Analysis of Ultra Low-cost Carriers and Airport Choice

by

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ABSTRACT

Since the mid-2000s, the domestic aviation industry has been influenced by new, rapidly growing ultra low-cost carriers (ULCCs) such as Allegiant Air, Spirit Airlines, and Frontier Airlines. These carriers augment the existing low-cost airline model by operating largely point-to-point routes with a minimum of passenger amenities. Existing literature, however, is limited for North American ULCCs, often lumping them together with mainstream low-cost carriers. The pattern of markets served by ULCCs is incongruous with the models of other airlines and requires further research to examine causal factors. This paper sought to establish conclusions about ULCCs and the relevant market factors used for airport choice decisions.

The relationship between ULCC operations and airport choice factors was analyzed using three methods: a collection of 2019 flight data to establish existing conditions and statistics, two regression analyses to evaluate airport market variables, and three case studies examining distinct scenarios through qualitative interviews with airport managers. ULCC enplanement data was assembled for every domestic airport offering scheduled ULCC service in 2019. Independent variable data informed by previous research were collected for every Part 139 airport in the U.S. The first regression analysis estimated a OLS regression model to analyze the log of enplanements. The second model estimated a binary logistic equation for ULCC service as a 0-1 dependent variable. Case studies for Bellingham, Washington, Waco, Texas, and Lincoln, Nebraska were selected based on compelling airport factors and relevant ULCC experience.

Results of the research methods confirm certain theories regarding ULCC airport choice, but left others unanswered. Maps of enplanements and market share revealed concentrations of ULCC operations on the East Coast. Each regression analysis showed a strong and positive relationship between population figures and the existence and quantity of ULCC operations. Tourism employment was only significantly related to enplanements. Other factors including distance and competition variables were significantly associated to ULCC service. Case studies revealed the importance of airport fees and costs in ULCC decision-making; factors that proved difficult to investigate quantitatively in this research. Further research may shed light on this complex and ever-changing subset of the domestic commercial aviation industry.

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CHAPTER 1

INTRODUCTION

The United States domestic commercial aviation market is crowded, and has continued to evolve and expand since federal deregulation in 1978 when air carriers were awarded freedom to pursue new routes, expand operations to new aviation markets, and charge competitive fares for flights (Goetz & Vowles, 2009). While legacy carriers such as United Airlines, Delta Air Lines, and American Airlines have dominated air travel across the nation for most of the post-deregulation era, challengers ascended in the form of low-cost and budget airlines beginning in earnest during the 1990s. Among these, Southwest Airlines has grown to become the world's largest low-cost carrier (LCC), becoming so successful that other airlines with a low-cost business model are now rare in the United States, although JetBlue Airways and Alaska Airlines loosely fit the category (How Southwest Pioneered The Low Cost Carrier Model - Simple Flying, n.d.). In the twenty-first century, a new class of airlines has quickly grown to capture a considerable amount of domestic market share. Ultra low-cost carriers (ULCCs) create a new level in the hierarchy of U.S. airlines by undercutting the low-cost model to even greater depths. Influenced by the success of European low-cost carriers Ryanair and EasyJet, the primary objective of an American ULCC is to provide short-haul, direct, point-to-point flights that do not depend on connecting passengers at hubs, with ancillary fees assessed for most amenities. Four ULCCs have implemented this revenue scheme to varying degrees within the United States: Allegiant Air, Frontier Airlines, Spirit Airlines, and Sun Country Airlines.

The first two decades of the twenty-first century witnessed consistent growth in domestic air travel with minor interruptions following the 9/11 attacks and the Great Recession of 2008. Much of the expansion of the domestic aviation sector in this time period was a result of the proliferation of ULCCs, which have consistently grown faster in terms of flights and enplanements than their legacy and low-cost rivals (U.S. Budget Airlines Aggressive and Growing Fast, n.d.). One causal factor for this success may be the aggressive pursuit amongst ULCCs of new aviation markets with negligible existing aviation service. Other airlines do not frequently employ such tactics. Delta Air Lines and American Airlines have for decades relied on a model of hub-and-spoke connections across the United States, consolidating operations to lucrative airports with high levels of service while reaching nearly every major population center at primary airports. In contrast, the success of Southwest Airlines has relied on attracting a loyal cohort of flyers to secondary airports with fewer costs, better reliability, and room to expand services often neglected by legacy carriers (Tierney & Kuby, 2008). ULCCs do not seem to fit entirely into either one of these business models. A brief examination of the domestic markets served by ULCCs reveals a collection of major metropolitan hubs, secondary airports, tourist destinations, as well as rural and underserved areas with spotty commercial aviation histories. This incongruous pattern of market selection defies the norms of the U.S. airline industry in which airlines typically serve one class of airport almost exclusively. Existing research has not fully examined this aspect of ULCCs or explained why many rural, disconnected, and small airports receive ULCC air service yet others do not. While studies have reviewed domestic low-cost carriers and European ultra low-cost carriers, analyses of American ULCCs and their criteria for airport selection are limited in number.

This paper will analyze the domestic aviation markets served by ULCCs and determine which market factors are the most conducive for enabling this specialized sector of commercial air service. By examining the ULCC performance data for 2019 across each of the 184 U.S. airports served by these airlines, the first section of analysis establishes a baseline of information for existing ULCC service. Then, using data collected across a range of unique independent variables relating to demographic, economic, and airport-related factors, a regression analysis will be utilized to detail the trends of certain aviation market factors in ULCC service and establish significance. The final section views these constructs through the lens of three airport case studies, using qualitative analysis to understand the complex nature of ULCC business models and decision-making for relevant aviation markets. The outcomes of paper will include a documentation of ULCC business priorities, support a coalescence of the preferences and criteria that promote the airport-ULCC relationship, and provide context to their significance, which can each be used to guide future development at U.S airports. This research constitutes the first comprehensive analysis of ULCC airport choice factors in the United States and serves as a starting point for further studies into these fast-evolving practices which drive commercial aviation forward.

CHAPTER 2

LITERATURE REVIEW

The following literature review analyzes existing research surrounding relevant low- and ultra low-cost carrier business models and the airports they serve to draw hypotheses and identify gaps for further study. Relevant literature was selected using a search of academic journal databases using a combination of key terms related to low-cost carriers and airport choice, as detailed in Table 1.

Table 1 – Literature Search Terms

Terms				
“Low-cost”	“Aviation”	“ULCC”	“LCC”	“Airport choice”
“Southwest”	“Ultra low-cost”	“Airline”		

To understand the spectrum of low-cost carriers it is important to establish what the terminology is referring to. Low-cost airlines broadly are not only offering passenger travel at low prices, they are also pursuing strategies that reduce operational costs for the airline as a whole. There is agreement in the literature that LCCs can be defined generally by their reliance on single aircraft types (Bachwich & Wittman, 2017), preference for short-haul point-to-point routes (Gillen & Lall, 2017), and reduced in-flight perks for passengers (Dennis, 2007). Throughout the existing research, the term low-cost carrier seems to be applied broadly to all airlines that do not offer the traditional level of service of a legacy carrier, although there is acknowledgement that there are degrees of separation. Only Bachwich and Wittman (2017) go as far as to carve out a unique definition for ULCCs within the context of North America. They define ultra low-cost carriers as those which:

1. Have significantly lower costs than even low-cost carriers,
2. Generate a significant portion of operating revenue through the sale of ancillary services, and
3. Realize lower passenger unit revenues than other carriers, even when ancillary revenues are included (Bachwich & Wittman, 2017).

Many academic research papers have focused on the success and proliferation of Southwest Airlines within North America as a low-cost carrier, despite the fact that the airline's business model today has evolved far beyond the constraints of the original low-cost model that it established as a regional carrier in Texas. While Southwest offers a minimum level of in-flight perks, offers cheap fares for short-haul service, and collects some ancillary revenues from passengers, their overall business strategy has been to build a brand identity as much as it has been to utilize a purely low-cost model (Gillen & Lall, 2017). Southwest has expanded slowly and has not aggressively pushed to provide service to marginal aviation markets in the same way that ULCCs have. As of 2015 they operated to many more hub or main airports (44%) than to secondary airports (24%) (Dobruszkes et al., 2017). In contrast, Allegiant routed only 4% of its service through main airports while 30% of seats were out of secondary airports (Dobruszkes et al., 2017). Further, over 80% of Southwest's workforce is unionized; a sharp contrast to other cost-sensitive European ULCCs such as Ryanair which almost exclusively employs contract workers for airline operations in-flight and on the ground (Gillen & Lall, 2017). Thus, there are certain criteria that establish carriers as ULCCs, and Southwest cannot be considered in this category. The following sections will profile European LCCs and how these innovative airlines inform the decisions of American ULCCs.

Low-cost airlines are driving the growth of the aviation industry across Europe, but especially in the United Kingdom, Ireland, and Spain (Dennis, 2007). In 2011, LCCs accounted for 36% of total market share in Europe compared to 30% for the United States (Graham, 2013). Both of these figures have certainly grown through 2019 as the West continued to recover from the last economic recession. Between 2008 and 2018 alone it was reported that the European LCCs grew by 14% (Button et al., 2018). The aviation industry in Europe provides important lessons for the U.S. market because of the diversified array of low-cost carriers and the impacts they continue to have on airports across the European continent. There are approximately 200 airports in Europe that can be classified as under-utilized secondary airports with less than 1 million passengers per year (Gillen & Lall, 2017). The majority of these airports are publicly owned, losing money, and are subsidized by local governments (Francis et al., 2003). Improving the financial standing of an airport usually relies on increasing passenger numbers. Therefore, attracting LCCs can be an appealing option to gain fresh investment for struggling airports and local economies, and the same can be true for airports in similar situations throughout the United States.

Several articles found that LCCs tend to increase the passenger catchment area of airports to a greater degree than would legacy or regional carriers offering the same service. The catchment area refers to the geographic nodal region surrounding an airport in which prospective passengers are drawn from. One of the heavily cited examples of LCC catchment stimulus is Charleroi airport in Belgium, a 40-mile drive from Brussels.

A commissioned study found that the majority of the passengers transiting through the airport for the LCC flight offerings were not from the immediate Charleroi region (Dennis, 2007). Most came from Brussels, as well as Northern Belgium, and the Netherlands, which each contributed equal or greater passenger figures than Charleroi itself (Dennis, 2007). Given that the region around the Charleroi airport struggles to sustain a post-industrial economy, and is not a sought-after destination, it seems anomalous that the airport attracts passengers from hours away. Dobruszkes, Givoni, and Vowles (2017) establish that LCCs often operate with a heterogeneous pairing of flight origins and destinations. Locations such as Charleroi have likely been calculated to be a mostly “departure” airport to locations across Europe, while others, especially those in southern Europe tend to be “arrival” airports (Dobruszkes et al., 2017). Arrival airports typically need to be more centrally located, as tourists probably appreciate greater proximity to their final destination than to their origin, and thus the same catchment expansion for some cities may not exist for others (Dobruszkes et al., 2017). This observation acknowledges the importance of tourism in the context of low-cost carriers’ airport choices as well as fundamentally different purposes between airport markets in context of low-cost airlines.

