of connecting service)}$$

It is easiest to understand the ACQI equation by looking at each term separately. The first term captures an airport's level of non-stop service, and is computed by multiplying the average number of daily scheduled flights (per destination) to airports of a certain type by the number of destinations served of that type. This product is then multiplied by a weighting term, such that an additional flight to a large hub is more valuable than an additional flight to a small hub, for instance. This computation is done for each airport type and then summed to yield the total non-stop connectivity score.

[7] For instance, if a flight on United Airlines is available from a small airport to Newark Liberty International Airport (EWR), from which a flight on Lufthansa is available to Frankfurt International Airport (FRA), FRA would be considered as a connecting destination from the small airport due to United and Lufthansa's membership in the Star Alliance. This allows the model to take into account the additional connectivity created by airline alliances.

The second term captures an airport's quality of connecting service. It is computed by multiplying the number of one-stop online or code-share connecting destinations served of each airport type by a weighting term w_h and then summing these terms across airport types. This product is then multiplied by a scaling term α, which weights the relative importance of a non-stop versus a one-stop destination. For instance, if $\alpha= 1$, an additional non-stop destination would be as valuable as an additional connecting destination. Adding this term to the first term yields the airport's total connectivity score.

This formulation of the ACQI model meets each of the connectivity model goals listed earlier. An airport's ACQI score would increase if more flights are offered to an existing non-stop destination (i.e. $f_{a,h}$ increases); if the number of non-stop destinations increases (i.e. $d_{a,h}$ increases); if more connecting service is available from an existing nonstop destination (i.e. $d'_{a,h}$ increases); or if the quality of existing nonstop or connecting destinations increases (resulting in a change in w_h).

4.4.1 Selecting Parameters for the ACQI Model

The ACQI model includes two parameters: the w_h terms, which reflect the relative quality of a destination airport, and α, which weights the importance of one-stop versus non-stop service. First, the w_h weighting terms were computed using average annual enplanements at each FAA airport hub type as a proxy for the economic, social, cultural, and political importance of each destination. To do so, we first calculate the average 2011 enplanement levels for each airport type, and then take the ratio of each type's average enplanement level to the large hub average enplanement level. This method results in the following weights:

Airport Type	Weight w_h
Large Hub	1.0
Medium Hub	0.21
Small Hub	0.05
Non-Hub/Essential Air Service	0.01
International	1.0

Table 4.1: w_h weighting terms for the ACQI model

From Table 4.1, we can observe that on average, a medium hub airport enplaned 21% of the passengers in 2011 of an average large hub airport. Similarly, a small hub airport enplaned about 5% of the passengers of a large hub airport in 2011, on average. Note that international destinations were assigned a weight of 1.0 to reflect the importance that international service plays in the U.S. air transportation system. Several alternative more complex weighting schemes for domestic and international destinations were also explored, but, as described in Section 4.6, they resulted in minimal changes to the ranking of airports when compared to the weights in Table 4.1.

The scaling factor α was selected based on the literature regarding the Quality Service Index (QSI), a model used by airlines to compute market share based on path quality (Lohatepanont and Barnhart, 2004). Used in predicting which of many itineraries a customer will select based on each itinerary's attributes, the QSI model has historically assumed a discounting factor for one-stop or connecting service as compared to nonstop service between two airports. That is, a connecting itinerary is seen as less valuable to a potential passenger than a nonstop itinerary.

The exact scale of this parameter has varied in different QSI models, but has generally fallen between 0.03 and 0.2, according to Jenkins (2011). This would indicate that a non-stop itinerary would be between five and thirty-three times more valuable than a connecting itinerary. Since direct service between smaller airports has generally been replaced by more service to connecting hubs, a value of α that is in the higher range of these values seems to be appropriate. To wit, Emrich and Harris (2008) suggested that a non-stop itinerary is up to eight times more valuable than a connecting itinerary. Following this logic, an α value of 0.125 has been used in the ACQI model. In sensitivity tests, small adjustments to α also result in limited changes in the ranking of airports in the ACQI model. These sensitivity analyses are discussed in detail in Section 4.6.

4.4.2 Sample Computation of ACQI Score

Suppose that we wish to compute the ACQI score for a small airport at which the only non-stop service is two flights per day to a nearby large hub. At the large hub, onward connections are available to 20 other large hubs, 30 medium hubs, and 50 small hub airports. Then, assuming the weights and scaling factor described in the previous section, this airport's ACQI score would be:

$$ACQI_a = (2 \cdot 1 \cdot 1.0) + 0.125 \cdot [(20 \cdot 1.0) + (30 \cdot 0.21) + (50 \cdot 0.05)] = 5.6$$

As is shown above, the quality of this airport's nonstop service is computed by multiplying the average daily flights per day to each airport type by the number of nonstop destinations of that airport type and the weighting factor for that airport type. The quality of connecting service is computed by multiplying the number of connecting destinations of each hub type by the appropriate weighting factor, summing these products, and multiplying the sum by the scaling factor α. This results in an ACQI score for this airport of 5.6.

The ACQI metric is a dimensionless measure that is best used to compare connectivity across airports or at a single airport at different periods in time. However, by examining the model results, we can generate a rough mapping of ACQI scores to the quality of available connections at a single airport. Table 4.2 provides one such set of "rule of thumb" guidelines for judging a single airport's connectivity based on its ACQI score. With a score of 5.6, the small airport described would have limited connectivity to the global air transportation network using the scale described in Table 4.2.

ACQI Score Range	Connectivity Quality
0 - 10	Limited connectivity
10 - 50	Moderate connectivity
50 - 150	Good connectivity
$\geq$ 150	Excellent connectivity

Table 4.2: Airport connectivity quality by ACQI score range

4.5 Computing ACQI Scores for U.S. Airports

4.5.1 Data Sources

ACQI scores for each of 462 U.S. airports from 2007-2012 were computed using schedule data from the Diio Mi Market Intelligence Portal. The Diio Mi data is sourced from Innovata SRS, which provides up-to-date schedule data for 99% of airlines worldwide (IATA, 2014). The Diio Mi schedule data includes information about marketing airline, origin, destination, equipment, and number of scheduled flights, seats, and ASMs in a requested period. For the computation of the ACQI score, data was aggregated on a yearly basis (January–December) for each year between 2007 and 2012. Flights that were scheduled fewer than 12 times per year (i.e., less than monthly) were treated as extraneous and removed from the dataset.

Data was collected for all airlines, domestic and international, with scheduled flights from the United States. Code-share connecting destinations were included by grouping appropriate airlines into each of the three major alliances: Star Alliance, SkyTeam, and Oneworld. Alliance definitions are current as of March, 2013. However, for data management reasons, schedule data were not loaded for flights originating outside of the United States. For instance, if a passenger at JFK were flying an itinerary to Stuttgart, Germany (STR) via Frankfurt, Germany (FRA) on Lufthansa, the ACQI model would capture Frankfurt as a nonstop destination but would not capture Stuttgart as a connecting destination. This may make a difference for larger airports with many nonstop international flights, but since the ACQI model only considers one-stop connecting itineraries, this is less of a concern for smaller airports with fewer direct international flights available.

4.5.2 ACQI Score Overview

Figure 4.5 shows the average ACQI score in 2007 and 2012 for each airport hub type.

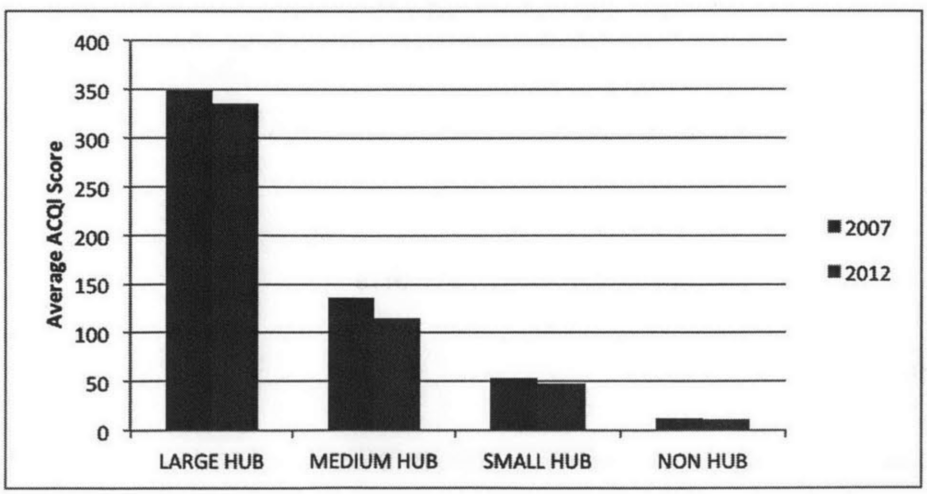

Figure 4.5: Average ACQI score by airport hub type

Figure 4.5 provides some insight into the relative differences in connectivity scores between airport types. In 2012, the average connectivity score for large-hub airports was roughly three times larger than medium-hubs, six times larger than small-hubs, and about fifteen times larger than non-hubs. Each of the top 25 most connected airports in the U.S. in 2012 was a large hub; Table 4.3 summarizes the ten most connected airports in the United States in that year, a full list of ACQI scores is available in the appendix.

Airport	ACQI Score (2012)	Rank (2012)
ORD : O'Hare International	624.47	1
ATL : Hartsfield Intl	606.93	2
LAX : Los Angeles Intl	565.59	3
DFW : Dallas/Ft Worth Intl	457.26	4
JFK : John F Kennedy Intl	428.01	5
SFO : San Francisco Intl	414.31	6
DEN : Denver International	412.48	7
EWR : Newark Intl	395.82	8
IAH : Houston Intcntl	384.87	9
LGA : La Guardia	371.19	10

Table 4.3: Top ten most connected airports in the U.S. in 2012

Note that there is significant variation in ACQI scores even among airports of the same type. For instance, as Table 4.3 shows, the 2012 ACQI score for ORD was 624.47, as compared to a score of 371.19 for LGA, the tenth most-connected airport in that year. This suggests that several U.S. airports—ORD, ATL, and LAX—to name a few, have a level of connectivity that is significantly higher than other airports in their FAA large-hub category. Additionally, there are some medium-hub airports, such as Portland International Airport (PDX), that have connectivity scores that are higher than some large-hub airports. As such, ranking airports by ACQI scores would lead to a unique airport classification scheme that could be used to complement the FAA hub definitions, which are based on enplaned passengers only.[8]

Figure 4.5 also shows the change in ACQI score for each hub type from 2007 to 2012, after the effects of the economic slowdown, high fuel prices, and capacity discipline began to appear in the U.S. air transportation system. The average ACQI score fell for each airport hub type during the

[8]Rodríguez-Déniz et al. (2013) and Ryerson and Kim (2013) have each recently proposed such an alternative "hub-type" classification for U.S. airports using an accessibility model based on path quality.

study period, suggesting that airport connectivity as a whole in the United States has declined from 2007-2012. However, just as capacity discipline strategies were not applied evenly across all airport types, so all U.S. airports did not feel the reduction in connectivity equally. Table 4.4 shows the percent change in connectivity for each airport type over the study period, and the next sections will discuss in detail the differences in connectivity changes at large-, medium-, small-, and non-hub airports.

Airport Type	% change in ACQI
Large Hub	-3.9%
Medium Hub	-15.6%
Small Hub	-11.0%
Non-Hub/EAS	-8.2%
Smaller Airports	-12.8%
All Airports	-8.3%

Table 4.4: Percent change in ACQI (connectivity) score by airport type, 2007-2012

Connectivity at medium-hub airports fell the most between 2007 and 2012, with these airports' ACQI scores declining by 15.6% over those years. On the other hand, large hub airports did relatively well, only losing 3.9% of their connectivity over the same period. In all, connectivity declined by 8.3% across all airports in the United States between 2007 and 2012, compared to a 12.8% decline in connectivity at smaller airports alone during those years.

4.5.3 Changes in connectivity at large-hub airports

Figure 4.6 shows how the average ACQI score at large-hub airports changed between 2007 and 2012.

The average ACQI score for large hubs declined from 348.55 in 2007 to a low of 329.01 before recovering to 335.10 by 2012. The effects of recent macroeconomic events and industry strategies can be seen in the v-shaped pattern of the average ACQI score. The decline in connectivity from 2007-2009 can be associated with the beginning of the U.S. recession and the transition to a period of high and unstable fuel prices. These factors caused airlines to cut capacity across the air transportation system, resulting in a decline in connectivity. Fueled by increased airline consolidation at larger airports, large hubs recovered slightly from 2010-2011, but the effects of airline capacity discipline

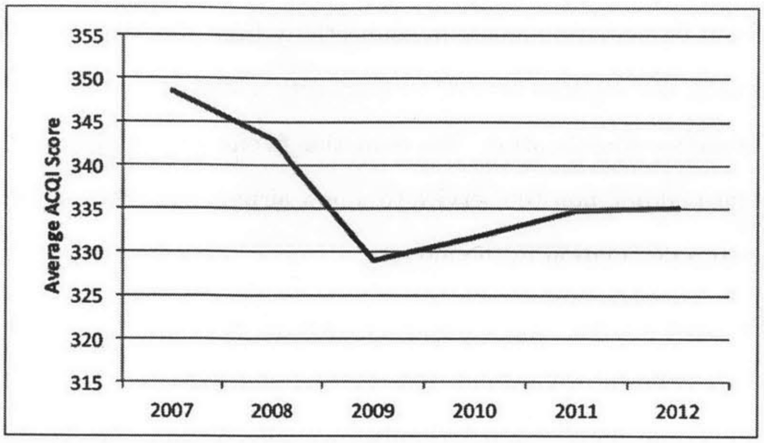

Figure 4.6: Average ACQI score for large-hub airports, 2007-2012

strategies limited the rebound and caused connectivity to remain essentially unchanged between 2011 and 2012. This v-shaped pattern is common among large hub airports and can be seen when examining changes in connectivity or capacity at many of the largest airports in the United States.

4.5.4 Large hub case study: SFO shows impressive growth

For each of the airport hub types, we will examine an airport that either typifies the changes in connectivity common among airports of that type or presents uncommon behavior that is worth exploring in depth. For instance, while most large hub airports lost connectivity between 2007 and 2012, there were four large hubs at which connectivity improved during those years. The most salient example is San Francisco International Airport (SFO). Compared to an average 3.9% decline in ACQI among large hub airports, SFO's ACQI score increased by 22.8% between 2007 and 2012. Table 4.5 summarizes the changes in SFO's connectivity score from 2007-2012, as well as the number of nonstop and one-stop destinations served from SFO during those years.

Year	2007	2008	2009	2010	2011	2012
ACQI Score	337.47	370.94	363.70	368.17	388.12	414.31
Nonstop destinations	96	104	100	103	106	109
One-stop destinations	470	462	444	444	418	421

Table 4.5: ACQI scores and destinations served from SFO, 2007-2012

As Table 4.5 shows, San Francisco's increase in connectivity from 2007-2012 was mostly as a result of an increase in nonstop destinations served, coupled with additional capacity to other large hub airports as a result of service consolidation. The reduction in one-stop destinations is typical among large hub airports, since adding nonstop service to a new airport will result in the removal of that destination as a one-stop destination in the model.

As we will see in the next section, San Francisco's increase in connectivity came at the expense of nearby medium-hub airports in Oakland, CA, (OAK) and San Jose, CA (SJC). This pattern has repeated itself in several multi-airport regions, including Boston, Los Angeles, and Phoenix. Secondary airports have started to lose service as a result of Southwest Airlines cutting services at those airports and network carriers consolidating their flights at large hubs within the region. This is one of the most important factors driving the significant loss of connectivity at medium-hub airports from 2007-2012.

4.5.5 Changes in connectivity at medium-hub airports

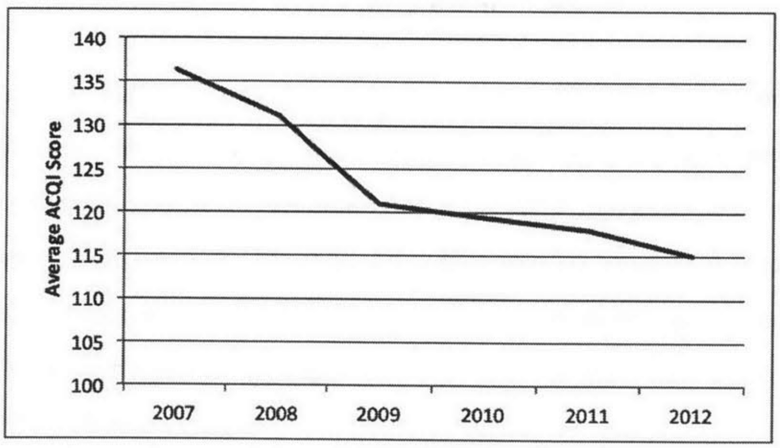

Figure 4.7: Average ACQI score for medium-hub airports, 2007-2012

As Figure 4.7 shows, the pattern of connectivity of medium-hub airports is different than that of large-hub airports. While both large-hubs and medium-hubs lost connectivity during the economic slowdown of 2007-2009, medium-hub airports did not undergo the same recovery in 2010 and 2011 that large-hub airports did. Instead, connectivity at medium-hubs continued to fall after 2010 as a result of capacity discipline strategies that targeted these airports as a primary focus for service reductions.

4.5.6 Case study: TUS typifies the challenges faced by medium-hubs

From 2007-2011, Tucson International Airport (TUS) in Tucson, AZ, was classified as a medium-hub. TUS had enjoyed relatively strong growth in Southwest Airlines service in the early 2000s as the airline attempted to build TUS as a secondary airport in the Arizona Sun Belt. At the same time, other network carriers began to exit TUS, as they were unable to compete on frequency or price with Southwest.

However, once Southwest's cost advantages through fuel hedging and low crew costs started to slowly evaporate in the late 2000s, even Southwest started to cut service to TUS and other medium-hubs, adding to service reductions by the network carriers. With the set of nonstop destinations out of TUS shrinking, passengers living in Tucson became accustomed to making the two-hour drive to take a direct flight from Phoenix Sky Harbor International Airport (PHX) in Phoenix instead of purchasing a connecting itinerary that left from TUS (Hatfield, 2012). Airport managers at TUS have struggled to attract airlines or passengers alike to fly from the airport, and connectivity has suffered. Table 4.6 shows the decline in connectivity and nonstop destinations at TUS from 2007 through 2012.

Year	2007	2008	2009	2010	2011	2012
ACQI Score	94.30	91.07	78.69	80.02	77.58	74.66
Nonstop destinations	29	30	16	15	16	16
One-stop destinations	444	459	412	408	408	401

Table 4.6: ACQI scores and destinations served from TUS, 2007-2012

As the table shows, TUS lost nearly half of its nonstop destinations from 2007-2012, along with nearly 20 points of its ACQI score. In the most recent FAA hub definitions released in late 2012, TUS was reclassified as a small hub, emphasizing how much capacity has been cut from TUS in recent years. This phenomenon at TUS, as well as similar patterns at current or former medium-hubs OAK and SJC (near SFO), ONT (near LAX), and MHT and PVD (near BOS) suggests that today's medium-hubs will likely begin to functionally resemble small-hubs in size, service, and level of connectivity over the next five years.