Tourist passengers and tourist markets are especially important to low-cost carriers throughout the world in part because tourists place lower value on the loyalty rewards of legacy airlines and do not mind the lack of amenities aboard LCC flights (Francis et al., 2003). The main factor considered when planning a leisure trip is cost, and therefore low-cost carriers can be effective in generating interest in a route through the fare alone (Dobruszkes, 2013). Dennis (2007) finds that LCCs take advantage of suppressed demand for travel by undercutting the fares of legacy carriers to expand existing markets, or to open new ones entirely. There is agreement in the literature that the conventional thinking in regards to European LCC's airport choice strategy has not painted a complete picture. It has long been assumed that LCCs' growth is primarily driven by unique and niche routes, which have untapped potential, to expand catchment areas and attract tourist primarily. However, Dobruszkes (2013) finds that growth among LCCs also comes from direct competition with legacy airlines on existing routes. LCCs serve many business travelers on high-density routes as long as the flight schedule is frequent, and thus LCCs are able to disrupt a classic dominion of legacy airlines (Dennis, 2007). These findings underscore the point that LCC and ULCC service is often not as heavily oriented towards secondary airports. The airport choice of LCCs can be broadly categorized as leaning towards major cities and catchment areas, as well as tourist destinations that are urban or coastal (Dobruszkes, 2013).

In a survey of European LCC airlines polling airport choice criteria, the respondents indicated that potential demand for services within an airport catchment area was the top factor when considering a new route (Warnock-Smith & Potter, 2005). The second-ranked factor was the availability of convenient flight times, as well as the airport possessing the capability for the fast turnaround of an inbound and outbound aircraft (Warnock-Smith & Potter, 2005). This finding correlates with the economic assertion that the LCC-airport relationship is not only defined by demand, but also by operational capacity or a lack thereof. Services to congested airports require higher yields to be profitable as there tends to be more delays on the ground and in the aerial approach (Dennis, 2007). At uncongested airports, flights do not need to be as full because carriers are able to provide more of them without delays (Dennis, 2007). With that information, it is possible to begin to draw clear operational distinctions between existing LCCs. On one side, airlines such as Spirit and easyJet make flights between main city airport pairs a central part of their business models, given that they can draw business travelers and tourists on reliably offered, relatively low-fare flights even if the overall number of these flights is hindered by congestion at crowded airports. Meanwhile, carriers such as Allegiant and Ryanair seek to tap into latent demand of small and secondary airports served by few other carriers in order to offer a wealth of flights to multiple destinations throughout the day. Their operational costs are so low at these airports that even marginally demanded routes can be profitable with a certain passenger yield.

With the information provided by the literature summarizing the operational behaviors of LCCs and ULCCs, considerations for airport development become much more apparent. The experience of smaller and regional airports in Europe has shown that LCCs seek to monopolize aviation markets and bargain to keep costs low, often threatening to remove service quickly if conditions are not being met (Button et al., 2018). A critical portion of the monopolization strategy is to reach the market first. Research shows that the first-mover advantage not only stymies potential competition (Button et al., 2018), but can provide LCCs with relative cost savings through the establishment of long-term service contracts with airports (Gillen & Lall, 2017). Further, survey data shows that existing LCC competition at an airport disincentivizes other airlines considering the same market (Warnock-Smith & Potter, 2005). The presence of a legacy carrier at an airport should not deter LCC entry because the legacy fares will usually be higher. Therefore, it is established that first-moving LCCs have a distinct advantage over other growing LCCs and entry barriers are created.

Why should airports want new LCC service? Besides the previously discussed advantages of the LCCs ability to draw passengers from a wider catchment area, there are other reasons why airports should be interested in new LCC service. Bachwich and Wittman (2017) confirmed that North American ULCCs induce a 20% drop in fares on all carriers operating to an airport following their entry into the market, compared to an 8% reduction for new LCCs. This may contribute to increased passenger demand for all flights. In addition to the income earned by the airport from aeronautical operations such as landing fees, taxes, and fueling services, non-aeronautical revenues are critical to the financial success of an airport. The fixed costs of operating and investing in new airport infrastructure is high, but the marginal costs of processing additional passengers is relatively low (Francis et al., 2003). If more money is spent on parking charges, retail sales, and food services, airports can accrue revenues at a rapid pace. Bringing in new air service provides exponential increases in passengers, and LCCs have unique traits that provide further economic advantages. As LCC passengers are frequently leisure travelers, they tend to arrive earlier than those flying for business. Francis, Fidato, and Humphreys (2003) found that LCC passengers on average spend between one to two full hours in the terminal prior to boarding. This creates many opportunities for airports to earn non-aeronautical revenues within the terminal through food and retail spending, especially because LCCs charge premiums for food and for other in-flight goods meaning passengers may be less likely to purchase when onboard and more likely to buy pre-flight.

While the literature establishes several factors that likely correlate LCC success with airport choice, particularly within Europe, there remain areas not extensively covered by current research. Alarmingly, there are few studies explaining the route preferences of ULCCs in the United States. Dobruszkes, Givoni, and Vowles (2017) provide a topical overview of airports served among LCCs and ULCCs, with the purpose of providing context to route selection based on market population alone. There is little explanation in the study of why certain ULCCs choose to operate to unique small city destinations, while others prefer only large cities. The authors also created a particularly narrow definition of an aviation market by only considering the market's population size. As a result, Las Vegas was classified as a fourth-tier "B" market, despite serving significant numbers of passengers, particularly in the LCC and ULCC segment (Dobruszkes et al., 2017). Nearly a quarter of all enplaned passengers at Las Vegas McCarran were served by ULCC flights in 2017. For context, McCarran was the 27th-busiest airport in the world the same year, and ranked 8th in the domestic market based on enplaned passengers. Clearly Las Vegas is a large market worth consideration as a major contributor to domestic air travel, one that is critical to understanding low-cost business models. A thorough review of ULCC airport choice is urgently needed for North America, one that examines the correlation between airlines, markets, and geography in the same vein as Dobruszkes (2013). Further study could also incorporate ranked airport factors that are important to domestic ULCCs as was done by Warnock-Smith and Potter (2005).

Overall, the reviewed literature establishes a base of knowledge surrounding European low-cost carriers, with limited comparisons to North American carriers, but particularly Southwest Airlines, and correlations of service with airport factors as well as geographical contexts. Compelling arguments are created for further investigation such as exploring how ULCCs have been able to rapidly expand throughout the United States following the 2008 recession and which airport choice factors have enabled their success. ULCCs capture a greater share of the aviation market every year, and it is critical that academics, airport managers, government agencies, and the public at large understand how business decisions are being made by such airlines.

CHAPTER 3

PROBLEM STATEMENT

Literature suggests that there are many considerations made on the part of ultra low-cost airlines in selecting aviation markets, particularly throughout Europe. What is not explained is how the same practices are reflected in North America, if at all, and how these factors may contribute to the recent growth of ULCCs in the U.S. The purpose of this paper is to assess the distribution of ULCC operations across the United States and analyze patterns that may explain how certain airport markets are prioritized for service over others. To actualize the overall goal, the research asks the following: *What are the primary factors that inform ULCC decisions to certain airport markets?*

Evidence suggests that one primary factor in domestic ULCC operations is the ability to capture tourist demand, while flights between large cities may suggest the importance of population and airline competition to ULCC success. The following analysis seeks to unravel the web of market, demographic, and airport factors which may be significant in the operational decision-making of ULCCs.

CHAPTER 4

METHODS AND DATA

To answer the primary research question, the first step in this process was to establish a baseline of data for current ULCC operations. Using domestic flight information from 2019, a roster of all airports in the United States and its territories served by ULCCs was created. From there it was possible to theorize a list of demographic and aviation-related variables that may be valuable to ULCCs and aid in explaining service patterns. Linear and logit multiple regression analysis were then used to analyze the relationships and significance of such independent variables. Finally, three case studies of airport markets were examined qualitatively through interviews with airport managers to capture a more detailed understanding of ULCC business characteristics and any special circumstances unaccounted for by quantitative analysis.

Dependent Variable – Data Sources and Processing

Data for 2019 ULCC operations were collected from online resources. In order to analyze existing ULCC flight activity, non-stop flight segment data were downloaded for all U.S. carriers in 2019 through the Bureau of Transportation Statistics T-100 domestic segment table. Instead of using data by route pairing such as that provided through the U.S. Department of Transportation's DB1B survey, the T-100 data portrayed a more comprehensive account of ULCC service across the United States on each of the classified carriers. The data were trimmed to leave only the four identified ULCC's (Allegiant, Frontier, Spirit, and Sun Country) flights intact. Data showing the flight service class "L – Non-scheduled civilian passenger/cargo service" were removed which included charter and non-revenue flights, leaving the service class "F – Scheduled civilian passenger/cargo service" remaining. Flight segments were sorted and summed by airport code, leaving the annual ULCC enplaned passenger totals as the dependent variable for each airport served. The list of Part 139 airports in 2019 was acquired from the Federal Aviation Administration. Part 139 certification is required by the Federal Aviation Administration for airports that serve scheduled aircraft with more than 30 seats. Therefore, the certification is required for virtually all airports with scheduled commercial passenger air service, or for those that anticipate receiving service. Airports must maintain certain infrastructure and operational capacities to acquire Part 139 certification including passable runways and taxiways, navigational aids, fueling services, and rescue and fire-fighting equipment.

Table 2 – Dependent Variable Data Sources

Data	Source
2019 ULCC Flight Segments	Bureau of Transportation Statistics Form 41 T-100 Domestic Segments 2019
Part 139 Airports	Federal Aviation Administration Part 139 Airport Certification 2019

Independent Variables – Hypotheses, Data Sources and Processing

A list of independent variables, informed by previous research which provided indications that ULCCs require certain market factors as prerequisites for operation to viable aviation markets, was formed for analysis through regression. Data were collected primarily from two sources: The Bureau of Transportation Statistics (BTS) and The U.S. Census Bureau. Most variables were calculated or finalized through ArcGIS in order to effectively join the demographic data to the specified airport areas. The background of the independent variables and the processing procedures undertaken are explained in detail below:

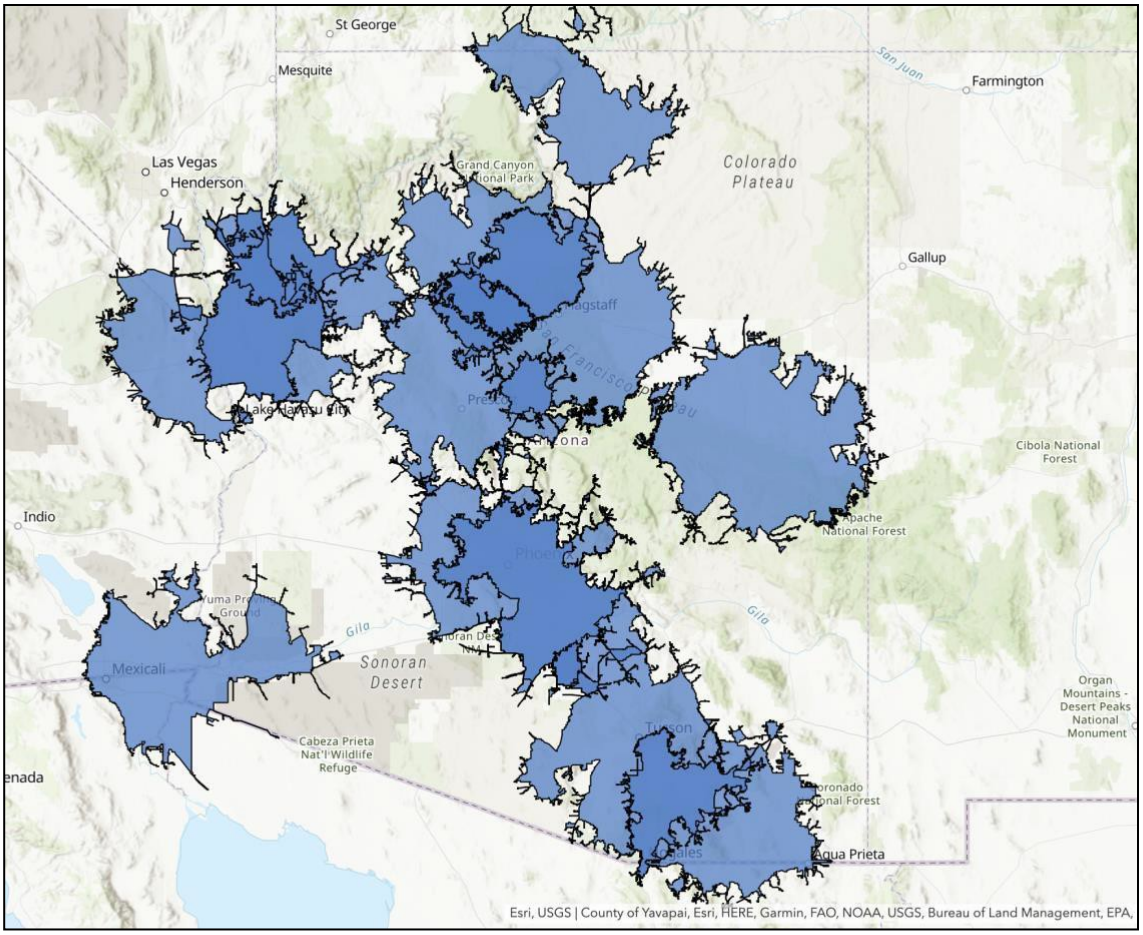
Metropolitan Statistical Area Population

Data were collected for the metropolitan or micropolitan statistical area populations for each airport in the study. Using data from the U.S. Census Bureau, population values for 2018 were extracted through overlay and extraction tools in ArcGIS. A total of 96 airports out of the 514 airports studied could not be placed within a metropolitan or micropolitan statistical area. These airports were given the population values of the county in which they reside. Airports sharing a metropolitan statistical area with more than one airport were assigned the same value.

Catchment Area Population

Totals were collected for the catchment area population of each Part 139 airport using tools in ArcGIS. With each airport plotted according to its latitude and longitude, the driving distance network analysis tool was utilized to generate a polygon of 70 miles from the starting point. The distance was chosen based on EAS criteria for minimum airport separation from a medium or large hub airport made effective in 2000 under the Department of Transportation and Related Agencies Appropriations Act. The driving distance polygon was then overlaid on 2019 census tract population data to create population estimates for each airport's 70-mile catchment area. An example of catchment area polygons used in the analysis is visible in Figure 1.

Figure 1 – Overlapping Driving Distance Polygons for Arizona Airports



Existing Southwest Airlines Service

Using flight data from the Bureau of Transportation Statistics for 2019, each airport with existing Southwest Airlines service was given a categorical value of “1”, and those without were marked as “0”. Southwest is discussed in literature as being negatively correlated with ULCC service and could be a barrier to entry for a ULCC into a new aviation market (Dobruszkes et al., 2017). Southwest operates relatively low-fare flights with few ancillary costs, and has consistent reliability from dedicated frequent flyer members as well as business travelers. This business model is therefore threatening to a ULCC in the same environment, when the ULCC does not have enough advantages in fare to make up for a lack of other amenities.

Existing ULCC Presence

Similar to Southwest Airlines data, airports with existing ULCC service are seen as unlikely to draw new ULCC entrants. Airports with multiple ULCCs offering service may indicate an abundance of travelers or simply a large aviation market that is too valuable to ignore. BTS flight data were used to categorize airports with two or more ULCCs in operation during 2019 as a "1", and those with one or fewer ULCCs as a "0".

Distance to Existing ULCC Airport

The distance between airports calculation was broken down in two ways using the driving distance network analysis tool in ArcGIS Online: first, each Part 139 without existing ULCC service was linked with the closest airport with ULCC service. The process was repeated by calculating the distance between existing ULCC airports. Therefore, each airport was mapped to the closest airport with existing ULCC service. This method was utilized due to the theory that airports near other airports with existing ULCC service would not be likely targets for new ULCC expansion, and therefore secondary airports without existing service would be attractive destinations. Likewise, an airport without ULCC service placed a greater distance away from an existing ULCC airport might carry a greater potential for service given a more independent catchment area.

EAS Service

Airports with existing EAS service were denoted by a categorical variable using data from the FAA for 2019. Airports with existing EAS service were given a value of "1" and those without were given a "0". It was hypothesized that airports with EAS service are less likely to be candidates for ULCC service given that a viable commercial market for ULCCs is less likely to exist, and that ULCC operations may not be competitive with subsidized air service.

Frost Belt State

To account for the possible effects of climate in stimulating ULCC passenger demand and air service, a variable was created based on data from the Köppen world climate classifications map. Airports were sorted by state and assigned categorical values using based on the dominant climate classification. Airports within states covered by roughly 50% or more of the land area with the *Dfb* "snow, warm-summer humid continental climate" classification were given a value of "1". States with less than 50% coverage by *Dfb* were given values of "0". The "snow, warm-summer humid continental climate" classification was chosen because of its unique properties related to temperature differences between winter and summer months. To be classified as a *Dfb* region, the coldest month of the year must average below 32 degrees Fahrenheit, and all months of the year must average below 71.6 degrees Fahrenheit (Kottek et al., 2006). These criteria indicate areas in which winters are harsh but summers are relatively mild. Airports in each of the following states were coded as "1": Connecticut, Massachusetts, Maine, Michigan, Minnesota, North Dakota, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, and Wisconsin.

Regional Tourism Economy

A critical theme repeated throughout aviation literature is the importance of tourism to the low-cost airline sector. Tourists are the most likely candidates to be induced to travel based on price (Dennis, 2007; Dobruszkes, 2013). ULCCs that are able to tap into tourist-rich areas seemingly have the potential to expand service exponentially. Therefore, it was important to find a way to quantify the significance of tourism to any given airport market in the United States. Using North American Industry Classification System (NAICS) codes for the Arts, Entertainment, and Recreation industries (71) and the Accommodation and Food Services industries (72) in 2017, counts of employees were totaled for each county in the U.S. in addition to the total employed population of each county. The data were joined in ArcGIS with county shapefiles. From there the 70-mile driving distance polygon for each airport was overlaid onto the employee data. The employee data were summarized within each polygon, providing a count of tourism-related employees and total employed population within each airport catchment area. Tourism employment figures were then divided by the total employed population, providing an estimate for the tourism percent of the local economy for each airport area.

Proximity to a Border Crossing

Based on existing ULCC route maps that some carriers operate flights to U.S. destinations in close proximity to international borders with Canada and Mexico, it was hypothesized that the low fares of ULCCs may stimulate eligible travelers to cross the border for a flight originating in the U.S. rather than pay the often-higher costs and fees associated with international air travel. The network analysis tool in ArcGIS included data for roadways in Canada and Mexico, so a categorical variable was created to account for airports that may be advantageous to commercial air service based on whether the 70-mile catchment area extended across an international border. A “1” was given to airports with a border crossing within 70 miles and a “0” was given to those without.

Distance to a Major City

To derive the distance from each subject airport to the closest major city, a driving distance network analysis tool was used in ArcGIS to calculate a driving distance in miles from the airport point to the nearest city with 50,000 residents or more. The tool finds the shortest driving route in distance but does not account for the type of road or typical congestion. It was hypothesized that airports in greater proximity to a major city would be more attractive to flyers.

Median Income

Economic theory establishes that areas with higher median incomes will typically have a higher degree of disposable income, which may promote greater rates of travel among the population (Varlamova & Larionova, 2015). Data on median income of the U.S. population were collected via census tract data provided by the U.S. Census Bureau. Placed into GIS, the data were overlaid by the catchment area polygons for each airport and extracted by taking the average of the median income in each intersected tract per airport area.

Household Size

If ULCCs are seeking to draw tourists to airports in Florida and other warmer climates, it can be inferred that families of travelers would compose a significant proportion of travelers on ULCC flights. The research tested the hypothesis that ULCC service is associated with the average family size of the airport's catchment area. Downloaded from the U.S. Census Bureau, data for household size by census tract was overlaid by airport catchment areas and averaged through the overlap. The resulting figures reflect the average household size in number of residents for each airport catchment area.

Airport Delays

Existing literature suggests that ULCCs avoid serving airports with frequent delays and congestion as this detracts from the overall bottom line of operations (Francis et al., 2003). Operationally, ULCCs prefer to keep ground time to a minimum and process as many flights per day as possible. Data were collected from the FAA for commercial traffic arrival delays for all airports that received air service from reporting airlines in 2019. The total minutes of delay for each eligible airport was divided by the number of flights received to compute the average arrival delay per flight.

Average Airport Wage

Analyzing the true cost of airport operations is a difficult task because there are many factors which contribute to aviation costs and several can vary between carriers, even those operating to the same airport. Costs including fuel, landing fees, overnighting, and labor, are all factored into the equation and may determine whether ULCCs consider an airport for operations. During the course of this research, an accessible resource that compiled such fees for all Part 139 airports in the U.S could not be located. As a proxy, data were compiled through NAICS codes for the average wage paid to workers in airport operations (codes 4881-) during 2017. Using the same process as the tourism data, the average wage paid to airport workers was derived for each airport area. However, the data varied wildly across aviation markets, particularly smaller markets with limited air service and was deemed unreliable.

Table 3 – Matrix of Independent Variables

Objective	Indicator	Variable	Expected Relationship	Data Source
Market Factors	Market Population	Metropolitan Statistical Area Population	+	U.S. Census Bureau
		Catchment area population	+	U.S. Census Bureau
	Competition	Existing Southwest Airlines service	-	Bureau of Transportation Statistics
		Existing ULCC presence	-	Bureau of Transportation Statistics
		Distance to existing ULCC airport	+	ArcGIS
		EAS service	-	Federal Aviation Administration
	Travel Purpose	Frost Belt state	+	Köppen Climate Regions
		Regional tourism economy	+	U.S. Census Bureau
	Proximity	Proximity to a border crossing	+	ArcGIS
		Distance to a major city	-	ArcGIS
Demographic Factors	Travelers	Median income	+	U.S. Census Bureau
		Household size	+	U.S. Census Bureau
Airport Factors	Facilities	Airport delays	-	Bureau of Transportation Statistics
		Average airport wage	-	U.S. Census Bureau

Other Data Trends

Additional variables were considered following a review of the descriptive statistics for 2019 ULCC service. There seemed to be anecdotal correlation between ULCC service on Allegiant and heavily populated college towns, such as State College, PA (SCE), Eugene, OR (EUG), and Provo, UT (PVU). Ski resorts and mountain airports also appeared to have potential implications for ULCC service. Small airports in Colorado, Montana, Idaho, and Wyoming received ULCC service in 2019 on at least a seasonal basis. These variables were deemed to be too niche and were not substantial enough to support the goal of this research. Further study could evaluate links between air service and these particular market characteristics.