4.5.7 Changes in connectivity at small-hub airports

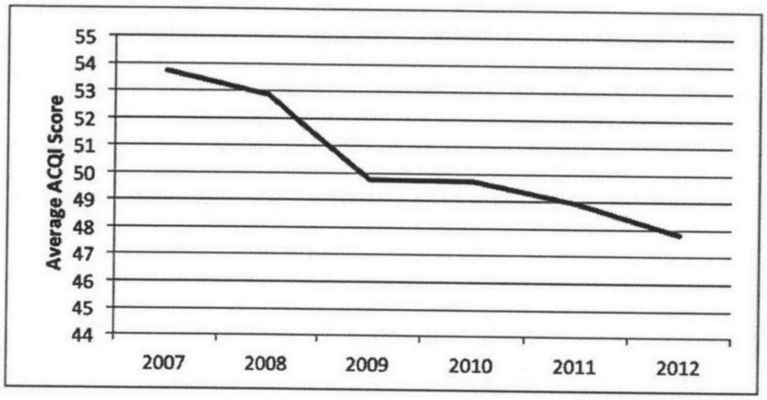

Figure 4.8: Average ACQI score for small-hub airports, 2007-2012

As Figure 4.8 demonstrates, small-hubs were also hit hard by airline capacity discipline. As with medium-hub airports, small-hubs retained their scheduled domestic service to large-hubs (albeit at reduced frequencies) while losing direct service to other smaller destinations. Much of this previous point-to-point service between nearby smaller airports started to disappear as the network carriers and Southwest continued to consolidate service at their hubs. However, the number of destinations reachable with a one-stop connecting itinerary increased from 2007-2012 at many airports.

4.5.8 Small-hub case study: moderate decline in service at TUL

Year	2007	2008	2009	2010	2011	2012
ACQI Score	78.11	75.95	70.71	73.63	72.77	71.50
Nonstop destinations	23	25	18	18	18	18
One-stop destinations	420	440	425	438	441	441

Table 4.7: ACQI scores and destinations served from TUL, 2007-2012

Like many small-hub airports, Tulsa International Airport (TUL) in Tulsa, OK, lost service to many nonstop destinations from 2007-2012. Table 4.7 shows that nonstop destinations decreased from a high of 25 in 2008 to 18 in 2012. However, one-stop destinations accessible from TUL increased over the same period, reflecting an increase in the number of connecting options available from the airports that TUL serves nonstop. Yet overall, TUL's connectivity score fell by 8.5% despite its increase in connecting destinations.

This is due in part to the low value of α in the ACQI model definition. If one-stop destinations were judged to be relatively more valuable in the model, airports like Tulsa could well see an increase in their ACQI score in a sensitivity analysis. For small changes in α, however, the model is robust in both the percent change in ACQI scores and the rankings of airports relative to their peers. That is, making small changes to the scaling factor results in relatively small changes to the model's results. This sensitivity analysis is discussed in detail in Section 4.6.

4.5.9 Changes in connectivity at non-hub and Essential Air Service (EAS) airports

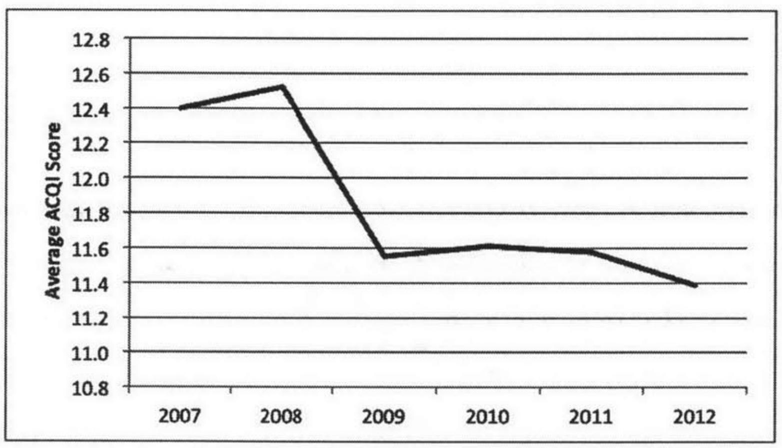

Figure 4.9: Average ACQI score for non-hub and Essential Air Service airports, 2007-2012

In the aggregate, fluctuations in connectivity at non-hub and Essential Air Service airports were relatively minor compared to the significant decreases in ACQI at medium- and small-hubs, as shown in Figure 4.9. The average ACQI score at non-hub and EAS airports decreased by 8.2% from 2007-2012, compared to a 15.6% decline at medium-hubs and an 11.0% reduction at small hubs. This is likely due to federally mandated levels of air service at Essential Air Service airports; these airports had avoided the wide-spread capacity cutting that occurred at slightly larger airports.

However, the relatively flat slope of the aggregate ACQI score decline for non-hubs and EAS airports masks some significant changes in connectivity at individual airports. Some of these smallest airports were successful in luring one or more network carriers to start service between 2007 and 2012, increasing their connectivity by many multiples. Other small airports lost all network carrier service over these years, causing a devastating drop in connectivity to an ACQI score of 0 in some years. Many of these airports have been able to win back service in recent years, often from an ultra-low cost carrier like Allegiant Air or Spirit Airlines.

However, the resulting level of connectivity with ULCC service is often less than with network carrier service, since ULCCs generally provide point-to-point service to vacation destinations with few connecting itineraries available. The appendix shows how some airports gained or lost significant portions of their connectivity score from 2007-2012, highlighting the volatility that small airports face and the importance of each and every flight and destination in maintaining attractive levels of connectivity for potential passengers.

4.5.10 Non-hub case study: entrepreneurial growth in service at COU

In 2007, Columbia Regional Airport (COU) in Columbia, MO, appeared like many other small airports. A US Airways affiliate provided Beechcraft service to in-state airports in Kansas City (MCI) and St. Louis (STL), from which only limited connecting service was available on Star Alliance partners to the rest of the United States. However, in 2011 and 2012, COU hired a consulting firm to aggressively campaign for additional service in future years (Zagier, 2012). By offering a combination of revenue guarantees, waived landing fees, and exclusive radio advertising, COU was able to attract new American Airlines, Frontier Airlines, and Delta Air Lines service from COU to each airline's hub, starting in 2012 and 2013. The increase in connectivity for COU passengers has been substantial, as shown in Table 4.8.

Year	2007	2008	2009	2010	2011	2012
ACQI Score	2.07	5.10	5.30	5.02	4.56	14.85
Nonstop destinations	2	2	1	1	1	2
One-stop destinations	22	98	99	91	84	230

Table 4.8: ACQI scores and destinations served from COU, 2007-2012

Through their aggressive campaigning, COU was able to increase their connectivity eightfold, representing an increase of nearly 620% from its low in 2007. Additional service coming online in 2013 will likely continue to boost COU's connectivity. COU is a good example of a non-hub airport that used an incentive-based strategy to attract or retain service. Airlines looking for new profitable routes have seemed willing to sample service in markets like COU as long as they have enough revenue guarantees to cover their bases. However, these airlines are usually equally willing to pull out of such small markets if demand is not strong enough to maintain profitability. Hence, an incentive-based strategy can be a risky one for a small airport, as airlines are liable to quickly discontinue service if the economics are not there to support it. Airport managers may wish to consider adding length-of-tenancy requirements to new incentive packages to help ensure that airlines do not quickly enter and exit these airports.

For many small airports, a status quo of stagnant or dwindling service is enough incentive to take a gamble on revenue guarantees to lure in a new airline and see how local passengers will respond. It remains to be seen how Columbia, MO, passengers will react to additional service at their hometown airport, and whether they will start flying locally instead of driving hours to Kansas City or St. Louis for more direct options. In what is perhaps a hint at the answer to this question, Frontier Airlines decided in May 2013 to end their service from Columbia to Orlando after just six months of operation.

4.5.11 Capacity discipline and airport connectivity

It is worthwhile to examine the extent to which capacity discipline in the form of reductions in scheduled domestic flights and available seats has directly impacted connectivity. If there is a direct correspondence between capacity discipline and connectivity, we should expect to see decreases in connectivity similar to the declines in flights and seats at these airports. Table 4.9 shows how the percentage change in ACQI compares to changes in capacity metrics like scheduled domestic flights and available domestic seats on those flights from 2007-2012.

For each airport type, the percent change in connectivity was significantly less than the percent change in both domestic seats and domestic flights over the study period. This suggests that a

Airport Type	% change in ACQI	% change in seats	% change in domestic flights
Large Hub	-3.9%	-7.2%	-8.8%
Medium Hub	-15.6%	-21.4%	-26.2%
Small Hub	-11.0%	-14.3%	-18.7%
Non-hub/EAS	-8.2%	-9.9%	-15.4%

Table 4.9: Changes in connectivity and capacity by airport type, 2007-2012

significant portion of the airlines' capacity discipline strategies did not directly decrease passengers' access to the global air transportation network, and instead involved cutting redundant service. Service could be called redundant if the connecting options from one hub overlap nearly completely with connection options from another hub that is already served. For instance, if passenger at a small airport can reach the same set of airports connecting on Delta service via Atlanta or Memphis, direct service to Memphis could ostensibly be cut without a large decrease in connectivity. In the aggregate, these repeated cuts of redundant service at duplicate hubs explain the large decrease in connectivity at Memphis, Salt Lake City, Pittsburgh, and Cincinnati from 2007-2012.

The table also shows the trend of upgauging aircraft, particularly in the regional jet (RJ) space as carriers shift from 50-seat to 76-seat regional jets. Since the percent change in seats was lower than the percent change in domestic flights at all airport types, we can infer that airlines were upgauging as they cut service, further limiting some of the impacts of capacity discipline on passengers.

4.5.12 Changes in connectivity in multi-airport regions

Passengers face a number of tradeoffs when choosing an airport in a multi-airport region. Larger airports often have more frequent flight options, more flexibility to change flights or rebook due to delays or irregular operations, and often offer more competitive fares. On the other hand, these airports are more likely to be congested. Smaller airports offer passengers a sense of convenience and familiarity; in some regions, smaller airports may be easier to access than larger ones. However, smaller airports may be unable to equally compete on frequency or price with larger airports.

These disadvantages at smaller airports were exacerbated as a result of capacity discipline. As airlines consolidated service at larger hubs, airport connectivity at secondary and tertiary airports in large metro regions decreased. Tables 4.10 and 4.11 show the 2012 connectivity index scores for primary and secondary airports in a variety of multi-airport regions in the United States. The percent change in connectivity from 2007-2012 is also displayed.

Region	Primary Airport	ACQI (2012)	% Δ ACQI 07-12
Boston	BOS	344.57	-5.8%
Chicago	ORD	624.47	-2.7%
Houston	IAH	384.87	-8.7%
Dallas	DFW	457.26	-3.3%
San Francisco	SFO	414.31	22.8%
Los Angeles	LAX	565.59	-3.3%
Phoenix	PHX	350.62	-9.4%

Table 4.10: Changes in primary airport connectivity in selected multi-airport regions

Region	Secondary Airport(s)	Avg. ACQI (2012)	% Δ ACQI 07-12
Boston	MHT, PVD	68.18	-27.2%
Chicago	MDW	173.43	-11.8%
Houston	HOU	95.42	+8.1%
Dallas	DAL	44.53	-5.1%
San Francisco	OAK, SJC	103.41	-29.0%
Los Angeles	BUR, SNA, ONT, LGB	69.03	-13.0%
Phoenix	TUS	74.66	-20.8%

Table 4.11: Changes in secondary airport connectivity in selected multi-airport regions

Tables 4.10 and 4.11 highlight how connectivity in multi-airport regions remains consolidated at primary airports. In each of the seven metro regions featured in the tables, the connectivity score for the primary airport is several times greater than the average connectivity score for the secondary airport(s) in the same region. Additionally, in most regions, the gaps in connectivity between primary and secondary airports have widened. The most extreme example is the San Francisco metropolitan area, in which connectivity at San Francisco International Airport (SFO) increased by 22.8% from 2007-2012. At the same time, connectivity fell by an average of 29.0% at Oakland International Airport (OAK) and Norman Y. Mineta San Jose International Airport (SJC). SFOs connectivity score is now roughly four times higher than the average connectivity score of OAK and SJC.

Much of the decline in connectivity at secondary airports was a result of the actions of Southwest Airlines, a low-cost carrier that was famous for serving alternative gateways in multi-airport regions. However, in a break from its traditional strategy, Southwest cut 10% of their capacity in smaller airports from 2007-2012 and instead began entering larger, primary airports. Secondary airports that had relied almost exclusively on Southwest suffered some of the largest decreases in connectivity. One exception was Houston Hobby Airport (HOU), a secondary airport that is served almost exclusively by Southwest but saw an 8.1% increase in connectivity despite a 2.2% decline in scheduled flights.

Additionally, as network carriers removed flights from smaller airports (and exited some of these airports entirely), ULCCs have quickly entered to provide infrequent service to vacation destinations. As a result, relatively few airports "went dark" completely from 2007-2012; ULCC service helped to provide a minimum level of service, and airport managers began to attract these airlines with incentive packages that waived landing fees and provided gratis advertising, for example. However, ULCC service offers a bare minimum level of connectivity. Small airports that saw network carrier service replaced by ULCC service from 2007-2012 effectively lost their connection to the global air transportation network.

These connectivity trends in multi-airport regions should be worrisome for secondary and tertiary airports. As discussed in Chapter 2, airlines found profitability through capacity discipline and the elimination of unprofitable flying and secondary hubs. Replacing network carrier service with ULCC service does not provide the same level of connectivity for passengers, and smaller airports may struggle in the coming years to provide levels of service necessary to prevent passengers in multi-airport regions from leaking to the larger airports in those regions.

4.6 Sensitivity Analyses and Model Extensions

Since the output of the ACQI model is dependent on the choice of two weighting parameters—the w_h destination quality parameters and the connecting destination weight α—it is important to consider how changes to these parameters will affect the model results. This section discusses sensitivity analyses for each of these parameters, as well as the pros and cons of alternative weighting schemes. We also discuss some model extensions that could improve the explanatory power of the ACQI model in future iterations of the work. However, any extensions to the base ACQI model presented in this section would have to trade-off the value of the enhanced explanatory power of the index with the additional data requirements and complexity that the extension would introduce.

4.6.1 Sensitivity of ACQI rankings to changes in w_h and α

First, we will consider how changing the values of the w_h and α parameters in the ACQI model will affect the model results. In a typical sensitivity analysis, we would investigate how changes in these parameters would affect the "raw" ACQI scores, perhaps for each airport type. However, note that both w_h and α are scalar parameters; that is, an increase in w_h or α will by definition result in an increase in ACQI scores for all airports. Therefore, looking at the changes in raw scores is not particularly useful if we want to examine how sensitive the ACQI score is to shifts in parameters.

Since the ACQI model is best suited for comparisons of connectivity between airports, we will instead investigate how the *rankings* of airports in the ACQI model shift relative to one another in response to changes in parameters. Yet with 462 airports analyzed over 6 years, resulting in over 2,700 individual calculations of ACQI, a broad analysis of changes in ACQI for all airports over all years would be cumbersome and potentially obscure overall trends. Hence, for simplicity, we will investigate how *rankings of the top 30 most-connected airports in 2012* change as a result of changes in the model parameters. That is, how would a increase in α or one or more w_h change the rank order of the most connected U.S. airports?

Δw_h	Large Hub	Medium Hub	Small Hub	Non-hub	Int'l
25% increase	10	4	0	0	4
10% increase	0	2	0	0	2
10% decrease	2	0	0	0	4
25% decrease	10	0	0	0	9

Table 4.12: Sensitivity analysis of w_h: number of airport rank changes among top 30 airports by 2012 ACQI compared to base case w_h weights

Table 4.12 shows how many of the top 30 most-connected U.S. airports changed their overall ranking in 2012 as a result in various changes in each of the w_h model parameters. For instance, a value of 2 in Table 4.12 suggests that two airports swapped positions as a result of the change in model parameters. Changes to the parameters were made one at a time, holding all other parameters equal to the values given in Table 4.1.

Note from Table 4.12 that the ACQI model is fairly robust to changes in destination quality parameters. For instance, a 10% increase in w_h parameters affects the rank order of no more than two airports in the top 30, depending on which hub-type weight is changed. The ranking of airports are affected most by 25% changes in large-hub weights; 10 out of 30 airports change their rank order as a result of such an increase or decrease.

As would be expected, changes in the large-hub and international weighting parameters result in the most changes in the rank order of airports; this is because these two parameters have a much higher value than the others, making them a relatively large portion of each airport's ACQI score. Conversely, even 25% increases or decreases in the weighting parameters for small-hub or non-hub airports result in no changes to airport rankings, since these parameters make up such a small portion of each airport's ACQI score.

Recall that α—the relative value of a connecting destination versus a nonstop destination—was chosen based on the literature on the Quality Service Index (QSI) as commonly used in airline route planning and market share calculation. While literature on QSI is limited, (Jenkins, 2011) suggests that α values of between 0.03 and 0.2 are common. At an absolute maximum, suppose that a connecting destination is no more than half as valuable as a non-stop destination ($\alpha = 0.5$).

Table 4.13 shows the changes in the rank order of the 30 most-connected airports by 2012 ACQI as a result various values of α as compared to the base case of $\alpha = 0.125$.

α	# of Airports Changing Rank Order
0.5	7
0.33	3
0.2	0
0.1	0
0.05	3
0.03	3

Table 4.13: Sensitivity analysis of α: number of airport rank changes among top 30 airports by 2012 ACQI, compared to $\alpha = 0.125$

Note that the ACQI is very robust to even large changes in α. For instance, even if α is increased to 0.5—a four-fold increase over the base value of 0.125—only 7 of the top 30 most-connected airports by 2012 ACQI change their rank order. Smaller changes in α result in minimal changes in the rank order of airports. The relative robustness of the ACQI model to changes in α also suggests that other modifications to the model that would change the definition of connecting destinations (for instance, using time-of-day schedule data to include only connections that fit within minimum connection time rules) would also likely have a small impact on the rank order of airports within ACQI.

Selecting weighting terms for a model like ACQI is more of an art than a science, and as such it is important to consider the sensitivity of model results to changes in parameters. However, the ACQI model has been shown to be fairly robust to even large changes in model weights. This suggests that even if small adjustments needed to be made to the ACQI model in the future to refine the weighting terms, the general trends and rankings described in previous chapters should still hold despite changes to these parameters.

4.6.2 Alternative weighting schemes for international destinations

In the ACQI model, all international destinations are currently weighted equally, with a w_h of 1.0 each. This means that an additional direct flight to London Heathrow (LHR) is weighted as equally valuable as a direct flight to a vacation destination like Nassau, Bahamas (NAS) or to a smaller international city like Saskatoon, Saskatchewan (YXE). This may understate connectivity at larger airports that connect to large international cities and overstate connectivity at small airports with flights to international vacation destinations.

Hence, a more nuanced weighing scheme for international flights might improve the model results. Some possible weighting schemes that would not treat all international destinations equally include the following:

- Important international connecting hubs like LHR could be identified and weighted separately from smaller international destinations. This would create an international "super-hub" category that could be given a higher weight of 1.5, for instance. Alternatively, these super-hubs could be given a weight of 1.0 (the same as domestic large-hubs), and other international destinations could be given a lower weight.

- Canadian airports could be assigned "artificial" U.S. hub type definitions based on their level of enplanements in the previous year and treated as if they were U.S. cities. This would limit the impact of smaller Canadian cities like Saskatoon on airport connectivity compared to the base model, since Saskatoon is arguably closer in scale to a "medium-hub" destination than larger Canadian cities such as Toronto or Montreal.
- Worldwide enplanement data could be used to map all international airports into FAA-style hub types. This would better express the differences in importance of airports like LHR and smaller vacation destinations like NAS.

Each of these alternative international weighting schemes offers some improvements over the simple ACQI model, and several of these proposed alternatives have been implemented in separate model runs that are not included in this chapter. Some of the alternative schemes may have adverse consequences; for instance, treating large Canadian airports like Toronto (YYZ) and Montreal (YUL) as if they were U.S. large hubs ends up overstating the connectivity of some U.S. airports like New York's LaGuardia Airport (LGA) which have frequent service to these Canadian airports, but no service to other worldwide destinations.

4.6.3 Extensions of the ACQI model and resulting impacts on connectivity

The connectivity index described in this chapter is a simple model that aims to capture changes in flights and destinations served over the study period. However, some extensions to the model may allow it to better reflect changes in airport connectivity.

For instance, it may be desirable to expand the model to include connecting opportunities for which the connecting point is an international destination. For instance, consider an itinerary in which a passenger leaving Chicago O'Hare (ORD) connects to Riga, Latvia (RIX) via a direct flight to Frankfurt, Germany (FRA). Since the model currently considers only flights that depart from the United States, RIX would not be included as a possible connecting destination for ORD passengers. Full international schedule data would likely result in an increase in connectivity for larger airports with direct flights to international connecting hubs like FRA, but likely no change in connectivity to smaller airports without such direct service.

The index could also be extended to consider itineraries with multiple connections, but such a model would likely require a temporal component to avoid overstating the number of available connecting destinations. Additionally, the α weight of double-connecting destinations would likely be very small, likely leading to minimal changes in the rank order of airports despite the additional effort necessary to consider these additional itineraries.

Eventually, the ACQI model could be extended using worldwide schedule data to create a global index of air transportation connectivity that is not focused on the United States alone. Such an index would likely be useful to global air transportation policy-making organizations like ICAO or the World Bank. The primary factor holding back this type of analysis is the lack of an attractive worldwide airport ranking system similar to FAA's hub types in the United States. Enplanement data could be used to create an arbitrary weighting classification of airports, but this data is hard to find and verify in some countries. Regardless, such an extension would likely be a useful exercise that could contribute valuable information about changes in the structure of the global air transportation network.

4.7 Conclusions: Future Trends in Small Airport Connectivity in the U.S.

The Airport Connectivity Quality Index (ACQI) developed in this report provides a straightforward way to compare connectivity between multiple airports or at a single airport over a period of time. We explored changes in connectivity at airports of various sizes from 2007-2012. In the aggregate, however, what trends can we extrapolate from the ACQI to anticipate changes in connectivity from 2014 forward?

Capacity discipline does indeed appear to be a dampening force on airport connectivity, particularly for smaller airports. On the whole, small community airports struggled to gain back connectivity since airline capacity discipline started in earnest in 2010, as airlines kept domestic capacity deliberately restricted despite the start of macroeconomic recovery in the country and stability in fuel prices. Barring any significant positive or negative macroeconomic shock, the downward trend in connectivity at small- and medium-size airports will likely continue, but the pace will most likely slow as airlines have already removed most redundant flying from their networks. However, the

American Airlines/US Airways merger could place further downward pressure on connectivity as schedule and route redundancies are removed from the combined airline's new network.

Hence, we expect to see small community airport connectivity to continue to stagnate in the near future. Individual airports may, through clever packages of incentives, continue to induce airlines to provide new service, boosting connectivity on a case-by-case basis. However, only service that can prove itself to be profitable will remain a long-term part of the U.S. air transportation network. Airports that win new service should expect to see their connectivity continue to fluctuate as airlines evaluate the economic merits of the new flights and incentive packages.

5 Evolving Trends in U.S. Domestic Airfares

5.1 Introduction

Economic theory suggests that prices of goods and services may rise as a result of "supply shocks" such as increases in net input prices. As previous chapters have described, the airline industry has met with a number of such "shocks" since 2007, from high and volatile fuel prices (which increased by 57% from 2007-2012, according to the MIT Airline Data Project) to a global economic downturn. Additionally, airlines have pursued conservative capacity strategies in recent years in an attempt to regain profitability, putting further upward pressure on prices. In all, these supply shocks and disciplined capacity management resulted in a 14.3% reduction in scheduled domestic flights in the U.S. from 2007-2012. Theoretically, we would expect airfares to also increase over the same period, adjusting for inflation. The purpose of this chapter is to investigate whether average airfares have indeed increased at U.S. airports from 2007-2012.

In this chapter, we examine airfares for domestic service at various individual airports and airport types, along with trends in airfares at specific airlines. Since there is a relationship between average fare and the length of a given flight, we also examine changes in average passenger itinerary distance at each of 445 U.S. airports. A detailed summary of average fares and passenger itinerary distances for these airports are given in the appendix.

While an analysis of average fares at each airport is a relatively straightforward method for comparing changes over time in the passenger costs of air travel in the United States, it is important to understand some of the limitations to this approach. For instance, virtually all airlines sell seats on a given flight at a variety of different prices. Average fare data does not provide information about the distribution of prices on a given flight and may mask some of these trends. Therefore, average fares shown in this chapter are not an indication of how much passengers should expect to pay for a given flight; prices vary based on seasonality, time-of-day, the time that the ticket is purchased, and many other factors.

The average fares for any given airport in this chapter also reflect prices across a variety of markets for all types of tickets, including first-class and business-class seats. These premium seats which are sold at higher prices are not removed from the average fare calculations. Average fares for travel from an airport include hundreds of different itineraries with varying distances and other characteristics. For instance, we would expect routes with heavy business traffic to have higher average fares than routes with heavy leisure traffic due to differences in passenger mix. These nuances are obscured when examining average fares alone.

Finally, the average fare data given here includes only the base fare and does not include ancillary fees for baggage or other services. Many carriers have started to rely on ancillary fees as a significant portion of their operating revenues, and the impact of these fees on passenger travel costs should not be ignored. However, collected data on ancillary fees is scarce and incomplete; due to these limitations, we examine only average base fares in this chapter.

Despite these caveats, it is still valuable to consider the changes in average fares at an airport, as long as we keep in mind the limitations listed above as well as changes in average stage length or passenger itinerary distance. Specifically, average fares can be helpful to show how prices changed over time at the same airport, or among airports of a similar hub type. In the rest of this chapter, we carefully explore some of the changes in average fares while keeping in mind the inherent limitations to this approach.

5.2 Data & Methodology

As with most studies of airfares in the United States, this chapter uses data from the U.S. Department of Transportation (DOT)'s Bureau of Transportation Statistics (BTS). The BTS' DB1B ticket sample provides a 10% sample of domestic passenger itineraries that were purchased in the relevant time period.[9] Information is provided about the marketing and operating carrier, the number of coupons (individual flight legs) in each itinerary, the origin and destination of the itinerary, whether the itinerary was non-stop or one-way, and the fare paid for the itinerary, among many other characteristics.

The BTS itself tracks airfares closely and regularly releases reports of average airfares at a variety of U.S. airports. These reports are often used in the media to rank the most-expensive airports in

[9]The DB1B sample contains information about all itineraries whose ticket numbers end in '0'.

the United States. The BTS also releases information about airfares for the 1,000 most popular air travel routes in the United States in their Domestic Airline Fares Consumer Report publications.[10] Fares in the Domestic Airline Fares Consumer Reports are aggregated by metro region and not by airport.

Note that the average fares given in this chapter do not match the BTS average airfares for the same period, even though both use BTS DB1B data as the source for their analysis. This is because we employ a different methodology for aggregating average fares than the BTS. For instance, consider two passengers flying from BOS-SFO. Suppose that one passenger purchases a round-trip ticket for $400, and another purchases a one-way ticket for $200. In this case, the average (one-way) fare out of BOS should clearly be $200, since we can divide the round-trip ticket price by two to obtain the average one-way fare.

However, the BTS calculations of average fares do not distinguish between one-way and round-trip fares. In our example, both passengers' itineraries would be treated as equal. That is, using the BTS calculation methodology, the average fare for the BOS-SFO route would be $300 = ($200+$400)/2. The BTS methodology appears to skew the actual airfares and presents an inaccurate picture of airfares at U.S. airports, particularly with the rising popularity of one-way tickets.

As such, the average airfares in this chapter are calculated to control for the differences in one-way and round-trip itineraries. The fare data in this report is sourced from aviation data provider Diio Mi, which also uses DB1B data. The Diio Mi data provides average one-way net fares, adjusting for round-trip itineraries as necessary and removing ticket taxes from the fares reported in the BTS data.

In this analysis, average fares at each airport or for each airline are weighted by the number of passengers that flew each itinerary over the given time period. This data processing method results in a more representative calculation of average fares that can be better used to compare prices across airports or airlines. Passenger-weighted data on average itinerary distances have also been sourced from the BTS DB1B data via Diio Mi.

[10] These reports are available at http://www.dot.gov/policy/aviation-policy/domestic-airline-fares-consumer-report.

5.3 Overview: Average Fares by Airport and Region

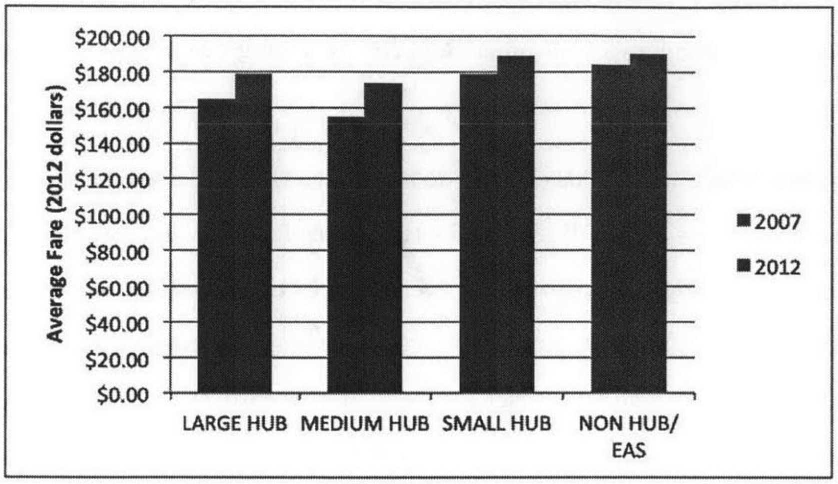

Figure 5.1: Average one-way fares by airport hub type (in 2012 dollars), adjusted for inflation

Figure 5.1 shows the average one-way fares paid (in 2012 dollars) for each FAA airport hub type. Fares have have been adjusted for inflation using the U.S. Bureau of Labor Statistics' Consumer Price Index (CPI) for 2007 and 2012. Average one-way fares in constant dollars increased at each hub type from 2007-2012. Fares at the 29 large-hub airports increased by 8.7% on average during the study period, compared to an 11.9% increase at the 35 medium-hub airports. Small-hub and non-hub airports, as well as airports that were part of the Essential Air Service (EAS) program, saw lower increases in average fares from 2007-2012—average fares at small hubs increased by 5.7% and fares at non-hub and EAS airports rose by 3.2%, adjusting for inflation.

The increases in average fares at each hub type should be put in context by the changes in average passenger itinerary distance over the study period. All things equal, we would expect to see a positive correlation between a longer average passenger itinerary distance and a higher fare; passengers flying cross-country will often pay more than passengers flying shorter trips. Later in this chapter, we will show that this correlation holds when controlling for airline competition and remained relatively unchanged from 2007-2012. As such, if average itinerary distances had increased significantly at each hub type, we could attribute the increases in fares to the longer distances instead of economic supply shocks or capacity discipline.

Hub Type	Avg. One-Way Fare(2007)	Avg. One-Way Fare (2012)	% Change in Avg. Fare (07-12)	% Change in Avg. Distance (07-12)
Large Hub	$164.52	$178.76	8.7%	2.1%
Medium Hub	$155.13	$173.63	11.9%	1.5%
Small Hub	$178.63	$188.83	5.7%	0.9%
Non-hub/EAS	$184.44	$190.34	3.2%	9.8%

Table 5.1: Percent changes in average one-way fare, itinerary distance, and domestic flights, 2007-2012

Table 5.1 summarizes the percentage change in inflation-adjusted average fares, passenger itinerary distance, and number of scheduled domestic flights at each airport hub type from 2007-2012. On average, the changes in passenger itinerary distances were relatively small in comparison to the changes in fares. Therefore, it does not appear that the increases in fares can be attributed to longer itinerary lengths alone.

Airport	2007 Fare (2012 $)	2012 Fare	% Change Avg. Fare	% Change Avg. Distance	% Change Flights
HNL	$173.57	$218.78	+26%	6%	-24.0%
MDW	$113.95	$140.00	+23%	0%	-13.6%
IAH	$185.64	$223.17	+20%	1%	-20.3%
PHL	$156.01	$186.79	+20%	5%	-8.7%
DTW	$154.34	$182.07	+18%	2%	-7.8%
BOS	$179.18	$178.89	0%	3%	-11.5%
DCA	$182.01	$179.41	-1%	5%	+1.7%
DEN	$152.65	$149.65	-2%	-1%	+0.6%
ATL	$170.80	$165.28	-3%	0%	-6.0%
SFO	$207.42	$198.50	-4%	-4%	+20.9%

Table 5.2: Large-hub airports with largest/smallest increase in average one-way fares, 2007-2012

Examining the data at individual airports, some trends emerge that describe which airports saw large increases or decreases in fares. Table 5.2 shows the percentage changes in average fares, itinerary distances, and flights at 10 large-hub airports—five airports with the highest percentage increases in average fares and the five airports with the lowest percentage increases in average fares. The changes in fares for all 445 U.S. airports analyzed in this chapter are available in the appendices.

For large-hub airports, there appears to be a relationship between changes in service and change in fares. Specifically, airports that gained new service from 2007-2012 were more likely to see their average fares drop over that period. DCA, DEN, and SFO are each examples of airports that both gained new service and saw average one-way fares drop. On the other hand, HNL, MDW, IAH, and PHL each saw increases in average fares of at least 20% from 2007-2012. These airports each lost service over the study period.

Airport	2007 Fare (2012 $)	2012 Fare	% Change Avg. Fare	% Change Avg. Distance	% Change Flights
DAL	$97.28	$133.21	37%	22%	-13.5%
HOU	$124.89	$157.94	26%	12%	-2.2%
OGG	$169.90	$214.26	26%	8%	-1.7%
CMH	$144.01	$174.62	21%	-2%	-21.2%
PIT	$144.84	$173.35	20%	4%	-39.7%
OAK	$127.54	$134.90	6%	-12%	-36.6%
PDX	$161.70	$170.07	5%	2%	-15.7%
CVG	$224.62	$224.01	0%	3%	-64.4%
SJU	$185.79	$175.65	-5%	-2%	-3.3%
MKE	$165.36	$153.53	-7%	4%	-36.9%

Table 5.3: Medium-hub airports with largest/smallest increase in average one-way fares, 2007-2012

However, for medium-hub airports, the relationship between losses in service and changes in airfares is much more tenuous. As Table 5.3 shows, some airports like Houston Hobby (HOU) and Kahului, HI (OGG), which had only minimal losses in flights from 2007-2012, each saw average one-way fares increase by 26%. Meanwhile, Cincinnati, OH (CVG), which lost 64.4% of its flights from 2007-2012—the largest loss in the country amongst all large-, medium-, and small-hubs—saw average fares remain essentially unchanged. Milwaukee, WI (MKE), which was one of only two medium-hubs to see fares decrease, lost over a third of its domestic flights over the same period and saw its average passenger itinerary distance increase by 4%.

This suggests that other factors besides changes in average itinerary distance or number of flights help to explain the changes in fares. For instance, note that three of the airports with the largest increases in average fare—Chicago Midway International Airport in Chicago, IL (MDW), Love Field in Dallas, TX (DAL) and William P. Hobby Airport in Houston, TX (HOU)—each have a significant percentage of their flights operated by Southwest Airlines.

Since changes in capacity were relatively low at these airports, a widespread pattern of price increases by Southwest Airlines could explain the increases in average fare at these airports. However, it is important to note that two of these airports saw large increases in average passenger itinerary distance as Southwest expanded the types of markets served from Houston Hobby and Love Field from 2007-2012. Nevertheless, average fares increased by 23% at Chicago Midway despite a negligible change in passenger itinerary distance. This implies that Southwest may have increased average fares across their network from 2007-2012; we will explore this subject in detail later in the chapter.

Additionally, MDW, DAL, and HOU could be each considered "secondary airports" in large metro regions that are also served by a large hub. O'Hare International Airport (ORD) in the Chicago area is one of the busiest airports in the world, Dallas/Fort Worth International Airport (DFW) is the largest airport in the Dallas metro region, and George Bush Intercontinental Airport in Houston (IAH) is a major hub for United Airlines that is also classified as a large hub by the FAA. In each case, a large-hub airport in the metro region saw fares increase by a smaller percentage than the secondary airport(s) in the region.

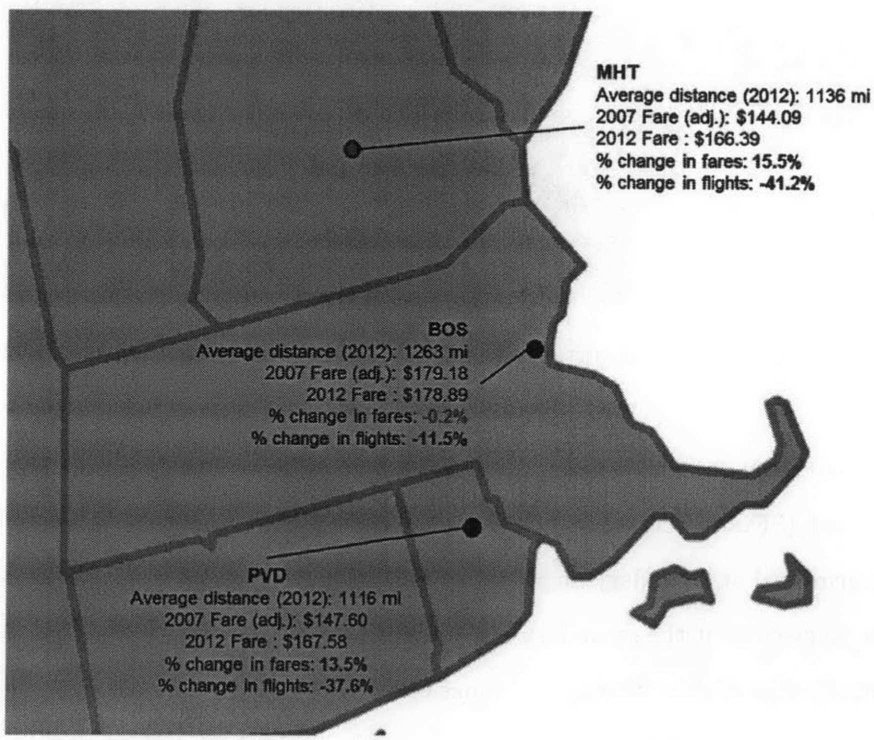

Figure 5.2: Changes in fares at airports in the Boston metro region, 2007-2012

This pattern repeats itself in metro regions throughout the country. Figure 5.2 shows the major airports in the Boston metropolitan region. Besides Boston Logan International Airport (BOS), the Boston metro region is also served by Manchester-Boston Regional Airport (MHT) in Manchester, NH, and T.F. Green Airport (PVD) in Providence, RI. While inflation-adjusted average fares dropped by 0.2% at BOS, fares increased by 15.5% and 13.5% at MHT and PVD, respectively. Thus, as airlines consolidated service at large-hub airports in multi-airport regions, secondary airports experiences not only fewer flights, but also larger increases in average fares. This makes it more challenging for these airports to attract passengers away from large-hub airports, since they are unable to compete on frequency or price.