Regression Models

For the regression analysis portion of the study, it was determined that two fundamental questions needed to be addressed within the setup of the regression in order to evaluate the ULCC-airport relationship:

1. Which factors increase the likelihood that an airport market is a viable option for ULCC service; and
2. Which factors influence the quantity of air service offered to an airport market.

To answer these questions, two models of regression analysis were used: binary logistic regression, and linear regression respectively. Binary logistic regression is a statistical method used to predict the relationship and evaluate significance between independent variables and the dependent variable when the dependent variable is a binary value. In this case, the binary dependent variable is whether or not ULCC service exists at an airport. Ordinary least squares (OLS) multiple regression model seeks to evaluate the strength of the predictive independent variables in relation to an interval or ratio dependent variable by fitting a linear equation to observed data in continuous numerical form. The dependent variable used in the linear regression was the amount of enplaned ULCC passengers processed by each airport in 2019.

Data input into the regression models was further adjusted by several means. First, based on an analysis of outlier data, observations (or cases) for airports in Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands were removed from the data table. During data collection, it was difficult to generate reliable data for the non-contiguous areas of the United States for independent variables such as the distance to the closest airport with existing ULCC service. In Hawaii and most regions of Alaska, for example, this variable field contained null values as many Part 139 airports are not connected by roads or are separated by water in these areas. Data for the U.S. Virgin Islands was unavailable from the selected data sources across many variables. Second, data for the catchment area populations and ULCC enplanements were transformed through common logarithmic calculations (base 10) to normalize the large and diverse values for these variables and enable a better fit to a linear relationship.

To ensure the highest quality regression results, several independent variables were left out of the analyses. They are listed below with reasonings for their exclusion:

- *Metropolitan Statistical Area*. Data values were inconsistent or unavailable, particularly for smaller markets. The 70-mile catchment area variable seemed to capture population values more evenly across the nation, and was more compelling for further investigation.

- *Existing Southwest Service*. It was determined that although evidence seems to suggest that ULCCs avoid particular airports or markets due to the presence of Southwest Airlines, the significance of Southwest service as an independent variable would be marred by endogeneity. In a sense, Southwest service may measure similar phenomena as ULCC service because both are focused on leisure and tourist markets, although not exactly in the same way. Therefore, the model would suffer from including them both and treating them as different factors.

Existing ULCC Presence. While this variable may be helpful in assessing whether or not ULCCs are likely to commence service to a market where ULCC competitors already exist, including this variable in either regression model was not appropriate. Airports with multiple ULCCs already present will naturally have higher ULCC enplanement totals, making a linear regression for enplanements ineffective. Using existing ULCC service to predict ULCC service through a binary logistic equation will understandably return a high significance. While existing ULCCs may dissuade other ULCCs from entering the market, this variable is not constructive for this research.

- *Frost Belt State*. In preliminary rounds of regression, the data for Frost Belt airports showed limited correlation to ULCC enplanements and was ineffective at predicting accurately the presence of ULCC service. The variable was eliminated from further analysis given that evidence of its relevance was rather anecdotal.

- *Median Income*. Data for median income correlated highly with population data, leading to multicollinearity. Larger cities have more diverse economic sectors, a range of employment opportunities for people with advanced professional degrees and higher salaries, which lead to higher median incomes. The variable was removed in favor of population.

- *Household Size*. The data collected for average household size tended to correlate with the catchment population data and were therefore viewed as collinear.

- *Airport Delays.* Data for this variable could only be collected for airports which handle commercial service from airlines which report delays to the FAA. Carriers that handle 0.5% of annual domestic scheduled-service passenger revenue report on-time data and the causes of delay. During 2019 the list of carriers did not include Sun Country Airlines, and 31% of Part 139 airports did not have carriers which met the threshold to report delays. The variable could not be included with the amount of missing data.

- *Airport Wages.* Due to the imprecision and unavailability of the specified NAICS codes related to airport support workers across many regions of the United States, data for the average airport worker wage varied wildly and was not distributed normally. As a result, the variable was eliminated due to its unreliability.

Case Study Interviews

The third method used to understand the ULCC-airport relationship were case studies of airports, informed by qualitative interviews. This method was chosen as a means to uncover details about ULCC decision-making that may be left out of a conventional quantitative analysis. Three airports were selected on account of their experience with ULCCs, or their unique characteristics that warranted further study. One airport, Bellingham, Washington, was selected due to the continued presence of a ULCC at the airport. A second, Waco, Texas, did not have ULCC service in 2019 despite having a sizable population, a centralized location in a growing urban region, and limited aviation competition. Third, Lincoln, Nebraska was selected for further study based on its history as a former ULCC market. Interviews were conducted with one representative of the airport management staff for each airport. The format of the interview was a short, structured discussion using an identical list of four questions. A copy of the interview questions is included in Appendix C. Notes from each interview were transcribed in process, and limited follow-up questions were asked to gain further insight to specific topics. Each of the case studies offered a unique context and perspective on the complexities of the domestic aviation landscape, and provided valuable details to add depth to the conclusions of the research.

CHAPTER 5

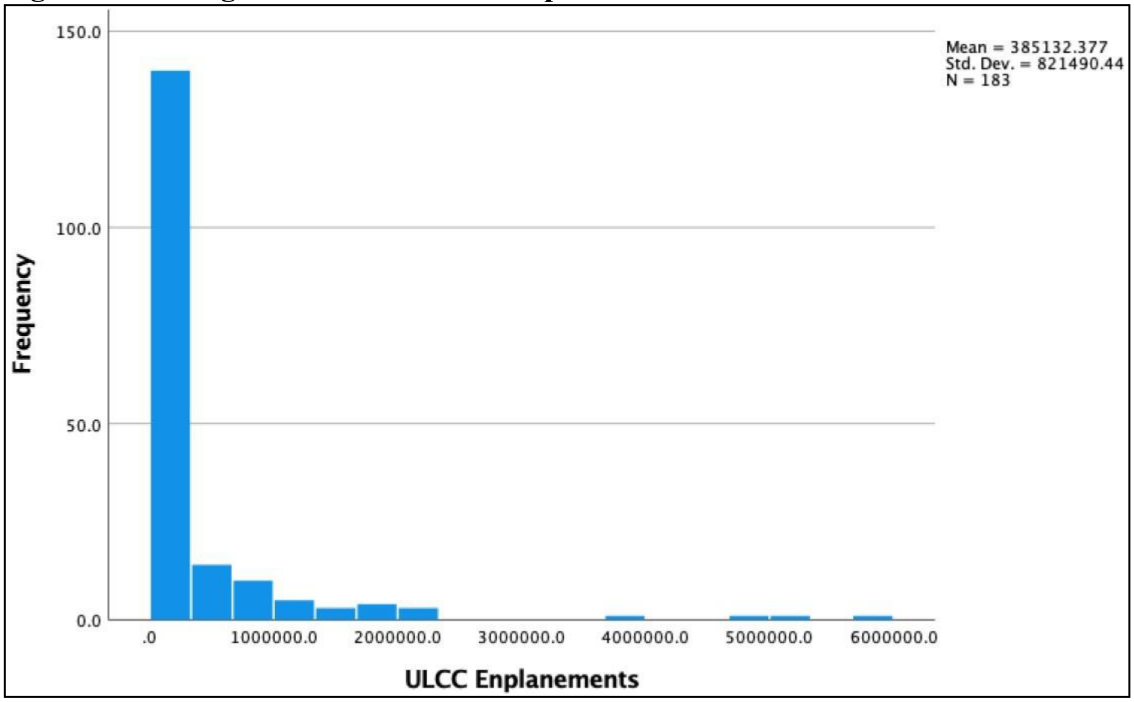
RESULTS

The results chapter is divided into two subsections. The first discusses the existing conditions observed for 2019 ULCC operations in the United States, showcasing them graphically, and the second examines the output of the regression analyses.

Existing ULCC Operations

A total of 183 airports in 49 states, Puerto Rico, and the U.S. Virgin Islands were served by scheduled ULCC commercial passenger service in 2019. There were no airports in the state of Delaware with ULCC service. McCarran International Airport (LAS) in Las Vegas led all airports with nearly 5.7 million total ULCC enplanements. Las Vegas was followed by Orlando International (MCO), Denver International (DEN), and Fort Lauderdale/Hollywood (FLL) each of which exceeded at least 3.8 million enplanements. For context, none of these airports were in top four ranking of U.S. airports for total domestic enplanements across all carriers in 2019, though Denver, Las Vegas, and Orlando placed among the top ten. This indicates that many of the largest airports in the country are not the top priorities for ULCC air service.

Figure 2 – Histogram of 2019 ULCC Enplanements



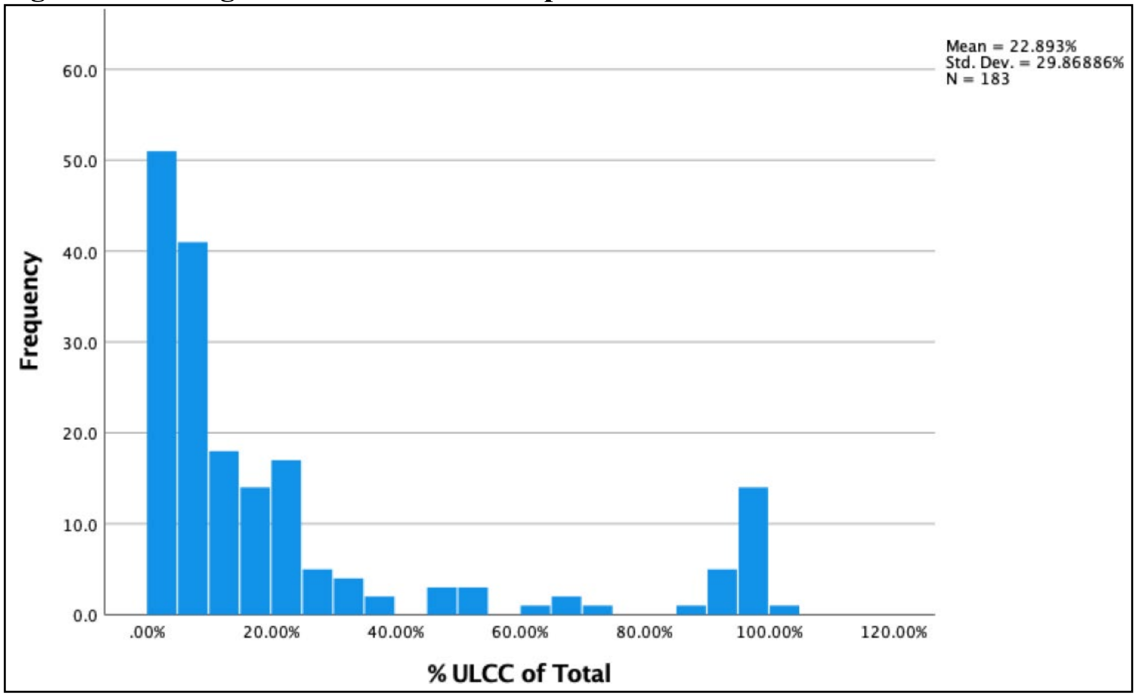
Outlined in Figure 2, the top four airports by ULCC enplanements are clearly separated from the remaining 180 airports; the next closest airport, Chicago O'Hare, processed only 2.2 million enplanements in 2019. It is worth noting that every one of the top four airports was served by all four ULCCs during 2019 with the one exception: Allegiant's absence from MCO. Therefore, the high numbers of enplanements may be simply explained by the frequency of ULCC flights to those airports. Saint George, Utah, saw the fewest ULCC enplanements of the airports served with 2,010 boardings on Allegiant during winter seasonal service. A total of nine airports served fewer than 10,000 enplaned passengers in total during 2019, likely for various reasons including seasonal service, new service started late in year, or service terminated at the beginning of the year. A sample of 2019 ULCC flight data is presented in Table 4.