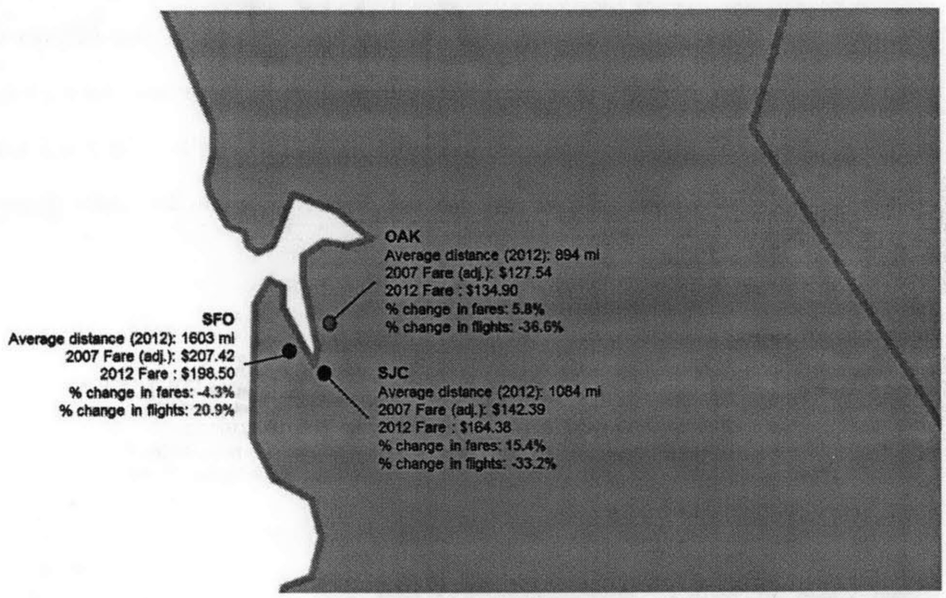

Figure 5.3: Changes in fares at airports in the San Francisco metro region, 2007-2012

Similarly, in the San Francisco metro region, fares at the largest airport in the region, San Francisco International Airport (SFO), decreased by 4.3% from 2007-2012 as shown in Figure 5.3. At the same time, fares increased at secondary airports in Oakland (OAK) and San Jose (SJC). Note that the average fares themselves at the secondary airports in the region are still lower than the fares at SFO. This is partially due to the differences in types of airlines typically serving secondary airports versus large-hub airports (low-cost carriers versus network carriers) as well as the differences in average itinerary distance and the types of itineraries being flown at each airport. Larger airports also are more likely to enplane more business or first-class passengers purchasing more expensive itineraries, which could also explain this difference. Nevertheless, the growing convergence in fares at primary and secondary airports in multi-airport regions is a new phenomenon, driven in part by the growing consolidation of service at larger airports by network carriers and LCCs.

The Los Angeles metro region, which is served by no fewer than five large-hub, medium-hub, and small-hub airports, also exhibits this pattern, as shown in Figure 5.4. While fares at Los Angeles International Airport (LAX) increased by 5.4%, the increase was less than at surrounding airports in Burbank (BUR; +9.0%), Ontario (ONT; +13.3%), and Santa Ana (SNA; +7.1%). The sole exception to this trend was Long Beach Airport (LGB), at which average fares fell by 22%. This airport saw increased service from low-cost carrier JetBlue Airways, helping to explain its competitive position relative to other airports in the Los Angeles area. As we will show later, the presence of JetBlue is one of the most important explanatory factors behind which airports have lower fares than others.

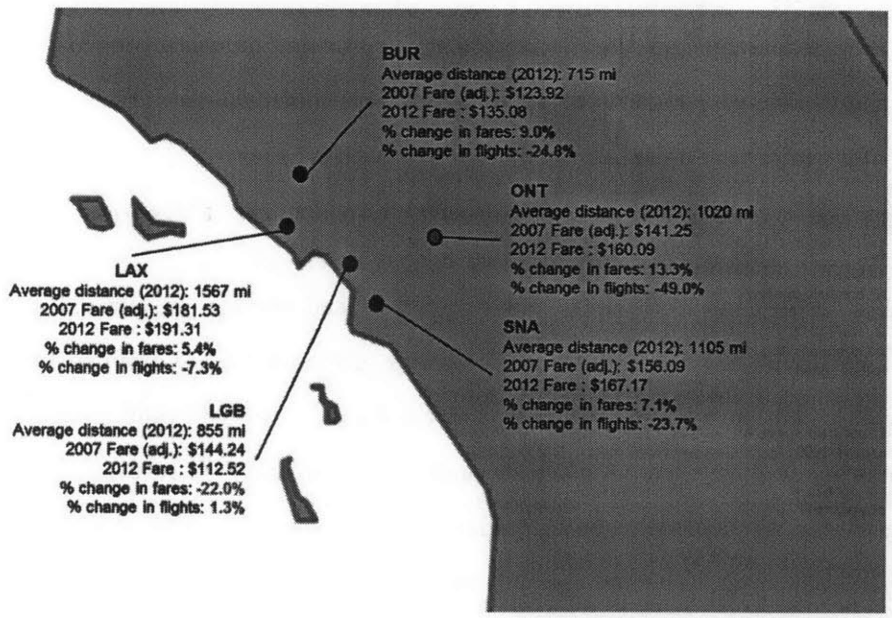

Figure 5.4: Changes in fares at airports in the Los Angeles metro region, 2007-2012

Table 5.4 summarizes the changes in fares at primary and secondary airports in various metro regions in the U.S. from 2007-2012. The table confirms that in many regions, fares increased at secondary airports by a greater percentage than primary airports in multi-airport regions. However, average fares themselves remained lower at secondary airports, due in large part to differences in average itinerary lengths as well as the types of airlines and passengers that fly out of larger airports. For instance, the average itinerary distance at LGB was nearly half that of LAX. This regional analysis also highlights the importance that individual airline behavior can play in determining the average fare at a particular airport. The next section examines in greater detail the trends in airfares at 12 U.S. airlines in an effort to identify which airlines are most closely associated with lower fares.

Region	Primary Airport	Avg. Fare (2012)	% Change in Fare 07-12	Secondary Airport(s)	Avg. Fare (2012)	% Change in Fare 07-12
Boston	BOS	$178.89	0%	MHT, PVD	$166.99	+14%
Chicago	ORD	$175.80	+10%	MDW	$140.00	+23%
Houston	IAH	$223.17	+20%	HOU	$157.94	+26%
Dallas	DFW	$194.65	+9%	DAL	$133.21	+37%
S.F.	SFO	$198.50	-4%	OAK, SJC	$149.64	+11%
L.A.	LAX	$191.31	+5%	BUR, SNA, ONT, LGB	$143.71	+2%
Phoenix	PHX	$159.85	+10%	TUS	$174.17	+9%

Table 5.4: Changes in fares in selected U.S. metro regions, 2007-2012

5.4 Trends in Average Domestic Fares at Major U.S. Carriers

Figure 5.5 shows the changes in average one-way fares[11] and average passenger itinerary distances for 12 U.S. air carriers from 2007-2012. The airlines in Figure 5.5 are grouped by category: the first four airlines (American, Delta, United, and US Airways) are generally classified as "network carriers;" the second four airlines (AirTran, Frontier, JetBlue, and Southwest) are typically referred to as "low-cost carriers;" Alaska and Hawaiian are both specialty carriers with unique network structures clustered around specific regions; and Allegiant and Spirit are two of a new breed of ultra-low-cost carriers that have primarily focused on serving tertiary airports and airports in small communities, offering customers in these communities flights to vacation destinations with very low base fares. We will examine the trends in airfares in each of these groups of carriers separately.

[11] Average fares shown include domestic itineraries only, have been adjusted for inflation using the Consumer Price Index, and are shown in 2012 dollars.

AIRLINE	2007 Avg. Fare*	2012 Avg. Fare	% Change in Avg. Fare	% Change in Avg. Distance*	2012 Avg. Distance*
American Airlines	$181.93	$199.00	9%	2%	1283 mi
DELTA	$186.65	$198.36	6%	-3%	1130 mi
UNITED	$196.62	$216.68	10%	4%	1313 mi
US AIRWAYS	$177.93	$197.60	11%	4%	1067 mi
AirTran	$111.59	$128.81	15%	6%	926 mi
FRONTIER AIRLINES	$142.86	$140.19	-2%	-1%	1117 mi
jetBlue	$144.89	$149.34	3%	-7%	1189 mi
SOUTHWEST	$112.46	$140.87	25%	12%	887 mi
Alaska Airlines	$156.60	$180.63	15%	29%	1250 mi
HAWAIIAN AIRLINES	$138.59	$155.59	12%	-7%	1207 mi
allegiant	$97.21	$86.89	-11%	1%	944 mi
spirit airlines	$105.40	$71.06	-33%	-10%	959 mi

*one-way, adjusted for inflation using CPI

*average passenger itinerary distance

*average passenger itinerary distance

Figure 5.5: Average domestic fares and passenger itinerary distances for 12 major U.S. airlines, 2007-12

5.4.1 Average network carrier fares increased as available capacity and itinerary lengths changed

Due in part to changes in capacity and average passenger itinerary distances, average one-way fares at network carriers rose between 6-11% from 2007-2012. Many of the network carriers struggled financially at times from 2007-2012, with several declaring bankruptcy over the study period. Delta and United both completed mergers with other iconic network carriers; American and US Airways received approval to merge in 2013.

These carriers emerged from this tumultuous period of bankruptcy and mergers with leaner operations and reduced frequencies across their networks. The network carriers continued to keep capacity low as they practiced a disciplined capacity management strategy that emphasizes flying profitable routes over gaining market share. As capacity is reduced, increases in average fares have less of an adverse effect on load factors. This strategy has led the network carriers to post their first consistent profits in nearly a decade. For these reasons, the increases in average fares seen at the network carriers from 2007-2012 can largely be attributed to the effects of capacity discipline strategies and to the differences in these carriers' networks following a round of mergers.

5.4.2 Low-cost carriers are not quite as low-cost for passengers

The types of domestic flights flown by network carriers—a mix of short-haul regional service and long-haul transcontinental options—differ from the service provided by low-cost carriers—a significant portion of which involves travel to leisure destinations. Hence, it is not surprising that the average fares of low-cost carriers have remained at least 25% lower than network carriers. Yet despite this, several of the low-cost carriers saw dramatic increases in their average one-way fares from 2007-2012. Average fares increased at AirTran Airways, which was acquired by Southwest Airlines in 2011, by about 15% from 2007-2012. Southwest Airlines itself saw an increase in average fares of 25% over the same period. Meanwhile, average fares at JetBlue Airways increased by just 3%.

There are several possible explanations for Southwest Airlines' significant increase in average fares. Southwest itself practiced some capacity discipline, particularly in smaller and mid-sized airports. Southwest cut scheduled domestic flights by 10% at smaller airports in the U.S. from 2007-2012; if there is indeed a link between cuts in service and increases in fares (as economic theory would predict), this could explain why some smaller airports dominated by Southwest Airlines, such as Dallas Love Field (DAL) and Houston Hobby (HOU), saw large increases in average fares coupled with deep cuts in service over the study period.

The capacity discipline era has also seen dramatic changes in Southwest's well-established network strategy. In the 1990s and early-2000s, Southwest found a niche in operating point-to-point flights from secondary airports in multi-airport regions, often at lower fares than could be found at primary airports in those regions. However, over this period, Southwest started to move into those same larger airports that it had previously forsaken. Southwest moved into Boston Logan (BOS), New York-LaGuardia (LGA), and Newark Liberty International Airport (EWR) from 2007-2012, and by 2012 the airline served 23 of the 29 largest airports in the United States. Southwest's merger with AirTran Airways will also give the combined airline a larger presence at Hartsfield-Jackson Atlanta International Airport (ATL)—the busiest airport in the United States by passenger enplanements.

Moving into larger airports could have increased Southwest's costs. Larger airports are more likely to be congested, leading to more costs in delays and cancellations. On the other hand, larger airports are more likely to attract business passengers, who often have a higher willingness-to-pay for airline tickets. Either or both of these factors could have given Southwest leverage to raise average fares. Southwest's operating costs may have also increased for other reasons. The advantages from the airline's famous fuel hedge have evaporated with constantly high fuel prices, and the seniority levels of the airline's employees have started to increase, requiring higher pay and retirement benefits. These increases in operating costs could have also led to Southwest's increase in average fares.

Finally, it is worth noting that Southwest, unlike its network carrier competition, does not rely on checked baggage fees as a source of ancillary revenue. It is possible that Southwest raised its base fares to make up for the lost revenue potential of offering free checked baggage. However, JetBlue Airways, which also does not charge fees for checked baggage, had only a modest increase in its average fares.

Whatever the reason for Southwest's increase in average fare, low-cost carriers started to behave more like traditional network carriers in the capacity discipline era. As their brands and their workforces both became more mature, the LCCs entered into larger markets at slightly higher average fares. While the low-cost carriers are not quite as low-cost for passengers any more, we do not expect to see a complete convergence in fares at network carriers and low-cost carriers. LCCs still offer lower fares to passengers in many markets, and we expect that these carriers will continue to maintain unique networks with a heavy focus on leisure travel in the next decade—this alone will continue to keep the average fares at these carriers lower than at the network carriers.

5.4.3 Specialty carriers adjusted fares as their networks changed

Airline analysts often have difficulty classifying Alaska Airlines and Hawaiian Airlines. Both airlines serve a targeted area of the United States that remains relatively unserved by other carriers. Traditionally, Alaska and Hawaiian generally provided a mix of short-haul service linking together small communities and long-haul service connecting the rest of the United States to hubs in Seattle and Honolulu.

However, these airlines—Alaska in particular—started to change their networks. Alaska's average itinerary distance increased by 29% from 2007-2012, reflecting a new commitment to longer-haul service. The airline has bolstered its presence at Seattle-Tacoma International Airport (SEA) while also building new cross-country service. As a result of these longer itinerary distances and stage lengths, Alaska's average one-way fares have increased by 15%. Hawaiian's fares rose by 12% over the study period, but its average itinerary distance fell by 7% as it has cut unprofitable long-haul service to focus more on inter-island and international service. We should expect to see further adjustments in fares from these carriers as their networks continue to change over the next decade.

5.4.4 A new breed of ultra-low-cost carriers is picking up where the traditional LCCs left off

The latter half of the 2000s saw the emergence of a new breed of low-cost airlines with a very different business model than that of the traditional low-cost carriers. These carriers, such as Allegiant Air, Spirit Airlines, Sun Country Airlines, and others, focused on providing infrequent service to tertiary airports in multi-airport regions, or to airports at which there was no currently existing commercial air service. At these airports, the ultra-low-cost carriers stepped in to provide service to vacation destinations at heavily discounted base fares, often packaging a flight with a hotel, rental car, or vacation package. Flights to the smallest airports in these airlines' networks may only be operated a few times per week.

Allegiant Air and Spirit Airlines have been two of the most successful ultra-low-cost carriers. Targeting an exclusively leisure demand segment, we would expect that their average fares to be lower than network carriers or even the existing low-cost carriers, which do serve some business routes. Indeed, average fares at LCCs were nearly twice as high as ULCC fares in 2012; average network carrier fares were nearly three times as high as ULCC fares in the same year. Additionally, while network carriers, LCCs, and specialty carriers alike were all increasing average fares from 2007-2012, fares at ULCCs decreased over the study period by as much as 33%.

While the decreases in base fares at the ULCCs are impressive, it is important to note that these fare decreases occurred at the same time as these carriers started to rely more on ancillary revenues as a significant portion of the full travel price. That is, while the base fare of a ULCC ticket is often very low, passengers may need to pay additional fees to check-in, check bags, access customer service personnel, or even carry-on a bag on some airlines. Hence, looking only at the base fare may present a skewed picture of the total passenger cost on ULCCs if ancillary fees are not taken into account.

Data on ancillary revenues is currently collected and defined inconsistently and not tied to individual itineraries. That is, we currently do not know how much an average Spirit Airlines passenger pays in ancillary services. Adding ancillary fees to average fares would assist in making apples-to-apples comparisons in total passenger itinerary cost between the ULCCs and other airlines. Absent that data, however, we are only able to make comparisons of base fares alone.

The ultra-low-cost carriers have unabashedly targeted extremely price sensitive passengers. Spirit Airlines CEO Ben Baldanza has suggested that these customers are likely to choose his airline repeatedly if it offers the lowest base fare, even if passengers have to pay substantially more in additional ancillary fees (Maxon, 2013). The business model of Spirit is still relatively new and its sustainability remains to be seen, but both Spirit and Allegiant Air have experienced robust financial success, even in challenging periods for airline profitability. However, these airlines' pricing strategies and competitive advantages could be eroded if consumer advocates succeed in passing legislation to require airlines to display full costs of travel—base fares and ancillary fees combined—on popular distribution systems and travel booking websites.

5.5 Determinants of Average Fares at U.S. Airports—the Effects of LCCs

Since the rise of the low-cost and low-fare carriers in the late 1990s and early 2000s, researchers have been interested in identifying the effects of these carriers on average airfares. Most early work focused on the largest and most popular low-cost carrier: Southwest Airlines. Specifically, researchers were interested in investigating whether the presence of low-cost carriers like Southwest Airlines has a dampening effect on the fares on a given route.

Past research on the "Southwest effect" has shown that either direct competition (competition on the same route) or adjacent competition (competition in a city-pair market between alternative airports in a multi-airport region) by Southwest Airlines tends to be associated with an increase in traffic on that route and a decrease in average fare. That is, once Southwest Airlines enters a market directly or adjacently, existing network carriers typically lower their fares to match Southwest's lower prices.[12]

However, with Southwest Airlines' average fares increasing by 25% from 2007 to 2012, it is unclear whether Southwest still holds the same degree of price leadership as it once did. Recent work by bin Salam and McMullen (2013) found that the Southwest effect had weakened between 2005 and 2010 in markets in which mergers had occurred between network carriers, such as United-Continental or Delta-Northwest. That is, the presence of Southwest Airlines on merger-affected routes did less to lower average fares than previous research would have suggested. Since the competitive effects of Southwest on network carrier airfares are often used by merger advocates as an argument in antitrust reviews, bin Salam and McMullen question whether Southwest can still be relied upon as a protection against monopolistic competition on air travel routes.

Meanwhile, the effects of other low-cost carriers like JetBlue Airways and the impacts of ultra-low-cost carriers like Allegiant Air and Spirit Airlines on airfares have not been explored individually in detail. While these airlines have smaller route networks than Southwest Airlines, they are important players in the U.S. air transportation system, particularly at smaller airports. This section investigates whether the presence of these low-cost carriers at U.S. airports reduces average fares at those airports, and how those effects have changed over time. We will also explore the effects of capacity discipline on average airfares, and examine if there is a statistically significant link between changes in capacity and changes in fares.

5.5.1 Econometric model

Following the research approaches of previous work, we will use a simple econometric model to identify the effects of LCC competition on average one-way airfares at U.S. airports. In this case, the econometric model is a linear equation that allows us to isolate the effects of one or more independent variables (e.g., LCC competition and other airport characteristics) on a dependent

[12] Studies investigating the Southwest Effect include Morrison (2001); Vowles (2001); Hofer et al. (2008); Goolsbee and Syverson (2008) and Brueckner et al. (2012).

variable (in this case, the average airfare at an airport). Using statistical techniques, we can test whether the coefficients of this linear equation are significantly different from zero (or not) at a given level of confidence. If an independent variable's coefficient is significantly different from zero, we can conclude that there is a relationship between the independent variable and the dependent variable. Otherwise, no such conclusion can be drawn.

The linear equation used in our econometric model of average airport airfares is shown in Equation 1.

$$FARE = \beta_0+\beta_1 \cdot DIST+\beta_2 \cdot WN+\beta_3 \cdot B6+\beta_4 \cdot FL+\beta_5 \cdot F9+\beta_6 \cdot G4+\beta_7 \cdot NK+\beta_8 \cdot VAC+\epsilon \quad (1)$$

Table 5.5 describes in detail each of the variables in the equation.

Variable	Description
FARE	Avg. fare at the airport
DIST	Avg. itinerary distance
WN	Presence of Southwest
B6	Presence of JetBlue
FL	Presence of AirTran
F9	Presence of Frontier
G4	Presence of Allegiant
NK	Presence of Spirit
VAC	Vacation destination (airports in FL and NV)

Table 5.5: Description of variables in Equation 1

As Table 5.5 describes, we are postulating that the average one-way fare at an airport will be a function of the average itinerary distance at the airport; the number of airlines competing at the airport; the presence of low-cost like Southwest, JetBlue, AirTran, and Frontier; the presence of ultra-low-cost carriers like Allegiant and Spirit; and whether the airport is a vacation destination or not (here, following Hofer et al. (2008), airports in Florida and Nevada are designated as vacation destinations for simplicity). Passenger enplanements are not included in the regression equation since there is a possibility that the number of passengers using an airport could itself be a function of airfares. Equation 1 also contains an error term ϵ, which is a common econometric practice to capture effects that are not directly specified by the model.

Data on average fares, itinerary distances, and airlines providing service were gathered from Diio Mi for 445 U.S. airports for the years 2007 and 2012. We estimated the coefficients of Equation 1 for each of these years, allowing us to see how the effects of Southwest or other low-cost or ultra-low-cost carriers have changed over time. Table 5.6 shows the results of the econometric model for these years.

Variable	(1) 2007 Fares	(2) 2012 Fares
Constant	92.72***	94.58***
	(4.488)	(5.203)
Avg. Itinerary Distance	0.122***	0.122***
	(0.005)	(0.006)
Southwest	-35.78***	-16.65**
	(7.105)	(6.692)
JetBlue	-29.84***	-32.20***
	(7.514)	(7.595)
AirTran	-15.51**	2.04
	(7.033)	(7.353)
Frontier	-2.53	7.14
	(7.517)	(6.522)
Allegiant	-20.47***	-28.52***
	(5.374)	(5.364)
Spirit	-27.48***	-22.10**
	(9.726)	(9.384)
Vacation Dest'n	-3.81	-22.57**
	(9.122)	(9.810)
N	445	445
Adjusted R^2	0.5800	0.5267

Coefficients are presented with standard errors in parentheses.
* = 90% significance, ** = 95% significance, *** = 99% significance

Table 5.6: Regression Results Fares on Distance and Competition

The top number of each row in Table 5.6 is the coefficient for that variable in Equation 1 as estimated using a standard ordinary least-squares (OLS) regression technique. The number in parenthesis beneath each estimated coefficient is the standard error for that coefficient's estimate. The significance of each coefficient (how sure we are that the coefficient is statistically different from zero) is shown using asterisks. A single asterisk indicates that we can be 90% confident that the coefficient is different from zero, two asterisks indicates a confidence level of 95%, and three asterisks indicates a confidence level of 99%. Finally, the adjusted R^2 value is a measure (ranging from 0-1) of how well the variables we selected explain the variations in average fares between airports.

5.5.2 Discussion of regression results: The JetBlue effect?

As expected, the average itinerary distance at an airport has a positive and significant relationship with average airfares; airports from which passengers fly longer distances have generally higher fares. This relationship has remained essentially unchanged over time. It is also interesting to note that while the number of airlines that provide service at a given airport did not have a significant relationship with airfares in 2012, the presence of specific competitors is associated with lower average airfares. The presence of an LCC like Southwest, JetBlue, Allegiant, or Spirit is associated with a decrease in average one-way fare of between $15-$36, depending on the airline and the year and controlling for distance and other airport characteristics.[13] However, the presence of AirTran and Frontier no longer have a significant effect on average one-way fares once other LCC competition is taken into account.

In 2007, the Southwest effect was highly substantial. The presence of Southwest Airlines at an airport in 2007 was associated with a decrease that airport's average fare of about $36, controlling for average itinerary distance and other competition. However, by 2012, that effect had declined to about $17. That is, the presence of Southwest Airlines no longer is associated with as much of a reduction in average airport fares as has been previously shown by other researchers. Indeed, the presence of some other low-cost carriers now outpaces the Southwest effect. In 2012, the presence of JetBlue Airways reduced average one-way airport fares by about $32, Allegiant Air service reduced average one-way airport fares by about $29, and the presence of Spirit reduced average one-way fares by about $22.

JetBlue is now the airline whose presence is associated with the largest decrease in average fares. As such, we would not be surprised to see airports, particularly small community airports or secondary airports in large multi-airport regions, work particularly hard to attract JetBlue service. Gaining

[13] We also tested if an airport's designation as a hub for a network carrier and/or an LCC had an effect on average one-way airfares at that airport; this variable was found to be insignificant in all years and was removed from the model.

service from an airline like JetBlue not only attracts customers through a decrease in average fare, but also through an increase in connectivity and the number of destinations that can be reached through both non-stop and connecting service. As Southwest begins to focus its expansion efforts internationally instead of domestically, we would expect the JetBlue effect to become part of the business development and academic lexicon surrounding low-cost carriers.

On the other hand, the recently diminished nature of the Southwest effect is not surprising given the scale of Southwest's fare increases. It should be noted, however, that Southwest Airlines does not charge fees for checked baggage, as opposed to many of its competitors who charge upwards of $25 for a checked bag.[14] It is possible that Southwest decided to raise base fares in lieu of charging bag fees in an attempt to separate themselves from competing airlines.

On the other end of the spectrum, Allegiant Air and Spirit Airlines have chosen strategies of offering the lowest possible base fare and gaining a large portion of revenue through ancillary sources. While passengers often see only the base fares when selecting which ticket to purchase, the ULCCs are offering a fundamentally different service coupled with their base fare as opposed to the full-service LCCs like Southwest and JetBlue, which offer free checked baggage, on-board amenities, and other features. Therefore, it may not be appropriate to directly compare the Southwest effect with the Spirit effect, given that these two airlines are offering different packages of products and services as part of their base fares.

5.5.3 Capacity discipline and changes in airfares

Economic theory suggests that restrictions in supply will result in higher prices. Capacity discipline strategies on the part of the airlines have restricted the number of available flights and seats in most markets. However, is there a direct correlation between capacity discipline and higher airfares? In other words, is there a negative correlation between percent changes in flights and seats and percent changes in fares? We can test the answer to this question by performing a Pearson's correlation test on percent changes in flights, seats, and airfares (from 2007-2012) for the 445 airports in our sample.

[14]As of July 2013, Southwest Airlines offered two free checked bags, JetBlue Airways offered one free checked bag, and Allegiant Air and Spirit Airlines both charged for checked baggage.

Variable	Correlation	p-value	R^2
% change in flights	-0.1988	<0.001	0.0373
% change in seats	-0.1488	<0.001	0.0199

Table 5.7: Correlation coefficients: % change in fares and % change in capacity, 2007-2012

Table 5.7 shows the Pearson's correlation coefficients for percent changes in fares and percent changes in capacity at 445 U.S. airports from 2007-2012. The correlation coefficient ranges between -1 and 1; a value of -1 suggests that the variables are perfectly negatively correlated; a value of 1 suggests that the variables are perfectly positively correlated; and a value of 0 suggests the variables are uncorrelated. The p-value tells us how certain we can be that the given correlation coefficient is statistically different from 0—in this case, we can be 99.9% sure that the coefficients are different from zero. Finally, as before, the R^2 value tells us how well the percent change in capacity explains the variations in percent changes in fares.

As expected, there is a negative correlation between percent changes in capacity and percent changes in fares. This means that as capacity increases, fares generally fall; conversely, decreases in capacity are associated with increases in fares. This suggests that the theoretical relationship between capacity discipline and fare increases does indeed exist in practice. However, it should be noted that the explanatory power of capacity discipline alone is very low—the R^2 values are very low, and the correlation coefficients themselves are fairly close to zero. Thus, other factors, such as the presence of low-cost carriers or changes in the average passenger itinerary distance at an airport, should also be included in any model that attempts to explaining changes in fares as a result of capacity discipline.

5.6 Conclusion: Future Changes in Airfares in an Environment of Capacity Discipline

There is no evidence that the current airline strategy of capacity discipline will be reversed in the near future. Airlines are experiencing profitability for the first time in years, and the equilibrium in which each of the largest airlines continues to keep capacity low (compared to historical levels and growth in GDP) seems to be stable in the short run. In the long run, an airline could deviate from the capacity discipline equilibrium in an attempt to gain market share—this theoretical increase of capacity would likely be associated with lower fares, particularly if other airlines match this strategy. Meanwhile, we should expect JetBlue Airways and the ultra-low-cost carriers to continue their pattern of steady growth.

If the levels of available domestic capacity follow the trends described above, we would expect average one-way domestic airfares to remain flat or increase slightly over the next five years, assuming that there is no shock to the price of fuel or another local or global economic downturn. In this scenario, major airlines would keep capacity at current levels (without cutting it further), and base fares would remain level as airlines continue their shift to ancillary revenues to bolster earnings. The growth of JetBlue and the other ULCCs could result in even lower average fares at airports served by these airlines.

The merger of American Airlines and US Airways will bring about further consolidation of the U.S. air transportation industry and could result in some capacity being removed from the system. As economic theory and our analysis suggests, a reduction in available capacity could result in higher fares in some markets. Our work and the work of others suggest that it is unclear whether low-cost carrier competition will temper the upward pressures of capacity discipline and mergers on prices; the Southwest effect has diminished in past years, although the effects of carriers like JetBlue, Allegiant, and Spirit on average one-way fares at U.S. airports remain strong.

At smaller airports and secondary airports in multi-airport regions, increases or decreases in average airfares will likely continue to outpace the changes at larger airports. These airports will face increasing pressure to obtain service from low-cost or ultra-low-cost carriersas network carriers continue to exit smaller airports, those airports that have not implemented a contingency plan to replace this service with LCC or ULCC flights could see average fares rise as daily departures fall. This is a challenging combination for a smaller airport, as passengers will often choose to fly out of a nearby larger airport to take advantage of lower fares and more flight options, even if this means a significant drive from the passenger's origin point. We have already started to see this pattern take hold in some metro areas at which average fares increased substantially more at secondary airports than at primary airports.

Finally, the total system impact of this continued consolidation of flights and connectivity at large hubs, coupled with a growing convergence in fares between primary and secondary airports, will be important to monitor. Risks of congestion and flight delays increase as passengers and departures cluster at larger airports. If current trends of consolidation continue and result in future growth in traffic at large-hub airports, improved air traffic management approaches may be necessary to avoid costly periods of increased delays in the National Airspace System.

6 Conclusion: The Future of Capacity Discipline

This thesis has examined the impacts that U.S. airline capacity discipline has had on available domestic service, airport connectivity, and fares at U.S. airports from 2007-2012. In this concluding chapter, we will briefly review some of the key results from the analyses and models introduced in previous chapters. We will also explore the U.S. government reaction to capacity discipline—specifically during the U.S. Department of Justice (DOJ) challenge of the proposed American Airlines/US Airways merger in 2013. Finally, with reference to the game theoretic model of capacity discipline discussed in Chapter 2, we summarize how capacity discipline might evolve as a competitive equilibrium from 2014 forward and discuss some possible future extensions to the analyses conducted in this thesis.

6.1 Summary of Key Results

In previous chapters, we examined the effects of "capacity discipline"—an airline strategy to restrict in growth in U.S. domestic capacity—from the years 2007-2012. We found that most airports lost service during this period as a result of an economic downturn that affected demand for air transportation, high and volatile fuel prices that changed the economics of operating some of the smaller aircraft that had typically served smaller communities, and a realization on the part of airlines that cutting unprofitable or redundant service would be a path to profitability after a decade of frequent bankruptcies and turbulent economic conditions. In all, 14.3% of scheduled domestic flights were cut from 2007-2012.

Smaller airports were more affected by airline capacity discipline than large airports. The 29 busiest airports in the United States (the FAA "large-hubs") lost 8.8% of their scheduled service from 2007-2012, as compared to a 21.3% reduction in service at all smaller airports in the U.S. over the same period. In particular, mid-sized "medium-hub" airports were the most affected by capacity discipline. These airports lost 26.2% of their scheduled service from 2007-2012 as airlines—particularly Southwest Airlines, which had provided a significant portion of the service in these mid-sized markets—refocused their capacity to larger airports. In multi-airport regions, secondary airports struggled to compete with primary airports on frequency and price. Many of these smaller airports saw their passenger numbers fall substantially, even after the U.S. recession had ended.

We also developed a model—the Airport Connectivity Quality Index (ACQI)—to examine how airports' level of connectivity to the global air transportation network changed during the capacity discipline era. The ACQI model evaluates network connectivity based on the quantity and quality of available nonstop and connecting service at each airport. We again found that smaller airports were affected the most by capacity discipline, as these airports lost a larger percentage of their connectivity than large-hub airports from 2007-2012. Some former connecting hubs, like Cincinnati/Northern Kentucky International Airport (CVG), which was de-hubbed by Delta following their merger with Northwest Airlines, saw a significant reduction in both available service and connectivity. Other smaller, "secondary hubs" in the U.S. run the risk of similar losses in connectivity as airlines rationalize their networks and remove redundant or unprofitable service.

Finally, we examined how domestic airfares changed as a result of these capacity strategies from 2007-2012. We would expect from basic economic theory that prices would increase as airlines restricted the supply of seats and flights, assuming that demand for air transportation remained relatively unchanged. Indeed, we found that average airfares rose at most U.S. airports during the study period, with the largest increases occurring again at the medium-sized airports. Additionally, Southwest Airlines, which has often been cited as a low-fare carrier that could provide significant downward pressure on the average fare in a market, increased averaged fares by 25% from 2007-2012 as the airline restructured their network in the face of rising costs. JetBlue Airways is now the carrier whose presence at an airport results in the largest reduction in average fare at that airport, although its effect on prices in 2012 was lower than the previous "Southwest Effect" in 2007.

At first glance, capacity discipline appears to be an unstable equilibrium: if an airline knows that its competitors will be keeping their levels of capacity low, that airline could rationally decide to increase their capacity to gain market share over their competitors. When all carriers follow the same rational behavior, we arrive at an equilibrium in which there is too much capacity introduced into the system, leading to lower levels of profitability for all airlines. This is a classic "prisoner's dilemma" construct, in which the decisions of non-cooperative actors following their best responses to their competitors leads to a suboptimal equilibrium.

However, we discussed that in a repeated-game construct, capacity discipline can emerge as a stable equilibrium if the airlines significantly value payoffs from future rounds of the game. In this model, capacity discipline would remain the equilibrium until it is broken by one airline, at which point the equilibrium would collapse and the prisoner's dilemma result would be reached. In the midst of several consecutive years of profitability, airlines have been signaling to their competitors through press releases and scheduling decisions that capacity discipline remains in effect. Yet if airlines proclaim the benefits of capacity discipline too loudly, they risk drawing the attention of regulators. This was the case during the 2013 proposed merger between American Airlines and US Airways.

6.2 Government Reaction to Capacity Discipline

Since deregulation, the government—particularly the Department of Justice and the Department of Transportation—have paid close attention to the competitive balance of the U.S. airline industry and the effects of industry trends on airline passengers. Coming on the heels of the approved mergers of Delta/Northwest, United/Continental, and Southwest/AirTran, the proposed merger in 2013 of American Airlines and US Airways drew an unprecedented government response. Congressional hearings were held in the lead-up to the merger, in which the sustainability of small community air service was often highlighted as a primary factor to be considered in the decision to approve or challenge the merger. Subsequent governmental reviews then focused specifically on capacity discipline as a competitive force that could continue to negatively affect passenger service, particularly in smaller communities.

At the request of Congress, the Government Accountability Office released in June 2013 a report detailing some of the competitive impacts of the potential merger between American and US Airways. In the report, the GAO notes that the competitive response of incumbent carriers to a removal of capacity has changed:

> Previously, we reported that although one airline may reduce capacity or leave the market, capacity returns relatively quickly through new airline entry and the expansion of the remaining airlines. However, in recent years this dynamic may be changing.

The GAO report also acknowledges the loss in redundant service described in Chapter 4 as a result of airline mergers:

> Given recent economic pressures, particularly increased fuel costs, the opportunity to lower costs by reducing redundant capacity may be especially appealing to airlines seeking to merge. (Government Accountability Office, 2013)

Using a broad methodology to compute the market overlap between American Airlines and US Airways, the GAO report identifies 13,963 airport-pairs that would effectively lose a competitor as a result of the proposed merger. The report cautions that the merged carrier "could be expected to rationalize its network over time," and that future capacity cuts—particularly in smaller communities—would likely be imminent as a result of approving the merger. (Government Accountability Office, 2013)

Despite Congressional hearings that were generally quite friendly to the merging airlines, on the heels of the Government Accountability Office (2013) report, the Department of Justice (DOJ) moved in August 2013 to block the American/US Airways merger. In their legal complaint, which was cosigned by six states (including American Airlines' home state of Texas) and the District of Columbia, the Department of Justice cited "increased industry-wide 'capacity discipline,' resulting in higher fares and less service" as a primary motivation behind its merger challenge. In the text of the complaint, the DOJ reviews some of the trends we discussed in previous chapters of this thesis:

> Legacy airlines have taken advantage of increasing consolidation to exercise "capacity discipline." "Capacity discipline" has meant restraining growth or reducing established service. The planned merger would be a further step in that industry-wide effort. (U.S. Department of Justice, 2013)

Through the merger challenge, much attention was also paid to the competitive position at Reagan National Airport (DCA), a slot controlled airport in Washington, DC. Regulators were concerned that a merged carrier would control over two-thirds of the slots at DCA, creating an indominable barrier to entry at DCA leading to increased fares. American and US Airways countered that if any of their slots at DCA were "divested" (i.e., auctioned off to low-cost carriers), DCA's status as a connecting hub to small communities would be harmed, as the low-cost carriers would use those slots to serve only larger markets. Members of Congress also became concerned that a slot divestiture could reduce or eliminate service from their home districts to the nation's capital (Naylor, 2013).