Table 4 – Examples of 2019 ULCC Enplanements

Airport	2019 ULCC Enplanements	ULCC Airlines
Washington Dulles (IAD)	151,794	Frontier, Sun Country
Grand Rapids (GRR)	334,197	Allegiant, Frontier
Seattle (SEA)	479,277	Frontier, Spirit, Sun Country
Atlantic City (ACY)	520,566	Spirit
Boston (BOS)	844,718	Allegiant, Frontier, Spirit, Sun Country
St. Petersburg-Clearwater (PIE)	1,119,067	Allegiant
Detroit (DTW)	1,953,269	Frontier, Spirit
Orlando (MCO)	5,181,972	Frontier, Spirit, Sun Country

Examining total domestic enplanements across all airlines for each airport enabled a calculation of ULCC service in respect to its total market share of each airport. From a percentage standpoint, 31 airports showed a 45% or higher value of ULCC enplanements out of the airport’s total. This demonstrates the degree to which ULCCs will seek to expand to underserved airports on the basis of cost savings, catchment area augmentation, or avoidance of other carriers. The distribution of 2019 ULCC enplanements as a percentage of the airport’s total 2019 domestic enplanements, or market share, is displayed in Figure 3.

Figure 3 – Histogram of 2019 ULCC Enplanement Market Share

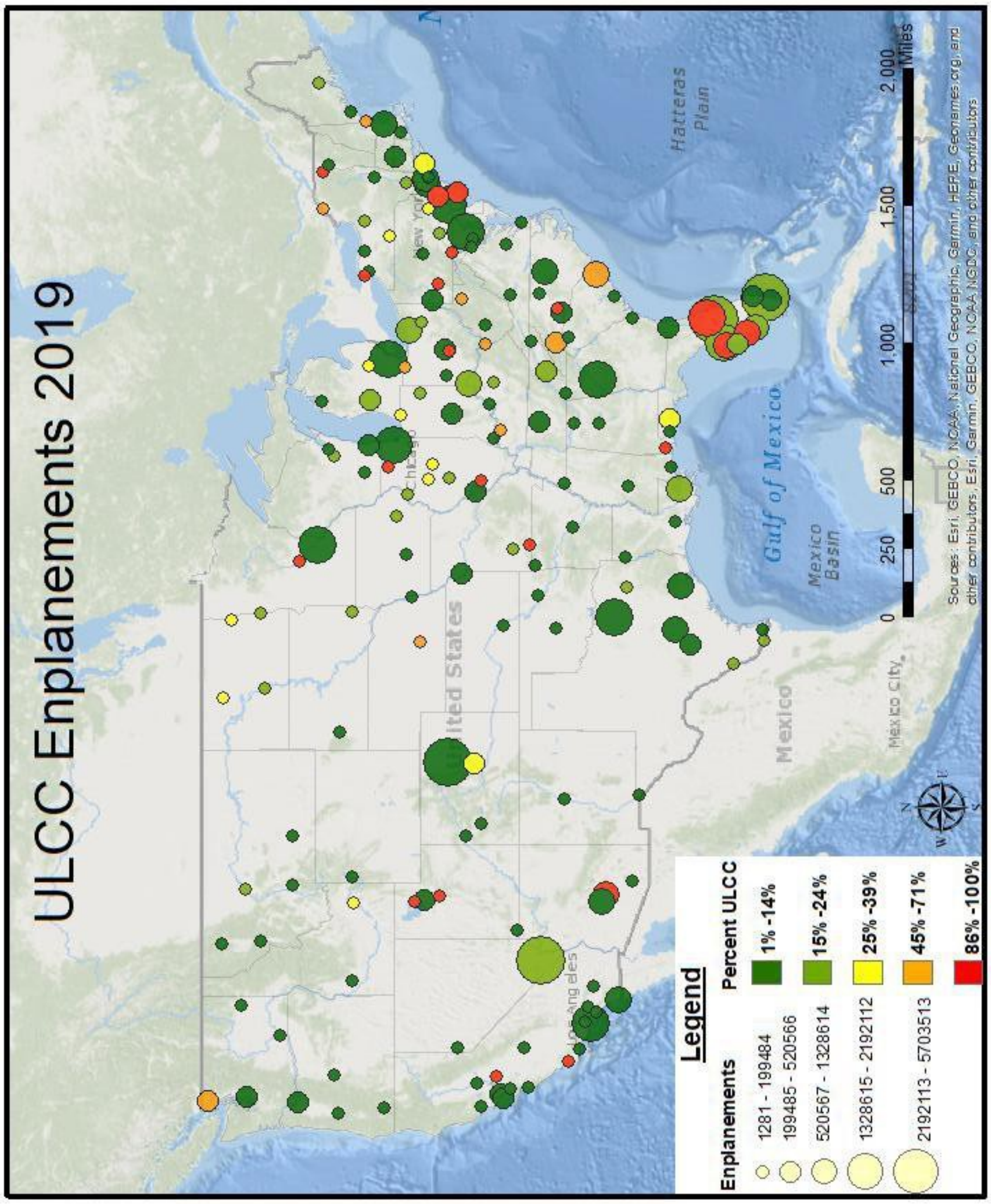


The bimodal distribution of airports' ULCC market shares indicates that while many do not receive high proportions of service, a significant number of airports are dominated by ULCCs. Allegiant Air is perhaps the most aggressive among ULCCs in pursuing untapped markets, serving as the exclusive regular commercial operator to airports such as Punta Gorda, Florida (PGD), Belleville, Illinois (BLV), Concord, North Carolina (USA), and Phoenix-Mesa, Arizona (AZA). Other ULCCs effectively control select airports on their own such as Frontier Airlines at Trenton, New Jersey (TTN), and Spirit Airlines at Atlantic City, New Jersey (ACY) and Latrobe, Pennsylvania (LBE). The remaining 153 airports with ULCC service capture comparatively smaller percentages of market share, normally due to competition from legacy and low-cost carriers at large airports, or regional airlines at small airports.

Table 5 – Examples of 2019 ULCC Market Shares

Airport	ULCC Enplanements of Total	ULCC Airlines
San Francisco (SFO)	1%	Frontier, Sun Country
Columbus (CMH)	7%	Frontier, Spirit
Fort Lauderdale (FLL)	21%	Allegiant, Frontier, Spirit, Sun Country
Bloomington/Normal (BMI)	32%	Allegiant, Frontier
Portsmouth (PSM)	52%	Allegiant
Myrtle Beach (MYR)	66%	Allegiant, Frontier, Spirit, Sun Country
Stockton (SCK)	93%	Allegiant
Trenton (TTN)	100%	Frontier

Figure 4 – 2019 ULCC Enplanements and Market Share



The results of data collection for 2019 ULCC service is displayed in map form in Figure 1. The points are georeferenced to each airport in the continental U.S. with ULCC service and the size of each point represents the total of enplaned passengers during 2019. Several ULCCs also serve domestic and international routes to the Caribbean and Central and South America. Only the domestic enplanement data for travelers terminating in Puerto Rico and the U.S. Virgin Islands is included in the map data. The points were sized using a natural breaks classification. The color of each point denotes the percentage of ULCC enplanements in relation to the airport's total enplanements among all commercial airlines, classified using defined intervals.

Notable on the map is the concentration of large enplanement values and high ULCC percentages in Florida. Nearly every Part 139 airport in the state has ULCC service and these airlines schedule high frequencies of flights to serve them. Also present is a cluster of significant and ULCC-valued airports along the Northeast Corridor between Washington, D.C. and Boston, as well as a belt of popular yet competitive large airports in the Great Lakes region. Meanwhile Denver and Las Vegas are by far the two largest ULCC markets in the western U.S., where relatively few airports manage to exceed 14% in ULCC market share. Given the national distribution of population, it may not be a surprise to see higher enplanement figures at more airports in the eastern half of the country. This pattern may also point to ULCCs being more competitive against legacy carriers and LCCs for popular intercity routes on the east coast compared to the west coast. Spirit Airlines, in particular, serves significant numbers of passengers in Atlanta, Dallas-Fort Worth, and Chicago at major hub airports, each dominated by a different legacy carrier. It is apparent that ULCCs serve a diverse mix of airports on the east coast and achieve a higher percentage of market share in the northeast than many locations to the west. It can be theorized from the map that a primary business strategy of ULCCs has been to draw latent travel demand to tourist-rich areas primarily in Florida, and a lesser extent to areas such as Myrtle Beach, South Carolina and the northern Gulf Coast.

Regression Results

The independent variable data were examined thoroughly before completing the regression analysis. As previously described, several variables were left out of the regression analyses for various reasons. The table below provides descriptive statistics for all variables used in each regression:

Table 6 – Variable Descriptive Statistics

Dependent Variables	Mean	Median	Standard Deviation	C.V.	Freq.“0”	Freq.“1”	Percent “1”
Existing ULCC Service	-	-	-	-	295	179	37.8%
ULCC Enplanements (Log10)	5.06	5.08	.69	13.64	-	-	-
Independent Variables							
Catchment Area Population (Log10)	5.96	6.02	.69	11.58	-	-	-
Existing EAS Service	-	-	-	-	388	86	18.1%
Distance to a Major City	43.38	10.08	55.17	127.18	-	-	-
Distance to ULCC airport	87.70	77.34	53.48	60.98	-	-	-
Within 70 Miles of a Border Crossing	-	-	-	-	439	35	7.4%
Tourism Percent of Economy	10.94%	10.40%	3.65%	33.36%	-	-	-

The logarithmic transformations of the population and enplanements data showed relatively normal distributions of values and a low coefficient of variation (standard deviation/mean). The data for the tourism proportion of the local economy were fairly normally distributed, which did not match the idea that airport markets would be split in a bi-modal trend between tourism origins and tourism destinations. However, the variables for distance to a major city and distance to a ULCC airport show higher coefficients of variation indicating that the data were spread farther from the mean. While a higher coefficient of variation is not an inherent issue, the data for distance to a major city may not fit as well to a regression equation as other variables.