Ultimately, however, it was the promise of slot divestitures that caused the Department of Justice to drop their suit against the American/US Airways merger. The combined carrier agreed to divest slots at DCA and New York's LaGuardia airport, as well as divest gate facilities at five other busy U.S. airports that are not slot controlled (Nicas and Kendall, 2013). The combined carrier continued to warn that the divestitures would hurt small community service to the key markets of New York and Washington, DC. Most of the divested slots at these airports were won at auction by LCCs Southwest and JetBlue. It remains to be seen how these airlines will use these slots, but the combined American Airlines quickly announced that as a result of the divestitures, the airline will cease service from DCA to 15 small communities, including Fayetteville, NC; Omaha, NE; Pensacola, FL; and Augusta, GA (Koenig, 2014).

The regulatory response to the proposed American Airlines/US Airways merger highlights that the government is paying attention to the industry trend of capacity discipline and the associated impacts on airline passengers. While the merger was ultimately allowed to proceed, openly citing capacity discipline strategies as a key to profitability now poses a higher risk of attracting government oversight. Instead, airlines will likely continue to reduce service in unprofitable markets while signaling to other carriers through press releases and future schedules that capacity levels will continue to remain low.

6.3 Future Evolution of Capacity Discipline

U.S. airlines have not shown any sign of deviating from the capacity discipline equilibrium in the short term. Airlines have continued to cut redundant service and remove unprofitable hubs. In 2013, Delta Air Lines announced that they would be ending hub service at Memphis International Airport (MEM), and United Airlines said it would cut 70% of its hub service from Cleveland Hopkins International Airport (CLE) in 2014. Some point-to-point service that was originally served by the incumbent carriers has indeed been reinstated by new entrants; for instance, Southwest Airlines quickly entered MEM to provide new service after Delta's departures, whereas Delta itself announced new service from CLE to Raleigh-Durham (RDU) and Indianapolis (IND) to replace previously existing United service (Grant, 2014).

Yet the scope of the new entry following the exit of a previous hub carrier is not likely to fully replicate the connectivity that airports like MEM and CLE had when they served as hubs in an airline network. Memphis and Cleveland will now join a collection of cities that have lost significant levels of service as a result of capacity discipline. These new announcements show that even in the midst of government scrutiny of capacity cutting through the American Airlines/US Airways merger, airlines are still not hesitant to remove significant amounts of service from unprofitable airports.

Additionally, the full effects of the American Airlines/US Airways merger on that combined carrier's network still remain to be seen. The combined carrier already announced cuts in service to smaller communities as a result of the slot divestitures required as part of the airline's merger. However, once the networks of the two carriers are fully combined, the airline may decide to further cut service to take advantage of overlaps in the combined route network. Some existing US Airways hubs, such as Philadelphia (PHL) and Phoenix (PHX), could be targets for future cuts in service following the carrier's combined operations. It will be safe to assume that government regulators will be watching these markets closely as well to see if the combined carrier will live up to the promises it made during the merger hearings to retain all of its current hubs.

Therefore, we can expect to see capacity discipline continue to impact the U.S. domestic aviation industry over the short- and medium-term. Depending on the robustness of economic growth in the U.S., an airline may eventually decide to cash in on the short-term benefits from increasing capacity. This could break the capacity discipline equilibrium if other carriers decide to follow suit. We will also need to closely watch the behavior of growing low-cost carriers like JetBlue to see if their growth will trigger a competitive response from the legacy carriers. However, it does not appear that these types of capacity games will take place in 2014, and it could be several years before capacity growth rebounds to the level that would have been expected in past decades.

6.4 Future Work

There are several avenues of future research that could be conducted to examine the extent of capacity discipline's effects on the domestic airline industry. First, the trend analyses in Chapters 2 and 3 of this thesis could be updated with recent schedule data as that data becomes available. A preliminary analysis of 2013 schedule data suggests that capacity discipline remained in full force in that year, but it would be worthwhile to complete a full analysis of 2013 and 2014 schedule data to identify the airports that are most affected by these competitive strategies. An analysis of the relationships between restricted capacity growth and new FAA regulations regarding pilot qualifications and work hours would also be a timely and important contribution to the literature.

Additionally, the connectivity model introduced in Chapter 4 could be extended to a model of regional accessibility to air transportation. For instance, airports could be grouped into geographic regions, and connectivity scores could be summed or aggregated across airports within each geographic region to compute a regional accessibility score. One possible level of geographic aggregation could be the U.S. Census Bureau Primary Statistical Areas (PSAs), a land cover that encompasses many metropolitan areas in the U.S. in which passengers have multiple choices of originating airports. Such an accessibility index would be useful to regional governmental officials and economists who could investigate the links between high-accessibility areas and a panel of economic and demographic characteristics for each region.

Finally, the fares regressions completed in Chapter 5 could be conducted in more detail using a less-aggregated dataset. An itinerary-level set of passenger fare data would likely provide a more robust picture of how the effects of airlines like Southwest and JetBlue have changed throughout the capacity discipline period. Work by bin Salam and McMullen (2013) on the evolution of the Southwest Effect is a good example of some of the interesting conclusions that can be drawn from a disaggregate fare database.

In any case, the airline industry, the U.S. government, policymakers, regulators, local officials, and the traveling public deserve to remain better informed of the changes in airline capacity strategies that have been introduced in this thesis as "capacity discipline." A full understanding of the strategic decisions of U.S. airlines will allow airports and other stakeholders to fully understand their roles in the complex U.S. air transportation network and how these roles will continue to evolve over time in an era of airline consolidation.

7 Appendix A: Data for Large-Hub Airports

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
ATL	444,291	417,559	-6.0%	643.05	606.93	-5.6%	$170.80	$165.28	-3.2%
BOS	162,228	143,526	-11.5%	365.67	344.57	-5.8%	$179.18	$178.89	-0.2%
BWI	117,797	114,371	-2.9%	224.83	216.69	-3.6%	$133.59	$155.00	16.0%
CLT	222,248	243,814	9.7%	305.76	337.40	10.3%	$174.35	$187.19	7.4%
DCA	135,446	137,761	1.7%	268.86	265.57	-1.2%	$182.01	$179.41	-1.4%
DEN	284,769	286,387	0.6%	424.71	412.48	-2.9%	$152.65	$149.65	-2.0%
DFW	307,489	288,002	-6.3%	472.66	457.26	-3.3%	$177.85	$194.65	9.4%
DTW	210,168	193,833	-7.8%	339.38	313.14	-7.7%	$154.34	$182.07	18.0%
EWR	163,463	148,082	-9.4%	396.77	395.82	-0.2%	$188.71	$208.77	10.6%
FLL	89,185	82,226	-7.8%	281.73	250.11	-11.2%	$136.91	$141.98	3.7%
HNL	86,377	65,684	-24.0%	107.91	105.30	-2.4%	$173.57	$218.78	26.0%
IAD	138,590	111,537	-19.5%	284.66	248.91	-12.6%	$190.02	$220.24	15.9%
IAH	242,654	193,456	-20.3%	420.86	384.87	-8.6%	$185.64	$223.17	20.2%
JFK	148,383	120,595	-18.7%	433.22	428.01	-1.2%	$184.76	$196.27	6.2%
LAS	197,254	160,027	-18.9%	388.83	327.59	-15.7%	$140.80	$149.44	6.1%
LAX	249,173	231,014	-7.3%	584.96	565.59	-3.3%	$181.53	$191.31	5.4%
LGA	187,947	171,585	-8.7%	353.71	371.19	4.9%	$159.98	$165.53	3.5%
MCO	155,754	126,347	-18.9%	318.33	286.36	-10.0%	$135.06	$145.63	7.8%
MDW	106,098	91,681	-13.6%	196.58	173.43	-11.8%	$113.95	$140.00	22.9%
MIA	80,157	81,031	1.1%	351.51	364.83	3.8%	$169.91	$180.64	6.3%
MSP	194,875	182,125	-6.5%	313.45	311.08	-0.8%	$182.70	$196.98	7.8%
ORD	413,665	383,248	-7.4%	641.99	624.47	-2.7%	$159.33	$175.80	10.3%
PHL	205,271	187,445	-8.7%	343.48	341.12	-0.7%	$156.01	$186.79	19.7%
PHX	216,095	185,855	-14.0%	387.08	350.62	-9.4%	$145.62	$159.85	9.8%
SAN	98,836	79,272	-19.8%	226.17	201.15	-11.1%	$157.42	$171.33	8.8%
SEA	149,611	133,169	-11.0%	271.79	258.87	-4.8%	$176.05	$184.20	4.6%

Appendix A: Large-Hubs (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
SFO	142,733	172,568	20.9%	337.47	414.31	22.8%	$207.42	$198.50	-4.3%
SLC	149,623	115,579	-22.8%	216.91	192.41	-11.3%	$166.56	$183.31	10.1%
TPA	98,212	74,351	-24.3%	205.68	167.87	-18.4%	$134.20	$153.42	14.3%

8 Appendix B: Data for Medium-Hub Airports

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
ABQ	46,537	34,485	-25.9%	112.21	91.74	-18.2%	$153.98	$164.88	7.1%
ANC	47,575	42,019	-11.7%	53.16	43.79	-17.6%	$238.61	$259.62	8.8%
AUS	54,166	48,434	-10.6%	121.47	130.26	7.2%	$164.65	$178.07	8.2%
BDL	42,327	32,146	-24.1%	122.98	107.21	-12.8%	$176.59	$191.00	8.2%
BNA	70,179	64,468	-8.1%	174.46	166.58	-4.5%	$145.67	$171.66	17.8%
BUF	38,413	34,990	-8.9%	116.64	111.75	-4.2%	$131.84	$153.44	16.4%
BUR	34,515	25,963	-24.8%	75.82	60.18	-20.6%	$123.92	$135.08	9.0%
CLE	107,290	79,574	-25.8%	213.02	176.04	-17.4%	$165.64	$195.29	17.9%
CMH	60,179	47,405	-21.2%	166.12	144.61	-12.9%	$144.01	$174.62	21.2%
CVG	151,468	53,970	-64.4%	217.89	146.84	-32.6%	$224.62	$224.01	-0.3%
DAL	54,699	47,294	-13.5%	46.94	44.53	-5.1%	$97.28	$133.21	36.9%
HOU	57,341	56,103	-2.2%	88.29	95.42	8.1%	$124.89	$157.94	26.5%
IND	62,539	49,641	-20.6%	168.30	150.26	-10.7%	$155.97	$183.71	17.8%
JAX	41,619	30,863	-25.8%	117.89	99.25	-15.8%	$148.53	$174.55	17.5%
MCI	87,976	61,421	-30.2%	183.61	157.73	-14.1%	$143.44	$162.97	13.6%
MEM	98,097	58,263	-40.6%	152.79	116.69	-23.6%	$198.39	$223.17	12.5%
MKE	76,321	48,171	-36.9%	148.95	134.88	-9.4%	$165.36	$153.53	-7.2%
MSY	41,843	43,723	4.5%	112.27	123.74	10.2%	$160.10	$179.83	12.3%
OAK	77,765	49,283	-36.6%	173.15	97.99	-43.4%	$127.54	$134.90	5.8%
OGG	37,215	36,590	-1.7%	85.70	71.29	-16.8%	$169.90	$214.26	26.1%
OMA	33,186	27,007	-18.6%	98.61	88.85	-9.9%	$157.93	$175.84	11.3%
ONT	43,735	22,290	-49.0%	94.21	62.14	-34.0%	$141.25	$160.09	13.3%
PBI	32,106	24,174	-24.7%	108.77	81.41	-25.2%	$143.50	$162.38	13.2%
PDX	92,391	77,887	-15.7%	185.39	164.04	-11.5%	$161.70	$170.07	5.2%
PIT	85,613	51,627	-39.7%	190.40	155.83	-18.2%	$144.84	$173.35	19.7%
PVD	36,583	22,832	-37.6%	107.33	76.15	-29.1%	$147.60	$167.58	13.5%

Appendix B: Medium-Hubs (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
RDU	80,351	61,658	-23.3%	210.40	180.19	-14.4%	$147.92	$163.68	10.7%
RNO	29,899	20,532	-31.3%	86.92	67.05	-22.9%	$138.91	$162.37	16.9%
RSW	37,208	31,465	-15.4%	106.66	93.62	-12.2%	$139.29	$161.52	16.0%
SAT	48,322	41,740	-13.6%	116.37	121.66	4.5%	$166.58	$179.34	7.7%
SJC	63,551	42,471	-33.2%	155.27	108.82	-29.9%	$142.39	$164.38	15.4%
SJU	44,319	42,870	-3.3%	155.48	139.35	-10.4%	$185.79	$175.65	-5.5%
SMF	60,860	46,131	-24.2%	140.28	117.92	-15.9%	$140.23	$163.19	16.4%
SNA	52,906	40,384	-23.7%	131.90	115.30	-12.6%	$156.09	$167.17	7.1%
STL	114,870	83,605	-27.2%	231.97	184.33	-20.5%	$154.62	$164.57	6.4%

9 Appendix C: Data for Small-Hub Airports

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
ABE	10,933	8,150	-25.5%	43.06	38.39	-10.9%	$176.93	$186.42	5.4%
ACY	4,616	4,406	-4.5%	24.82	14.44	-41.8%	$105.65	$62.05	-41.3%
ALB	26,123	21,522	-17.6%	85.90	71.15	-17.2%	$166.12	$194.50	17.1%
AMA	9,061	7,370	-18.7%	30.02	29.39	-2.1%	$138.21	$175.04	26.6%
AZA	209	4,883	2236.4%	0.31	7.86	2447.3%	N/A	N/A	N/A
BGR	6,431	4,431	-31.1%	35.80	21.26	-40.6%	$230.61	$217.22	-5.8%
BHM	27,052	22,248	-17.8%	79.54	70.67	-11.2%	$163.52	$181.49	11.0%
BIL	10,718	9,146	-14.7%	29.99	26.47	-11.8%	$199.46	$190.85	-4.3%
BLI	4,134	4,976	20.4%	15.34	16.59	8.1%	$149.87	$124.24	-17.1%
BOI	29,062	17,476	-39.9%	71.99	49.40	-31.4%	$144.18	$175.59	21.8%
BTR	12,040	9,817	-18.5%	48.13	43.14	-10.4%	$202.67	$208.47	2.9%
BTV	15,380	11,625	-24.4%	60.91	49.50	-18.7%	$178.90	$198.84	11.1%
BZN	7,132	6,509	-8.7%	35.64	35.90	0.7%	$228.65	$201.99	-11.7%
CAE	16,569	11,977	-27.7%	63.02	53.64	-14.9%	$224.05	$229.13	2.3%
CAK	12,962	12,426	-4.1%	48.99	48.04	-2.0%	$138.19	$154.00	11.4%
CHS	21,643	20,802	-3.9%	76.89	79.15	2.9%	$185.53	$190.55	2.7%
CID	13,983	11,601	-17.0%	52.81	49.63	-6.0%	$197.41	$205.31	4.0%
COS	17,951	13,657	-23.9%	66.56	56.16	-15.6%	$181.07	$177.94	-1.7%
DAY	28,094	22,054	-21.5%	88.88	79.21	-10.9%	$161.53	$171.22	6.0%
DSM	22,279	17,436	-21.7%	69.98	64.92	-7.2%	$197.16	$194.88	-1.2%
ECP	-	5,784	N/A	0.00	25.76	N/A	N/A	N/A	N/A
ELP	23,142	20,667	-10.7%	64.64	63.33	-2.0%	$163.69	$191.85	17.2%
EUG	10,007	7,995	-20.1%	30.52	23.04	-24.5%	$184.04	$171.58	-6.8%
FAI	15,061	14,792	-1.8%	14.25	14.31	0.5%	$245.15	$265.91	8.5%
FAT	17,070	12,780	-25.1%	58.25	47.92	-17.7%	$197.38	$196.83	-0.3%
FNT	10,367	6,830	-34.1%	40.40	31.07	-23.1%	$136.95	$166.47	21.6%

Appendix C: Small-Hubs (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
FSD	7,664	7,963	3.9%	36.94	38.44	4.1%	$211.75	$194.59	-8.1%
GEG	24,097	17,713	-26.5%	62.49	50.36	-19.4%	$143.71	$166.80	16.1%
GPT	8,330	6,287	-24.5%	38.54	33.66	-12.7%	$176.82	$220.42	24.7%
GRR	19,742	18,032	-8.7%	64.47	64.99	0.8%	$190.77	$198.97	4.3%
GSO	25,739	18,645	-27.6%	87.55	73.83	-15.7%	$178.72	$181.34	1.5%
GSP	20,892	17,858	-14.5%	71.18	65.12	-8.5%	$205.33	$176.15	-14.2%
GUM	3,235	3,090	-4.5%	25.45	28.19	10.8%	$639.57	$606.27	-5.2%
HPN	20,368	17,848	-12.4%	70.35	58.45	-16.9%	$156.06	$174.17	11.6%
HSV	14,324	11,811	-17.5%	53.82	51.29	-4.7%	$230.64	$226.83	-1.7%
ICT	16,366	12,107	-26.0%	61.98	51.48	-16.9%	$193.02	$188.10	-2.5%
ILM	7,458	7,665	2.8%	35.68	35.57	-0.3%	$178.02	$186.51	4.8%
ISP	14,784	7,930	-46.4%	52.42	27.74	-47.1%	$112.12	$141.22	26.0%
ITO	11,605	7,270	-37.4%	27.93	26.27	-6.0%	$68.42	$111.70	63.2%
JAN	14,628	11,717	-19.9%	54.61	45.61	-16.5%	$176.99	$203.25	14.8%
KOA	20,666	19,086	-7.6%	55.91	48.42	-13.4%	$156.51	$205.84	31.5%
LBB	9,554	7,935	-16.9%	29.81	28.59	-4.1%	$128.67	$169.09	31.4%
LEX	14,348	11,692	-18.5%	54.21	49.30	-9.1%	$200.20	$196.47	-1.9%
LGB	14,215	14,397	1.3%	38.79	38.51	-0.7%	$144.24	$112.52	-22.0%
LIH	16,695	14,576	-12.7%	52.97	45.82	-13.5%	$149.14	$210.97	41.5%
LIT	22,670	18,210	-19.7%	69.01	62.29	-9.7%	$164.35	$183.41	11.6%
MAF	8,576	8,162	-4.8%	27.19	29.72	9.3%	$135.53	$180.10	32.9%
MDT	16,457	15,367	-6.6%	59.08	58.99	-0.2%	$210.13	$211.39	0.6%
MHT	27,769	16,320	-41.2%	94.28	60.21	-36.1%	$144.09	$166.39	15.5%
MLI	11,363	9,158	-19.4%	48.00	41.57	-13.4%	$160.46	$194.71	21.3%
MSN	17,845	14,110	-20.9%	58.28	56.10	-3.7%	$195.56	$208.24	6.5%
MYR	10,822	9,236	-14.7%	47.11	40.05	-15.0%	$140.75	$121.07	-14.0%
OKC	30,346	25,921	-14.6%	85.70	81.38	-5.0%	$169.70	$193.91	14.3%

Appendix C: Small-Hubs (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
ORF	33,949	27,479	-19.1%	105.82	96.44	-8.9%	$176.72	$189.53	7.2%
PHF	10,372	7,246	-30.1%	43.75	33.47	-23.5%	$140.14	$187.80	34.0%
PIE	3,103	3,061	-1.4%	6.16	0.78	-87.3%	$95.67	$88.26	-7.7%
PNS	15,546	12,995	-16.4%	58.29	55.43	-4.9%	$179.92	$195.33	8.6%
PSP	14,080	12,488	-11.3%	59.07	51.44	-12.9%	$185.66	$181.89	-2.0%
PWM	16,651	13,559	-18.6%	64.04	56.66	-11.5%	$182.77	$189.74	3.8%
RIC	33,897	27,129	-20.0%	106.80	96.92	-9.2%	$170.30	$192.31	12.9%
ROC	27,571	21,829	-20.8%	91.44	79.86	-12.7%	$152.26	$165.49	8.7%
SAV	16,406	13,344	-18.7%	65.69	59.25	-9.8%	$173.47	$207.51	19.6%
SBA	14,989	11,177	-25.4%	50.07	40.92	-18.3%	$205.13	$203.24	-0.9%
SDF	35,162	27,132	-22.8%	99.49	92.64	-6.9%	$157.80	$185.78	17.7%
SFB	3,270	4,866	48.8%	1.71	2.39	39.5%	$87.99	$82.63	-6.1%
SPN	7,600	7,473	-1.7%	6.93	8.31	20.0%	N/A	N/A	N/A
SRQ	9,617	5,973	-37.9%	46.47	31.69	-31.8%	$143.48	$166.32	15.9%
STT	14,799	13,405	-9.4%	36.33	43.56	19.9%	$222.15	$215.89	-2.8%
SYR	24,915	19,469	-21.9%	82.32	73.22	-11.1%	$177.40	$196.11	10.5%
TUL	28,419	20,909	-26.4%	78.11	71.50	-8.5%	$158.87	$196.07	23.4%
TUS	28,211	21,007	-25.5%	94.30	74.66	-20.8%	$159.49	$174.17	9.2%
TYS	22,622	18,273	-19.2%	74.81	69.30	-7.4%	$201.24	$194.53	-3.3%
VPS	8,412	8,074	-4.0%	39.01	39.04	0.1%	$228.96	$215.35	-5.9%
XNA	16,723	14,412	-13.8%	63.49	57.59	-9.3%	$237.51	$253.13	6.6%

10 Appendix D: Data for Non-Hub and Essential Air Service Airports

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
ABI	3,644	2,439	-33.1%	22.72	16.52	-27.3%	$199.60	$236.04	18.3%
ABR	2,341	718	-69.3%	11.49	9.06	-21.2%	$260.38	$175.53	-32.6%
ABY	1,312	999	-23.9%	18.89	16.38	-13.3%	$254.61	$247.15	-2.9%
ACK	20,986	17,482	-16.7%	31.31	29.37	-6.2%	$87.55	$85.56	-2.3%
ACT	3,612	2,221	-38.5%	22.70	19.21	-15.4%	$189.15	$215.30	13.8%
ACV	4,945	3,691	-25.4%	16.02	13.48	-15.8%	$170.64	$243.93	42.9%
ADQ	4,027	6,310	56.7%	2.48	2.17	-12.2%	$200.27	$207.12	3.4%
AEX	5,387	4,192	-22.2%	30.66	28.53	-6.9%	$232.44	$251.07	8.0%
AGS	4,369	5,762	31.9%	27.40	31.60	15.3%	$252.17	$203.31	-19.4%
AHN	678	704	3.8%	8.73	1.70	-80.5%	$248.29	$109.38	-55.9%
AIA	991	875	-11.7%	1.76	0.73	-58.5%	$155.71	$150.46	-3.4%
AKN	4,312	6,061	40.6%	1.82	1.61	-12.0%	$224.23	$240.42	7.2%
ALO	1,344	669	-50.2%	11.17	10.62	-4.9%	$214.45	$226.99	5.8%
ALS	939	1,062	13.1%	2.61	2.57	-1.6%	$172.92	$190.02	9.9%
ALW	1,114	655	-41.2%	6.18	5.64	-8.8%	$168.17	$151.21	-10.1%
ANI	4,334	2,925	-32.5%	0.84	0.39	-52.9%	$115.67	$119.87	3.6%
AOO	1,124	948	-15.7%	10.25	9.67	-5.7%	$160.74	$193.22	20.2%
APN	1,213	691	-43.0%	9.67	10.59	9.4%	$247.15	$205.21	-17.0%
ART	2,108	626	-70.3%	7.48	8.81	17.8%	$166.42	$236.90	42.3%
ASE	5,311	5,195	-2.2%	27.70	31.39	13.3%	$255.19	$249.64	-2.2%
ATW	9,597	5,415	-43.6%	38.36	30.16	-21.4%	$201.80	$228.35	13.2%
ATY	1,458	1,059	-27.4%	9.51	9.68	1.7%	$183.43	$228.68	24.7%
AUG	1,263	1,011	-20.0%	6.38	2.78	-56.4%	$208.50	$157.59	-24.4%
AVL	8,129	7,842	-3.5%	42.19	41.40	-1.9%	$217.80	$196.25	-9.9%
AVP	6,714	6,586	-1.9%	31.91	35.82	12.2%	$201.44	$219.42	8.9%
AZO	6,382	3,960	-38.0%	34.00	20.48	-39.8%	$214.22	$254.20	18.7%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
BED	1,801	168	-90.7%	0.17	0.00	-97.4%	N/A	N/A	N/A
BET	7,802	23,409	200.0%	2.04	2.22	8.6%	$154.79	$146.77	-5.2%
BFD	1,354	941	-30.5%	3.68	4.07	10.6%	$211.19	$212.83	0.8%
BFF	1,023	1,399	36.8%	2.84	3.10	9.0%	$172.64	$186.39	8.0%
BFI	6,654	2,667	-59.9%	0.52	0.13	-75.6%	$47.27	$47.45	0.4%
BFL	5,183	3,771	-27.2%	29.40	25.13	-14.5%	$220.32	$253.29	15.0%
BGM	4,586	3,680	-19.8%	30.76	22.03	-28.4%	$195.97	$202.44	3.3%
BHB	1,429	1,163	-18.6%	6.74	6.18	-8.4%	$239.25	$176.94	-26.0%
BID	2,608	3,108	19.2%	0.07	0.08	18.8%	$49.83	$30.00	-39.8%
BIS	3,498	4,348	24.3%	17.43	22.14	27.0%	$229.48	$240.20	4.7%
BJI	1,772	702	-60.4%	11.28	9.01	-20.1%	$251.08	$170.89	-31.9%
BKW	990	639	-35.5%	9.53	9.37	-1.7%	$143.86	$201.41	40.0%
BLD	883	472	-46.5%	0.03	0.01	-49.3%	N/A	N/A	N/A
BMI	6,132	4,574	-25.4%	34.51	29.03	-15.9%	$144.83	$182.99	26.4%
BPT	1,698	680	-60.0%	16.93	14.20	-16.1%	$225.09	$294.66	30.9%
BQK	995	955	-4.0%	18.02	16.26	-9.7%	$212.86	$217.18	2.0%
BQN	1,630	1,681	3.1%	23.04	19.80	-14.1%	$163.85	$151.67	-7.4%
BRD	1,841	658	-64.3%	10.84	8.89	-18.0%	$218.58	$235.66	7.8%
BRL	449	1,383	208.0%	3.71	2.17	-41.6%	$167.40	$172.77	3.2%
BRO	2,347	2,328	-0.8%	18.71	19.78	5.7%	$218.10	$251.53	15.3%
BRW	2,869	3,269	13.9%	1.18	1.08	-8.3%	$235.39	$246.77	4.8%
BTM	1,549	703	-54.6%	8.19	6.43	-21.5%	$223.93	$186.20	-16.9%
CDC	1,570	646	-58.9%	9.50	6.27	-34.0%	$126.67	$97.07	-23.4%
CDR	626	839	34.0%	0.14	1.48	940.3%	$157.93	$181.22	14.7%
CDV	1,148	1,124	-2.1%	1.39	1.15	-16.9%	$174.38	$205.35	17.8%
CEC	1,055	1,008	-4.5%	7.96	8.09	1.6%	$134.90	$181.41	34.5%
CEZ	953	1,161	21.8%	2.65	2.95	11.3%	$174.95	$192.14	9.8%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
CGI	320	1,253	291.6%	6.27	0.73	-88.4%	$173.88	$127.74	-26.5%
CHA	8,418	7,760	-7.8%	35.51	36.91	4.0%	$193.97	$192.67	-0.7%
CHO	8,143	7,291	-10.5%	37.34	35.79	-4.1%	$221.26	$205.26	-7.2%
CIC	1,375	1,287	-6.4%	9.82	9.69	-1.3%	$117.64	$162.40	38.0%
CIU	729	654	-10.3%	8.34	9.44	13.1%	$225.35	$256.24	13.7%
CKB	816	962	17.9%	5.06	10.25	102.7%	$294.31	$236.00	-19.8%
CLD	2,727	2,370	-13.1%	17.25	12.98	-24.7%	N/A	N/A	N/A
CLL	4,040	2,819	-30.2%	23.87	20.84	-12.7%	$195.93	$228.82	16.8%
CLM	3,187	1,088	-65.9%	0.22	0.03	-85.1%	$49.83	$42.80	-14.1%
CMI	3,520	2,278	-35.3%	21.24	17.41	-18.0%	$197.20	$227.19	15.2%
CMX	1,082	733	-32.3%	10.46	11.81	12.9%	$214.07	$184.96	-13.6%
CNM	748	1,014	35.6%	0.25	0.37	47.3%	$140.03	$131.47	-6.1%
CNY	658	994	51.1%	2.70	1.89	-30.0%	$141.17	$219.70	55.6%
COD	1,336	919	-31.2%	9.83	8.58	-12.7%	$238.79	$212.29	-11.1%
COU	1,252	924	-26.2%	2.07	14.85	619.1%	$140.78	$188.53	33.9%
CPR	3,893	2,304	-40.8%	18.76	12.27	-34.6%	$260.47	$204.23	-21.6%
CRP	9,122	7,246	-20.6%	38.15	29.54	-22.6%	$166.71	$217.65	30.6%
CRW	10,983	8,049	-26.7%	44.86	41.08	-8.4%	$212.92	$206.86	-2.8%
CSG	1,401	2,115	51.0%	19.13	21.23	11.0%	$310.53	$264.85	-14.7%
CVN	755	637	-15.6%	0.50	0.46	-9.1%	$152.97	$184.60	20.7%
CWA	5,568	3,487	-37.4%	25.53	21.23	-16.9%	$209.27	$252.68	20.7%
CYS	2,440	1,972	-19.2%	6.72	14.83	120.6%	$206.31	$223.93	8.5%
DAB	3,699	2,762	-25.3%	34.41	21.33	-38.0%	$151.87	$161.26	6.2%
DBQ	1,415	1,017	-28.1%	11.36	9.88	-13.0%	$179.15	$226.51	26.4%
DDC	1,914	1,462	-23.6%	3.03	2.42	-20.1%	$166.16	$202.30	21.7%
DEC	1,462	1,882	28.7%	5.16	3.11	-39.6%	$110.82	$202.21	82.5%
DHN	1,639	1,354	-17.4%	19.78	17.35	-12.3%	$335.78	$314.00	-6.5%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
DIK	1,822	1,571	-13.8%	2.56	4.15	62.3%	$180.01	$251.57	39.7%
DLG	4,547	2,573	-43.4%	1.84	1.46	-21.0%	$206.65	$227.76	10.2%
DLH	3,636	3,592	-1.2%	17.77	20.18	13.5%	$202.92	$204.32	0.7%
DRO	3,936	4,036	2.5%	17.49	21.81	24.7%	$220.53	$194.41	-11.8%
DRT	983	700	-28.8%	14.97	14.26	-4.8%	$223.11	$246.29	10.4%
DUJ	1,132	1,305	15.3%	3.82	4.27	11.6%	$209.94	$210.46	0.2%
DUT	2,512	995	-60.4%	1.79	0.03	-98.5%	$501.63	$582.52	16.1%
DVL	626	958	53.0%	0.14	2.01	1301.3%	$292.76	$350.19	19.6%
EAR	990	1,316	32.9%	2.75	2.79	1.6%	$187.21	$201.91	7.9%
EAT	1,632	1,631	-0.1%	7.81	6.70	-14.2%	$172.27	$165.79	-3.8%
EAU	1,963	729	-62.9%	11.44	11.80	3.2%	$195.84	$161.98	-17.3%
EGE	3,353	2,150	-35.9%	32.50	28.85	-11.2%	$223.58	$230.61	3.1%
EKO	1,821	1,000	-45.1%	10.57	7.24	-31.5%	$202.35	$160.99	-20.4%
ELD	1,252	1,255	0.2%	1.73	0.55	-68.2%	$137.36	$115.16	-16.2%
ELM	4,080	3,848	-5.7%	19.96	23.31	16.8%	$181.58	$197.88	9.0%
ELY	315	327	3.8%	0.38	0.90	133.1%	$118.61	$154.41	30.2%
ENA	7,878	9,220	17.0%	4.49	5.31	18.2%	$106.17	$110.19	3.8%
ERI	5,397	3,510	-35.0%	26.34	17.16	-34.9%	$178.04	$185.63	4.3%
ESC	995	1,232	23.8%	3.23	9.39	190.5%	$175.98	$248.87	41.4%
EVV	7,757	4,710	-39.3%	32.50	29.36	-9.7%	$212.46	$236.46	11.3%
EWB	2,026	2,618	29.2%	0.21	0.23	10.7%	$48.36	$33.49	-30.8%
EWN	3,202	3,547	10.8%	24.32	23.48	-3.5%	$204.07	$195.95	-4.0%
EYW	12,901	9,273	-28.1%	48.56	37.11	-23.6%	$197.05	$193.89	-1.6%
FAR	6,006	6,911	15.1%	27.98	29.70	6.2%	$232.90	$227.79	-2.2%
FAY	4,958	6,161	24.3%	29.02	32.19	10.9%	$257.76	$224.29	-13.0%
FBS	1,696	1,156	-31.8%	0.17	0.66	280.2%	N/A	N/A	N/A
FCA	4,408	3,301	-25.1%	28.13	24.30	-13.6%	N/A	N/A	N/A