The next step was to examine correlations between variables and determine whether multicollinearity existed. Next, Pearson correlation analysis was performed to examine the relationship between variables. A selection of Pearson correlation coefficient results is shown in Table 7.

Table 7 – Pearson Correlations

	1.	2.	3.	4.	5.
1. EAS Service	-				
2. Distance to Major City	.521**	-			
3. Distance to ULCC Airport	.194**	.407**	-		
4. Tourism Economy	-.145**	.113*	.073	-	
5. Catchment Population (Log10)	-.444**	-.693**	-.626**	-.175**	-

**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

The results of the correlation analysis show that there were several correlations that could be classified as strong across the tested variables and that many were highly significant. The significant and positive correlation between EAS service and the distance of an airport to a major city is intrinsic given that that distance from population centers is the main characteristic qualifying an airport for EAS service. Both variables warrant further investigation as to how they influence ULCC service. One might expect the distance to ULCC airport variable to correlate strongly with the EAS variable; while the correlation is significant, the coefficient is fairly low. This likely relates to the fact that few Part 139 airports utilize Essential Air Service. The catchment population variable correlated substantially with the distance to major city and distance to ULCC airport variables, and moderately with the EAS variable, all with negative *r*-values. This matches the assumption that a lack of population predicts EAS eligibility and that greater population tends to encourage proximate airport development and requires less distance to find ULCC air service. The full table of Pearson correlations may be found in Appendix B. Finally, the results of the two regression analyses solidified details of the relationships between aviation market factors and ULCC air service.

Linear Regression

The linear regression analysis was executed with ULCC enplanements for 2019 by airport as the dependent variable, transformed logarithmically. Assumptions were addressed for multicollinearity, autocorrelation of residuals, linearity, and homoscedasticity. None of the variance inflation factor (VIF) values were below 0.1 and no tolerance values exceeded a value of ten. Therefore, the assumption of no multicollinearity was satisfied. The scatterplot of standardized residuals compared to standardized predicted value did not indicate a curve or funnel thus satisfying the assumptions of linearity and homoscedasticity. Furthermore, the computed Durbin-Watson value of 1.896 for the regression points toward a lack of autocorrelation bias present in the data.

To summarize the Analysis of Variance table (ANOVA), the degrees of freedom (df) showed a value of 6 for the regression and 172 for the residuals, corresponding to the variable inputs to the equation. The F-value of 15.79 with an overall significance of <.001 indicates that the model provides a better fit to the line equation than the constant intercept would by itself. The model summary shows an R-square value of 0.355. Translating this value to a percentage, the linear regression model as a whole was able to predict 35.5% of ULCC enplanements using the independent variables provided. The full output for the coefficients table is provided in Table 8.

Table 8 – Linear Regression Coefficients

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.219	.724		-.303	.762
	Lg10 Pop	.718	.100	.560	7.151	<.001
	Distance to Other Airport (Miles)	.001	.001	.059	.818	.415
	EAS Service (2019)	-.004	.274	-.001	-.014	.989
	Tourism Percent	.069	.019	.228	3.680	<.001
	Within 70 miles of a Border Crossing	.077	.150	.033	.515	.607
	Distance to Major City (Miles)	-.002	.001	-.081	-1.146	.253

a. Dependent Variable: Lg10 Enplane

The main takeaways from the table are the strength and significance of the positive relationship between catchment area population and the number of ULCC enplanements, as well as the significance of the local tourism economy in predicting ULCC enplanements. The quantity of ULCC enplanements for 2019 was predicted by the 70-mile airport catchment area ($\beta = .56$, $t = -7.151$, $p < .001$). When both dependent and independent variables are logged, the coefficients are understood as percentages. For every 10% increase in the catchment area population, ULCC enplanements rose by 5.6%. With similar significance, although much less strong ($\beta = .228$, $t = 3.68$, $p < .001$), the percent of employees working in tourism-related industries (tourism percent) also indicated increases in ULCC enplanements. For every 10% increase in the proportion of the local economy dedicated to tourism, ULCC enplanements increase 0.69%. The other variables analyzed did not have significant results in the linear regression.

Binary Logistic Regression

Many of the independent variables did not show significance in the linear regression model, and additional assumptions about the relationship between ULCC service needed to be tested through other means. It was determined that a binary logistic regression model could properly evaluate whether other variables were important to the existence of any ULCC service for the 472 airports within the study group, rather than to the quantity of service. The regression was executed using the category value of Existing ULCC service translated from “Yes/No” to “1/0”. The Log10 enplanement data were left out of the regression.

Table 9 – Binary Logistic Regression Summary

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	517.038[a]	.207	.282

Summarizing a binary logistic regression in one value is difficult because determining the fit of a range of variables to a categorical variable does not have the depth of a typical linear regression. Using the Nagelkerke R-square, which is able to interpret the full range of likelihood for categorical variables, the model shows a value of 0.282. Therefore 28.2% of the variance in ULCC service is explained by the independent variables. This value leaves more to be desired, but the purpose of this regression is to continue evaluating independent variables rather than the model as a whole. The classification table below details how well the model was able to predict the existence of ULCC service.

Table 10 – Binary Logistic Regression Classification Table

Classification Table[a]					
	Observed		Predicted		
			Existing ULCC Service (Category)		Percentage Correct
			0	1	
Step 1	Existing ULCC Service (Category)	0	229	64	78.2
		1	77	102	57.0
	Overall Percentage				70.1

a. The cut value is .500

The model performed relatively well in predicting airports that did not receive ULCC service in 2019, correctly predicting about 78% of those airports, and it had moderate success predicting those that did, with 57% correct. The variables results are displayed in Table 11.

Table 11 – Binary Logistic Regression Results

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	EAS Service (2019)	-1.499	.517	8.389	1	.004	.223
	Distance to Major City (Miles)	-.011	.004	10.170	1	.001	.989
	Distance to ULCC Airport (Miles)	.009	.003	10.916	1	<.001	1.009
	Within 70 miles of a Border Crossing	1.167	.455	6.590	1	.010	3.212
	Tourism Percent	.006	.037	.027	1	.870	1.006
	Lg10 Pop	.932	.280	11.040	1	<.001	2.539
	Constant	-6.523	1.997	10.665	1	.001	.001

Highly significant relationships (at the 99% level or higher) are evident between the dependent categorical variable of existing ULCC service and the independent variables of (1) EAS service, (2) distance to major city, (3) distance to a ULCC airport, (4) log of population, and (5) proximity of the airport to a border crossing. As a result of the odds ratio (Exp(β)) values, it is possible to form conclusions about the variable relationships. Airports with EAS service are less likely to receive ULCC service by a factor of 0.223. Airports with a greater distance to an airport with existing ULCC service are more likely to receive ULCC service by a factor of 1.009 per additional mile. Airports located closer to a major city had a lesser likelihood of ULCC service per mile of distance (.989). Airports with higher catchment area populations had a much greater likelihood for ULCC service (2.539) which indicates that the odds increase by 2.539 for every increase of the population by a power of ten. The variable for tourism percent of the economy was the only variable that was not highly significant (.870).

CHAPTER 6

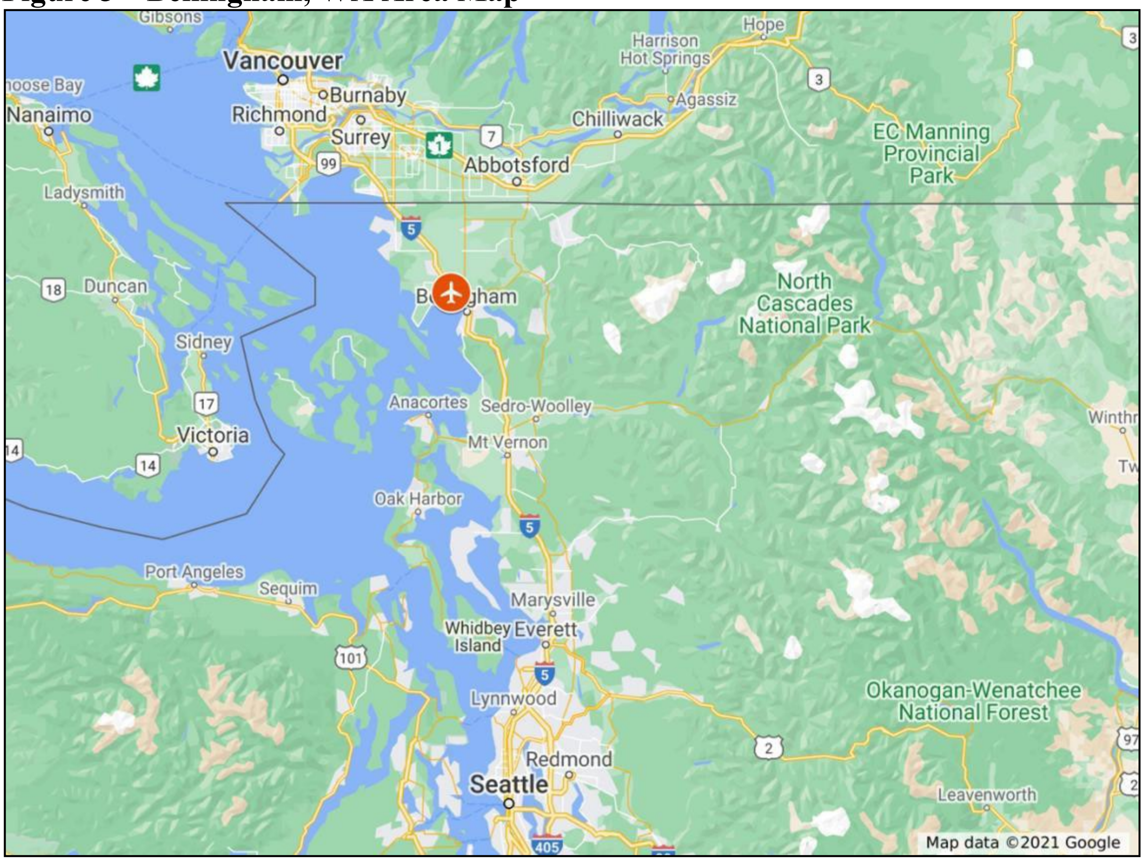
CASE STUDIES

Case studies were undertaken to provide additional context and qualitative analysis to the 2019 operational figures and regression analyses. Three airports were selected for further study based on their relevant experience with ULCCs and unique characteristics making them worthy of further study. It was determined that the most efficient method to understand the causes and effects of ULCC operations was to profile at least one airport that had existing ULCC service, one without current ULCC service, and one which recently lost ULCC service. Interviews were conducted with airport management staff at each airport whose responsibilities include the oversight and development of air service operations at their respective airports. The results of the interviews are included below along with background conditions and factors of each airport.

Bellingham, Washington – Existing ULCC Service

The first case study selected for further research was Bellingham International Airport (BLI) in Bellingham, Washington. Jointly developed by Whatcom County and the U.S. Army Air Forces before the Second World War, the modern history of the airfield starts after deregulation opened regular commercial aviation service to Bellingham in the late 1970s (*Bellingham International Airport | Port of Bellingham, WA - Official Website*, n.d.). The airport has long been attractive to low-cost airlines, from fledgling commuter airlines providing shuttle service to Seattle to regional carriers operating to outlying destinations in the Pacific Northwest. Bellingham was even home to a ULCC of its own when Western Airlines began short-lived operations in 2007. Today the airport is served by Allegiant Air, which operates full-time to six west coast destinations and a further two seasonally. Alaska Airlines operates daily shuttles to Seattle/Tacoma International Airport. Comprising two-thirds of the market share, Allegiant dominates commercial traffic at the airport.