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
FKL	802	1,254	56.4%	3.63	4.27	17.4%	$165.36	$239.59	44.9%
FLG	1,896	2,260	19.2%	11.19	11.93	6.6%	$208.34	$206.45	-0.9%
FLO	2,321	2,071	-10.8%	21.65	13.66	-36.9%	$230.71	$189.81	-17.7%
FMN	3,058	2,305	-24.6%	11.44	4.65	-59.4%	$178.15	$214.19	20.2%
FNL	223	227	1.8%	0.74	0.71	-3.5%	$81.31	$61.52	-24.3%
FOD	939	1,007	7.2%	0.15	9.44	6161.5%	$144.22	$209.37	45.2%
FOE	64	-	-100.0%	0.30	0.00	-100.0%	N/A	N/A	N/A
FRD	2,270	1,040	-54.2%	0.19	0.03	-83.9%	N/A	N/A	N/A
FSM	3,502	2,431	-30.6%	23.13	20.81	-10.1%	$220.27	$247.34	12.3%
FWA	9,840	6,573	-33.2%	38.89	34.74	-10.7%	$207.85	$205.06	-1.3%
GAL	2,953	2,975	0.7%	0.25	0.24	-6.4%	$131.25	$113.91	-13.2%
GBD	783	641	-18.1%	1.56	0.14	-90.8%	$138.25	$177.82	28.6%
GCC	1,664	2,126	27.8%	4.60	10.58	130.3%	$250.65	$206.83	-17.5%
GCK	1,693	1,122	-33.7%	4.11	12.35	200.6%	$175.06	$209.54	19.7%
GCN	976	155	-84.1%	0.03	0.00	-84.2%	$94.12	$47.00	-50.1%
GCW	-	472	N/A	0.00	0.01	247.1%	N/A	N/A	N/A
GDV	722	627	-13.2%	0.03	0.02	-10.2%	$114.60	$136.68	19.3%
GFK	1,926	2,552	32.5%	12.06	13.81	14.5%	$262.41	$211.88	-19.3%
GGG	1,094	680	-37.8%	11.88	11.71	-1.4%	$188.87	$214.23	13.4%
GGW	626	581	-7.2%	0.02	0.02	-5.5%	$89.11	$114.93	29.0%
GJT	5,998	5,275	-12.1%	23.09	27.70	20.0%	$222.32	$206.19	-7.3%
GLH	727	837	15.1%	4.67	4.10	-12.2%	$242.87	$196.27	-19.2%
GNV	4,499	5,311	18.0%	28.50	30.55	7.2%	$211.49	$203.83	-3.6%
GRB	10,437	7,132	-31.7%	41.07	29.98	-27.0%	$191.44	$251.73	31.5%
GRI	1,565	897	-42.7%	1.85	12.01	549.0%	$107.02	$144.73	35.2%
GRK	6,707	5,545	-17.3%	36.57	32.23	-11.9%	$226.02	$254.11	12.4%
GST	1,643	1,828	11.3%	0.21	0.21	1.8%	$135.36	$123.49	-8.8%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
GTF	4,099	3,788	-7.6%	16.65	15.77	-5.2%	$232.95	$195.17	-16.2%
GTR	1,008	1,007	-0.1%	18.05	16.41	-9.1%	$258.22	$246.60	-4.5%
GUC	1,273	601	-52.8%	12.70	15.14	19.3%	$191.18	$213.32	11.6%
HDN	2,684	1,789	-33.3%	30.37	25.75	-15.2%	$190.34	$201.13	5.7%
HGR	468	1,374	193.6%	3.54	3.74	5.7%	$167.59	$70.93	-57.7%
HHH	3,733	2,665	-28.6%	25.52	15.31	-40.0%	N/A	N/A	N/A
HIB	1,383	1,041	-24.7%	9.51	8.83	-7.1%	$205.69	$240.12	16.7%
HLN	3,350	2,713	-19.0%	14.11	13.74	-2.6%	$245.95	$236.83	-3.7%
HNH	2,689	1,956	-27.3%	0.08	0.06	-30.6%	$46.31	$37.55	-18.9%
HOM	3,823	3,265	-14.6%	2.02	1.82	-9.5%	$91.37	$122.89	34.5%
HON	1,152	1,111	-3.6%	1.50	1.34	-10.8%	$148.28	$207.66	40.1%
HOT	1,316	1,152	-12.5%	1.85	0.40	-78.2%	$90.36	$110.63	22.4%
HRL	6,017	4,386	-27.1%	20.13	18.74	-6.9%	$130.59	$164.68	26.1%
HRO	1,148	1,466	27.7%	0.37	0.76	107.4%	$131.23	$111.49	-15.0%
HTS	2,187	2,072	-5.3%	19.43	14.52	-25.2%	$185.34	$128.86	-30.5%
HVN	2,286	1,376	-39.8%	13.43	12.02	-10.5%	$189.27	$202.22	6.8%
HVR	626	627	0.2%	0.02	0.02	-0.1%	$101.62	$150.02	47.6%
HYA	15,031	11,654	-22.5%	7.87	3.13	-60.2%	$57.74	$35.32	-38.8%
HYS	1,315	1,986	51.0%	3.31	3.76	13.8%	$198.21	$214.72	8.3%
IAG	6	586	9666.7%	0.16	5.39	3302.8%	N/A	N/A	N/A
IDA	4,581	3,456	-24.6%	17.71	16.37	-7.6%	$213.50	$202.87	-5.0%
IFP	240	1	-99.6%	3.52	2.72	-22.8%	$128.14	$162.40	26.7%
IGM	973	732	-24.8%	5.68	1.85	-67.4%	$113.63	$172.26	51.6%
IMT	1,254	693	-44.7%	3.27	7.36	124.9%	$169.37	$223.01	31.7%
INL	1,049	644	-38.6%	9.22	8.37	-9.2%	$249.56	$219.00	-12.2%
IPL	1,300	727	-44.1%	9.94	8.50	-14.5%	$110.54	$172.30	55.9%
IPT	1,735	1,040	-40.1%	12.94	11.10	-14.2%	$223.48	$256.66	14.8%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
IRK	1,248	1,095	-12.3%	1.99	0.63	-68.1%	$128.45	$119.69	-6.8%
ISN	911	2,031	122.9%	0.15	11.76	7742.6%	$209.08	$301.34	44.1%
ITH	3,996	3,815	-4.5%	21.53	25.27	17.4%	$203.99	$194.57	-4.6%
IWD	720	691	-4.0%	2.88	1.57	-45.5%	$161.64	$175.93	8.8%
JAC	3,597	3,243	-9.8%	28.95	30.64	5.8%	$232.36	$253.89	9.3%
JBR	626	942	50.5%	0.14	0.55	285.5%	$143.38	$148.42	3.5%
JHW	1,350	1,393	3.2%	3.48	4.29	23.4%	$190.28	$230.71	21.2%
JLN	1,430	730	-49.0%	2.52	11.85	370.9%	$114.24	$221.21	93.6%
JMS	626	1,153	84.2%	0.14	9.46	6500.1%	$224.69	$265.27	18.1%
JNU	14,871	11,073	-25.5%	7.71	7.70	-0.2%	$203.18	$200.96	-1.1%
JST	1,247	1,040	-16.6%	3.99	10.59	165.5%	$228.13	$210.47	-7.7%
KSM	1,741	1,694	-2.7%	0.13	0.26	95.2%	$88.07	$122.14	38.7%
KTN	9,644	11,208	16.2%	7.12	7.58	6.6%	$227.46	$194.40	-14.5%
LAN	5,345	4,479	-16.2%	30.64	22.51	-26.5%	$180.02	$188.94	5.0%
LAR	1,617	1,467	-9.3%	2.77	8.45	205.1%	$170.29	$222.20	30.5%
LAW	2,338	1,875	-19.8%	15.29	14.98	-2.0%	$247.63	$265.29	7.1%
LBE	727	587	-19.3%	9.66	5.45	-43.6%	$175.20	$62.10	-64.6%
LBF	1,022	1,034	1.2%	2.84	2.70	-4.7%	$220.04	$200.34	-9.0%
LBL	988	1,123	13.7%	1.25	1.75	40.1%	$175.66	$203.83	16.0%
LCH	2,056	2,370	15.3%	17.91	19.62	9.5%	$232.43	$250.67	7.8%
LEB	1,194	2,290	91.8%	5.58	4.13	-26.1%	$173.21	$125.95	-27.3%
LFT	6,965	6,164	-11.5%	34.98	33.85	-3.2%	$218.27	$239.35	9.7%
LMT	1,150	823	-28.4%	2.42	7.61	213.8%	$190.07	$188.79	-0.7%
LNK	4,386	3,295	-24.9%	24.34	19.59	-19.5%	$198.36	$229.35	15.6%
LNS	702	1,650	135.0%	3.68	4.51	22.7%	$126.94	$91.05	-28.3%
LNY	3,453	2,937	-14.9%	8.78	7.01	-20.2%	$193.45	$88.86	-54.1%
LRD	3,019	2,600	-13.9%	21.01	20.08	-4.4%	$201.52	$214.05	6.2%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
LSE	3,489	2,964	-15.0%	19.34	17.87	-7.6%	$239.72	$265.67	10.8%
LUP	1,092	1,098	0.5%	0.65	0.18	-72.0%	$44.37	$39.64	-10.7%
LWB	1,061	710	-33.1%	17.65	18.25	3.4%	$247.76	$216.23	-12.7%
LWS	2,963	1,672	-43.6%	10.98	8.07	-26.6%	$180.41	$187.80	4.1%
LWT	1,252	1,255	0.2%	0.12	0.11	-12.2%	$80.72	$226.37	180.4%
LYH	2,352	2,081	-11.5%	21.74	13.69	-37.0%	$253.45	$212.72	-16.1%
MAZ	1,561	1,462	-6.3%	1.16	1.22	5.6%	$78.51	$113.80	45.0%
MBL	674	362	-46.3%	2.88	2.41	-16.5%	$126.90	$90.99	-28.3%
MBS	3,845	3,572	-7.1%	22.96	20.39	-11.2%	$198.02	$209.81	6.0%
MCE	1,604	1,331	-17.0%	7.31	1.68	-77.0%	$111.53	$155.68	39.6%
MCK	626	1,036	65.5%	0.07	1.88	2598.2%	$124.71	$205.28	64.6%
MCN	996	1,359	36.4%	18.02	3.71	-79.4%	$248.14	$225.52	-9.1%
MCW	1,878	1,311	-30.2%	10.09	10.27	1.7%	$189.05	$244.05	29.1%
MEI	679	697	2.7%	17.15	15.56	-9.3%	$284.48	$286.17	0.6%
MFE	5,501	4,350	-20.9%	35.01	28.72	-18.0%	$199.25	$214.76	7.8%
MFR	10,354	6,355	-38.6%	28.84	22.22	-23.0%	$180.16	$173.84	-3.5%
MGM	5,227	5,179	-0.9%	30.05	29.61	-1.5%	$236.02	$229.80	-2.6%
MGW	1,102	1,081	-1.9%	5.21	10.00	91.9%	$270.35	$198.86	-26.4%
MHK	1,333	1,763	32.3%	1.87	16.01	756.6%	$224.76	$225.55	0.4%
MKG	2,385	729	-69.4%	11.18	11.80	5.5%	$190.03	$150.84	-20.6%
MKK	9,236	8,621	-6.7%	18.59	13.85	-25.5%	$72.90	$44.00	-39.6%
MKL	188	1,201	538.8%	6.19	0.70	-88.8%	$173.78	$75.00	-56.8%
MLB	2,062	2,449	18.8%	22.45	20.48	-8.8%	$204.33	$164.35	-19.6%
MLS	1,237	1,132	-8.5%	0.12	0.11	-13.7%	$80.47	$127.04	57.9%
MLU	5,152	3,358	-34.8%	30.01	26.26	-12.5%	$220.74	$246.04	11.5%
MMH	-	686	N/A	0.00	8.20	N/A	N/A	N/A	N/A
MOB	7,830	6,780	-13.4%	37.72	35.58	-5.7%	$239.54	$241.01	0.6%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
MOD	3,060	1,299	-57.5%	17.03	9.72	-42.9%	$114.24	$181.02	58.5%
MOT	1,083	3,986	268.1%	10.46	18.19	73.9%	$277.20	$277.86	0.2%
MQT	3,593	978	-72.8%	16.91	11.48	-32.1%	N/A	N/A	N/A
MRY	8,750	6,147	-29.7%	33.65	26.82	-20.3%	$220.25	$197.53	-10.3%
MSL	990	641	-35.3%	4.42	14.49	228.1%	$184.99	$173.83	-6.0%
MSO	7,098	5,136	-27.6%	26.29	24.08	-8.4%	$217.91	$201.37	-7.6%
MSS	939	1,095	16.6%	0.18	0.28	50.5%	$114.22	$129.54	13.4%
MTJ	2,594	1,710	-34.1%	29.86	26.14	-12.4%	$207.91	$237.54	14.3%
MVY	6,685	6,864	2.7%	13.12	21.00	60.1%	$96.16	$121.41	26.3%
MWA	947	1,879	98.4%	3.82	1.08	-71.6%	$136.79	$117.19	-14.3%
OAJ	4,016	4,675	16.4%	26.55	26.46	-0.4%	$255.14	$217.53	-14.7%
OGS	1,295	1,095	-15.4%	0.19	0.28	42.9%	$109.18	$125.69	15.1%
OLF	991	966	-2.5%	0.12	0.10	-13.7%	$129.29	$140.09	8.4%
OME	7,914	9,075	14.7%	1.58	1.35	-14.4%	$153.67	$190.86	24.2%
OTH	1,367	1,711	25.2%	2.55	8.76	243.9%	$171.30	$185.55	8.3%
OTZ	6,380	9,225	44.6%	1.34	1.16	-13.6%	$146.55	$165.36	12.8%
OWB	187	1,138	508.6%	6.19	1.08	-82.6%	$165.96	$87.08	-47.5%
PAH	1,087	731	-32.8%	4.87	11.80	142.2%	$208.01	$164.68	-20.8%
PBG	525	1,504	186.5%	6.61	9.78	47.9%	$155.26	$126.31	-18.6%
PDT	987	1,145	16.0%	1.99	0.66	-66.8%	$126.68	$99.00	-21.9%
PGA	1,134	1,897	67.3%	2.77	3.60	29.7%	$155.74	$213.82	37.3%
PGD	-	703	N/A	0.00	0.36	N/A	N/A	N/A	N/A
PGV	1,766	1,741	-1.4%	11.71	12.76	9.0%	$190.28	$190.63	0.2%
PIA	6,933	6,878	-0.8%	36.97	35.49	-4.0%	$175.51	$187.95	7.1%
PIB	730	640	-12.3%	4.67	4.33	-7.2%	$235.72	$254.43	7.9%
PIH	1,982	991	-50.0%	10.60	7.21	-31.9%	$185.85	$160.88	-13.4%
PIR	1,925	1,879	-2.4%	1.91	9.48	395.8%	$215.12	$243.99	13.4%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
PKB	823	1,254	52.4%	5.37	4.61	-14.1%	$227.88	$222.37	-2.4%
PLN	1,218	808	-33.7%	11.01	9.68	-12.0%	$254.25	$262.67	3.3%
PPG	103	110	6.8%	7.24	8.93	23.3%	$611.07	$620.65	1.6%
PQI	998	1,182	18.4%	6.19	6.22	0.5%	$270.91	$276.40	2.0%
PRC	1,788	1,288	-28.0%	8.47	2.23	-73.7%	$119.08	$182.62	53.4%
PSC	6,677	5,934	-11.1%	21.45	24.29	13.2%	$211.78	$185.09	-12.6%
PSE	2,628	835	-68.2%	22.62	7.53	-66.7%	$149.55	$144.59	-3.3%
PSG	1,002	727	-27.4%	0.19	0.18	-6.0%	$201.62	$122.52	-39.2%
PUB	625	1,238	98.1%	1.75	3.21	83.4%	$168.70	$128.80	-23.7%
PUW	1,502	960	-36.1%	5.05	6.47	28.1%	$156.09	$161.84	3.7%
PVC	2,250	2,260	0.4%	6.17	5.99	-2.9%	$71.29	$78.09	9.5%
PVU	-	366	N/A	0.00	5.08	N/A	N/A	N/A	N/A
RAP	5,436	5,735	5.5%	26.56	31.94	20.3%	$233.34	$234.77	0.6%
RDD	3,231	1,737	-46.2%	12.85	10.36	-19.4%	$166.05	$205.47	23.7%
RDM	8,136	5,389	-33.8%	21.62	17.51	-19.0%	$164.18	$171.75	4.6%
RFD	1,289	693	-46.2%	8.14	4.99	-38.7%	$123.57	$109.84	-11.1%
RHI	3,113	776	-75.1%	10.66	2.07	-80.6%	$209.38	$135.59	-35.2%
RIW	1,120	1,135	1.3%	3.10	2.98	-4.1%	$229.72	$226.85	-1.2%
RKD	1,687	1,316	-22.0%	5.60	3.61	-35.5%	$220.81	$131.13	-40.6%
RKS	1,619	2,193	35.5%	4.47	11.07	147.6%	$225.46	$222.67	-1.2%
ROA	11,285	8,982	-20.4%	46.00	39.87	-13.3%	$209.14	$214.65	2.6%
ROP	1,736	1,580	-9.0%	2.89	2.50	-13.7%	N/A	N/A	N/A
ROW	1,176	1,042	-11.4%	9.84	12.70	29.0%	$161.25	$249.26	54.6%
RST	5,114	3,235	-36.7%	24.50	17.63	-28.0%	$190.25	$224.79	18.2%
RUT	684	1,155	68.9%	5.33	3.17	-40.5%	$157.98	$123.48	-21.8%
SAF	1,123	1,484	32.1%	2.83	14.55	413.5%	$250.57	$218.34	-12.9%
SBN	10,086	6,417	-36.4%	37.53	31.33	-16.5%	$169.73	$187.40	10.4%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
SBP	7,041	4,910	-30.3%	30.39	22.16	-27.1%	$202.88	$218.59	7.7%
SBY	2,888	2,344	-18.8%	17.06	15.92	-6.7%	$179.13	$167.80	-6.3%
SCC	2,096	1,837	-12.4%	1.33	0.91	-31.5%	$313.11	$282.35	-9.8%
SCE	5,312	4,736	-10.8%	29.05	24.92	-14.2%	N/A	N/A	N/A
SCK	253	444	75.5%	0.77	1.42	85.5%	$63.70	$52.79	-17.1%
SDY	1,041	1,117	7.3%	0.15	0.15	-0.2%	$137.68	$158.88	15.4%
SGF	11,730	8,061	-31.3%	45.40	37.31	-17.8%	$211.12	$204.81	-3.0%
SGU	3,639	2,034	-44.1%	19.57	12.93	-33.9%	$113.99	$106.58	-6.5%
SHD	1,064	1,400	31.6%	10.39	11.39	9.7%	$155.43	$197.79	27.3%
SHR	2,213	1,096	-50.5%	5.17	3.03	-41.5%	$186.88	$228.36	22.2%
SHV	10,187	7,795	-23.5%	44.29	36.78	-17.0%	$228.95	$241.62	5.5%
SIG	1,031	-	-100.0%	0.15	0.00	-100.0%	N/A	N/A	N/A
SIT	1,340	1,265	-5.6%	4.00	4.35	8.8%	$204.80	$173.03	-15.5%
SJT	2,602	1,422	-45.3%	19.93	13.74	-31.1%	$204.63	$244.23	19.3%
SLK	1,373	1,243	-9.5%	6.65	3.41	-48.7%	$161.58	$146.02	-9.6%
SLN	757	942	24.4%	1.54	0.54	-64.8%	$116.24	$90.00	-22.6%
SMX	1,937	1,549	-20.0%	13.40	10.73	-19.9%	$175.92	$152.24	-13.5%
SOW	1,060	1,372	29.4%	2.56	2.77	7.9%	$94.31	$164.04	73.9%
SPI	2,562	2,069	-19.2%	17.89	18.38	2.8%	$191.15	$191.63	0.3%
SPS	2,317	1,292	-44.2%	15.23	13.39	-12.1%	$249.64	$274.37	9.9%
STS	972	1,870	92.4%	6.46	8.55	32.2%	$125.52	$130.00	3.6%
STX	10,196	8,620	-15.5%	24.46	22.64	-7.4%	$219.13	$162.47	-25.9%
SUN	3,953	2,029	-48.7%	16.78	11.12	-33.8%	$195.93	$194.38	-0.8%
SUX	1,828	674	-63.1%	12.70	10.64	-16.3%	$212.63	$211.19	-0.7%
SVC	625	670	7.2%	0.36	0.60	64.5%	$125.01	$136.21	9.0%
SWF	7,387	3,757	-49.1%	35.90	24.84	-30.8%	$130.70	$176.33	34.9%
TBN	361	1,513	319.1%	3.66	0.87	-76.1%	$216.01	$199.99	-7.4%

Appendix D: Non-Hubs and EAS Airports (continued)

Airport	Flights (2007)	Flights (2012)	% Δ flights 07-12	ACQI (2007)	ACQI (2012)	% Δ ACQI 07-12	Avg. Fare (2007)	Avg. Fare (2012)	% Δ Fare 07-12
TEX	1,438	776	-46.0%	9.84	2.06	-79.1%	$265.65	$236.25	-11.1%
TIQ	4,736	4,715	-0.4%	0.13	0.13	-0.7%	N/A	N/A	N/A
TLH	12,558	8,201	-34.7%	48.44	40.14	-17.1%	$202.56	$216.00	6.6%
TOL	6,376	1,600	-74.9%	28.28	10.94	-61.3%	$171.93	$162.74	-5.3%
TRI	7,540	5,048	-33.1%	31.37	27.85	-11.2%	$229.17	$201.10	-12.3%
TUP	2,420	1,302	-46.2%	17.57	4.63	-73.6%	$237.21	$261.38	10.2%
TVC	4,548	4,457	-2.0%	30.52	23.92	-21.6%	$210.56	$239.44	13.7%
TVF	626	865	38.2%	0.14	1.30	804.6%	$188.92	$206.43	9.3%
TWF	1,979	1,076	-45.6%	11.00	7.41	-32.7%	$190.59	$153.42	-19.5%
TXK	1,879	1,055	-43.9%	17.95	12.74	-29.0%	$250.75	$286.43	14.2%
TYR	3,505	2,773	-20.9%	22.41	20.72	-7.5%	$195.50	$218.35	11.7%
UIN	1,215	1,897	56.1%	5.04	1.09	-78.3%	$156.87	$119.75	-23.7%
UNK	1,696	3,422	101.8%	0.27	0.40	46.3%	$130.40	$146.03	12.0%
UTM	-	-	N/A	0.00	0.00	N/A	N/A	N/A	N/A
VCT	730	438	-40.0%	14.28	13.54	-5.2%	$212.06	$258.71	22.0%
VDZ	955	1,661	73.9%	0.56	0.97	72.9%	$110.92	$133.22	20.1%
VEL	670	980	46.3%	2.71	1.94	-28.1%	$122.75	$226.12	84.2%
VIS	1,242	1,448	16.6%	7.01	2.13	-69.7%	$120.22	$147.58	22.8%
VLD	1,058	1,034	-2.3%	18.19	16.48	-9.4%	$224.33	$240.32	7.1%
VQS	4,936	5,966	20.9%	6.05	3.92	-35.2%	$97.04	$126.57	30.4%
WRG	726	727	0.1%	0.15	0.15	0.0%	$193.65	$100.54	-48.1%
WRL	626	615	-1.8%	0.14	0.14	0.6%	$173.62	$199.70	15.0%
WYS	266	280	5.3%	6.31	5.27	-16.5%	$191.27	$201.56	5.4%
YAK	726	724	-0.3%	0.18	0.18	-0.1%	$186.57	$167.06	-10.5%
YKM	2,587	2,222	-14.1%	12.94	7.02	-45.8%	$189.42	$181.60	-4.1%
YNG	79	247	212.7%	0.10	0.17	62.9%	$85.89	$81.07	-5.6%
YUM	3,509	3,195	-8.9%	18.20	17.17	-5.6%	N/A	N/A	N/A

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