Figure 5 – Bellingham, WA Area Map



Several factors may explain the appeal of Bellingham to ULCCs. For one, the airport is only 20 miles from the border with Canada and a further 20 miles to Vancouver, British Columbia with its metropolitan area population of nearly 2.5 million people. Combined with portions of the Seattle region, which supports 4 million residents, the airport has a sizeable catchment area population despite relatively low population densities in the vicinity of the airport itself. According to airport management, roughly 65% of air passengers transiting through Bellingham International Airport are Canadian residents. Many cross the border to Bellingham during times when the exchange rate between the Canadian Dollar and the U.S. Dollar is favorable, making ULCC flights all the more attractive. Canada as a nation tends to have higher airfares due to steep fees and taxes imposed by government authorities on airline operations (*Why It's Getting More Expensive for Canadians to Fly - Macleans.Ca*, n.d.). A recent study by the Canadian government showed that flights to the same destination from Toronto and Buffalo, NY – cities separated by 60 miles across the border – cost those on the Toronto flight 43% more when accounting for taxes and the currency conversion (Levere, 2013). For ULCCs, operating to U.S. airports in proximity to foreign population centers represents an opportunity for large catchment area expansion with no added costs. Other factors that aid ULCC service at Bellingham are the low fees assessed to traveling passengers by the airport by way of the operator and the discounted rates for parking. Parking fees alone can account for 60% of the revenues that Bellingham International Airport earns in a given year. Smaller airports like these want to attract carriers that will draw travelers to drive and park their cars on airport property and airlines with a leisure focus tend to facilitate that goal. However, despite these benefits to ULCCs, annual enplanements at Bellingham have dropped year over year since a peak of 1.1 million in 2012 (*Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports - Previous Years – Airports*, n.d.)

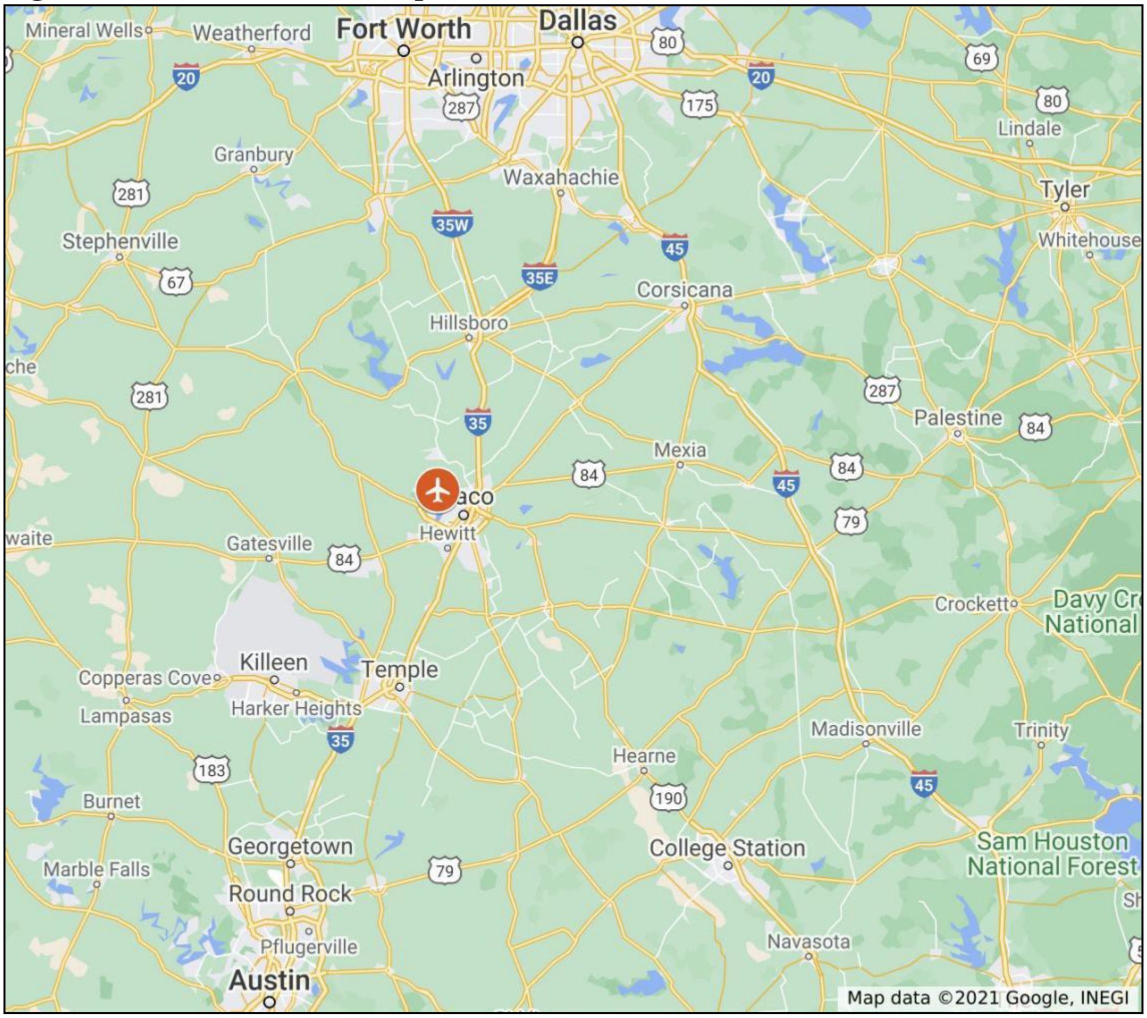
The decline of commercial aviation service to Bellingham may be explained by several factors. Passenger traffic at the largest airport in the region, Seattle/Tacoma (SEA), increased sharply over the same period during which Bellingham saw declines, likely due to expanded flight offerings by Delta Air Lines and Alaska Airlines, both of which have built operations hubs at SeaTac. Also, Paine Field (PAE) in Everett opened for commercial aviation in 2018, welcoming Alaska and United Airlines to the airport 25 miles north of Seattle. Although passenger numbers are still relatively small at PAE, the presence of commercial service in Everett may serve as one further barrier keeping Seattle-area residents from traveling north to Bellingham. However, since the majority of air travelers at BLI originate in Canada, what might explain their dwindling numbers? In 2011, the Canadian Dollar was hovering near the highest peak of its value relative to the U.S. Dollar in over 25 years (*Xe: USD / CAD Currency Chart. US Dollar to Canadian Dollar Rates*, n.d.). This meant that Canadians could get ever greater deals on American ULCC flights than in other times and may partially explain the arrival of Frontier with summer seasonal service and the expanded presence of Allegiant and at Bellingham during this time. Since then, the exchange rate has become less advantageous and currently favors the U.S. Dollar. Further, Canada has also launched its own version of ULCCs. Swoop, a subsidiary of Canadian low-cost carrier WestJet, took to the skies in 2018 operating ultra-low-cost flights within Canada and to the United States and the Caribbean. Operating from Abbottsford, British Columbia, Swoop's west coast focus city is located a mere 18 miles from Bellingham. While its current flight destinations from Abbottsford do not overlap with any operated by Allegiant in Bellingham, it is difficult to imagine that Swoop would not be able to poach a considerable number of fliers from Bellingham if fares were competitive to similar types of destinations. Flair Airlines and Canada Jetlines are the other Canadian ULCCs new to operation, although neither presently offers international service.

While the presence of Allegiant Air at Bellingham seems to corroborate the importance of select border locations to ULCC business models, there remain unanswered questions about the long-term viability of such markets. The case has shown that airports with heavy reliance on foreign travelers to occupy aircraft seats are more vulnerable to the shifting tides of international relations and economies. While population growth in the Bellingham metropolitan area has been consistent, it is possible that ULCCs operating as the dominant carrier at an outlying secondary airport may not gain as much visibility due to a lack of fare competition as they would at a large hub airport with several legacy carriers present. Bellingham initiated the Airline Incentive Program in 2018, seeking to offer benefits such as waived landing fees and remain-overnight fees for new airlines or current airlines offering new routes for a fixed duration. It remains to be seen whether existing or new carriers will take advantage of such incentives or if the Bellingham market is substantial enough for the incentives to be worth the costs of service.

Waco, Texas – No Existing ULCC Service

The Waco Regional Airport lies a mere six miles from the downtown core of Waco, Texas. Home to Baylor University and nearly one million residents nestled between the growing metropolitan regions of Dallas-Fort Worth and Austin, Waco is a steadily growing population hub in central Texas. The airport has never supported a significant quantity of commercial service since transitioning to civilian ownership from military oversight in 1945 (Ray & Burke, n.d.). Despite its centralized location within the state, Waco has been passed over by major aviation players including Texas' home airline Southwest and other airlines with considerable presence in Texas. Currently, American Airlines operates 5 daily flights aboard regional jets connecting Waco to its Dallas-Fort Worth (DFW) hub for onward connections.

Figure 6 – Waco, TX Area Map



Waco Regional Airport performs well according to figures from 2019. The airport reported fewer delays on arriving flights than nearly every other Texas airport. While the tourism percentage of the economy was average for the state, the median income, distance to major city, and distance to other airport variables were favorable to Waco, including in relation to airports that currently host ULCCs. The lack of service can be attributed primarily to the lack of a sizeable population in the immediate vicinity of Waco, the proximity to two large metropolitan areas with multiple airports, and the lack of substantial pull factors for travelers. While the proximity of Waco to Dallas and Austin would indicate the potential for ULCC service as a secondary airport to either destination, the airport is perhaps too far from either location to be viewed as a successful market for a ULCC. Prior research has established that distance decay for ground transportation to/from the airport is a relevant phenomenon to air travelers when seeking an airport for flights (Lieshout, 2012). Prospective passengers are not likely to journey farther than two hours travel time when seeking an airport (Lieshout, 2012). Expansions to Interstate 35 connecting Dallas, Waco, Austin, and points beyond will reduce the time and hassle of driving, likely increasing the degree of air traveler leakage to other airports.

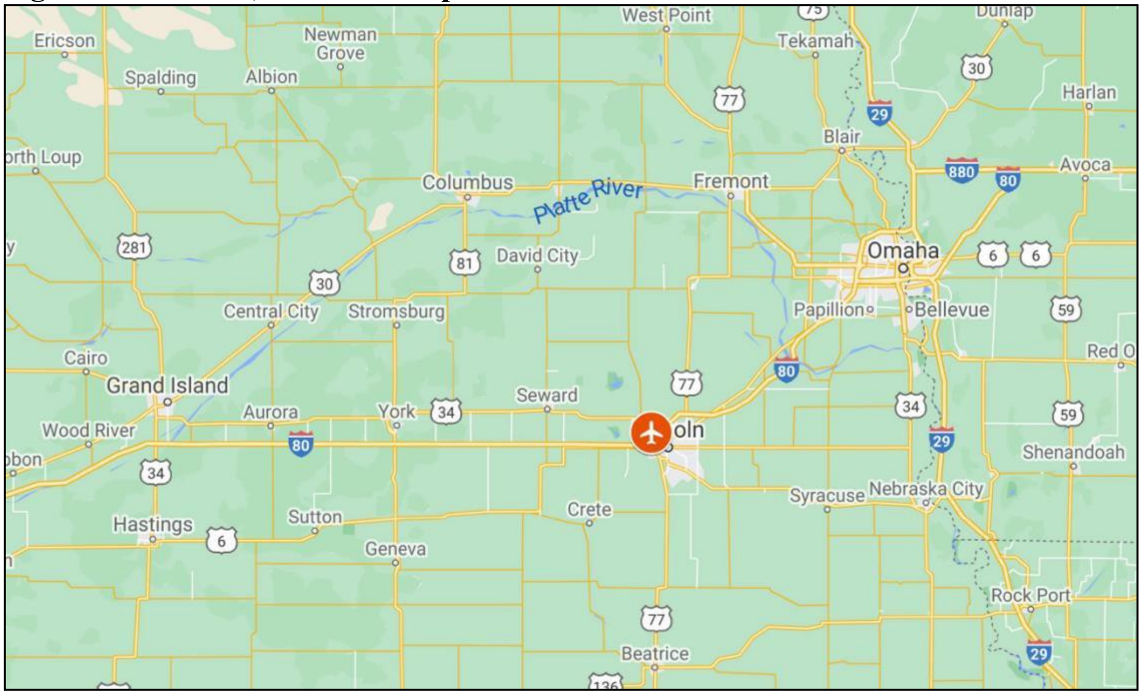
In some ways, Waco reflects similar conditions to those that exist in Charleroi, Belgium, a classic example of low-cost carrier catchment expansion in a less than typical airport setting. The Charleroi metropolitan area supports only 520,000 people, but the larger region encompasses much larger cities including Brussels, Antwerp, and Ghent in Belgium, as well as communities across northern France, western Germany, and Luxembourg. Together these populations contribute to a robust catchment area that is drawn to Charleroi Airport by ULCCs offering cheap fares to a variety of destinations. The key difference between Charleroi and Waco may be their latitudes. ULCCs in Europe, much like North America, tend to operate in a north-south pattern. The destination map from Charleroi is littered with locations in Spain, Italy, Greece, Portugal, the Mediterranean coastline, and North Africa. It is evident that this region of Belgium is a nucleus at the top of an umbrella of leisure flights – mostly to points south. While this pattern resonates in the United States as well, Waco, Texas is simply too far south to be a source of leisure travelers, many of whom are seeking destinations already in Texas, the Gulf Coast, or Florida. A similarly size and oriented airport in the northern half of the country would probably be more able to market itself as a source for leisure travelers escaping to warmer climates.

On a positive note, Waco has continued to pursue other avenues for air service development. United Airlines tentatively plans to commence service in 2021 connecting Waco via regional jets to their Houston hub at George Bush Intercontinental Airport, in a similar service style as American operations between Waco and Dallas. As one airport manager described, air service tends to breed new air service in a typical model of commercial aviation. While ULCCs do not always follow this model, the start of new air service to an airport market indicates to other carriers that the economics of the region and traveler's demands are drawing the service there. If one carrier decides to jump into a market, it brings attention to the airport across the industry. Therefore, it is an encouraging sign that Waco continues growing its commercial air service capacity. Whether a ULCC, a regional carrier, or another operation decides to invest in the community in the near future, it is clear that there is potential in Waco today.

Lincoln, Nebraska – Discontinued ULCC Service

Many airports in the United States have been featured on a ULCC route map at one time or another, only to have service suddenly ceased by the carrier. Such is the nature of a business model that must respond quickly to market conditions or insufficient revenues from a particular route. ULCCs have a very thin margin on which to operate when starting service to a new market given the drastic steps taken to cut costs before service has even begun. Allegiant Air service to Lincoln, Nebraska, commenced in 2006 with twice-weekly flights to its Las Vegas hub. Two and a half years later, the airline announced that the service would be dropped from Lincoln and transferred 85 miles west to Grand Island, Nebraska. Central Nebraska Regional Airport in Grand Island was and continues to be eligible for EAS-subsidized flights and is served by American Eagle offering daily flights to Dallas-Fort Worth (DFW). It may not seem logical for a leisure-driven airline to shift service from a large and recognizable city of 290,000 to a distant EAS market less than one-fifth the size, but the reality underscores the thought process of an airline seeking the most efficient avenue to cut every cost and to attract the highest passenger demand in a given area. Despite its status as a prominent university town and a state capital, Lincoln and its airport have struggled for years to maintain and grow leisure air service, according to airport management. A significant reason for this is the proximity to Omaha, which lies 42 miles northeast. Lincoln Airport leaks 75% of potential passengers to Omaha, a larger metropolis and the economic engine of the region. At one hour's driving time, Omaha – and the seven major carriers that fly there, including Southwest Airlines – can quickly be reached from Lincoln.

Figure 7 – Lincoln, NE Area Map



It is undeniable that Southwest service at Omaha has had a damaging effect on air service development in Lincoln. Allegiant's own statements in the press following its move to Grand Island in 2008 confirmed that competitive influences from Southwest coupled with high fuel costs at Lincoln triggered the shift in service (*Allegiant Dropping Lincoln Flights to Las Vegas | Business | Journalstar.Com*, n.d.). Allegiant's Lincoln flights were meeting their load factor targets at about 90% capacity per flight (*Allegiant Dropping Lincoln Flights to Las Vegas | Business | Journalstar.Com*, n.d.). The main factor contributing to the demise of ULCC service to Lincoln was cost competition with Southwest at Omaha and Allegiant could not maintain the status quo. Further, some of the highest demanded destinations from Lincoln are in Texas in large part due to University of Nebraska athletics. Currently, flights to Texas operate out of Omaha on Southwest, American, and United as well as from Grand Island on the American Eagle EAS-subsidized flights. This is a losing scenario for Lincoln in which even highly demanded flights cannot be offered in a cost-efficient manner by any competing airline.

Competition emerges with geography to form barriers against potential ULCC service in Lincoln. Flanked by Grand Island and Omaha on either side, and within reasonable driving distances to both, Lincoln is not well-positioned to offer unique flights that would be competitive with either city unless costs were able to be reduced significantly. However, the airport is further restricted by an uncommon arrangement with its fixed base operator which provides select commercial aviation services independent of the airport authority. The fixed base operator at Lincoln sets fuel prices that all carriers must abide by, when typically at an airport of its size, airport management would be granted more control over fuel prices. As a result, fuel prices are higher at Lincoln than at Grand Island specifically, and this fact matters to ULCC operators.

In the near future, it is difficult to imagine that the status of ULCC operations in Lincoln would change. Allegiant's operations to Omaha and Grand Island complicate the prospects for leisure service from Lincoln. Frontier flies from Omaha to Denver and Las Vegas as well, and while there apparently have been discussions to shift or add service to Lincoln, nothing has come of it. The plausibility of a third ULCC entrant, Spirit or Sun Country, into the region remains low given the intense competition provided by Southwest and the other ULCCs, as well as the comparatively higher fuel costs at Lincoln. Ultimately the case study outlines the importance of cost in a competitive multi-airport environment and provides some indications of the extent to which a ULCC operator may stretch to hold onto fliers, even in reduced numbers, while minimizing costs as much as possible.

CHAPTER 7

DISCUSSION

By examining the ULCC performance data for 2019 across each of the 184 U.S. airports served by these airlines, the first section of analysis established a baseline of information for existing ULCC service. Large airports including Las Vegas (LAS), Orlando (MCO), Fort Lauderdale (FLL), and Denver (DEN) processed elevated amounts of ULCC passengers. However, many smaller aviation markets across the United States experience concentrated and solitary commercial air service from ULCCs specifically. Tertiary markets, such as Stockton, California (SCK), Trenton, New Jersey (TTN), and Rockford, Illinois (RFD), receive exclusive service from ULCCs and are just as critical when evaluating airport choice factors as their larger rivals. While the majority of airports (153) receive less than a 40% share of ULCC market traffic, 17% of airports (31) receive ULCC service at a 45% share or higher. The review of existing ULCC operations also reveals consistent patterns of flights to Florida, particularly from the Great Lakes region through to the Northeast. Numerous airports on both ends of these routes supported ULCC service regardless of airport size or population, indicating that other factors may be involved. Nearly every metropolitan region east of the Mississippi River was served by at least one regularly scheduled ULCC flight to Florida. This data tended to support the hypothesis that tourism access was a vital factor in determining the volume of ULCC service.

Two regression analyses were executed. Through the results of the OLS regression analysis with enplanements as the dependent variable, it is evident that the independent variables for population and the share of the local economy related to tourism were highly successful in predicting the quantities of ULCC enplanements. The relationships both trended positively and were significant at the >.001 level. The outcomes for market population size and tourism were not surprising given the observed patterns of existing ULCC flight operations for 2019, but each reassured the hypothesis that both are related to airport choice. It is notable that the standardized coefficient for the tourism variable (.228) was weaker than the population variable (.560). The weakness could be related to the disparity between the enplanement values and the tourism percentages of airports in Florida. Only Sanford (SFB) and Fort Myers (RSW) placed among the top twenty ULCC airports in the tourism percentage variable. When considering that six of the top twenty airports for enplanements were in Florida, it is understandable why the correlation was not higher between the two variables. The State of Florida's larger population and diversity of economic activity, especially when compared to Las Vegas, may provide some context as to the reason the percent of tourism in the local economy was not higher for many airport catchment areas in the state. None of the other variables tested in the linear regression were significant in the linear regression. This was surprising given that the two distance variables, for major cities and other ULCC airports, showed robust correlation with the catchment area population variable. It may be that distance variables would show greater significance if the population variable was removed from the analysis. It would seem natural that areas farther from a major city would have fewer ULCC enplanements, however the insignificance may be explained by the range of airports served by ULCCs which can be urban or far from a major urban center. The lack of significance between distance to the nearest existing ULCC airport and enplanements is likely due to isolation from other

ULCC airports being viewed as an asset or a barrier. Certain ULCCs, such as Allegiant Air, seem to operate akin to Southwest Airlines and seek secondary or tertiary airports with lower costs and less competition, often at distanced locations. Others such as Spirit Airlines see the benefits of competing directly with legacy carriers based on fares, and will operate to major hub airports. Therefore, enplanements are split between outlying and primary airports, and the distance from non-ULCC airports is viewed as unrelated to the enplanements. Overall, the linear regression model provided credence to two of the primary variables examined in this research, but the picture for other variables was muddied.

To further evaluate the involvement of other factors in airport choice considerations, a binary logistic regression was utilized to assess variables including border proximity, Essential Air Service, distance variables, tourism, and catchment population against the presence of ULCC service in a binary dependent variable. The sample size for this regression was much larger as it included all 472 Part 139 airports in the continental U.S. A high level of significance existed for five of the six independent variables, with the exception of tourism percent. The tourism variable suffered from special cases in the data, although these cases were too numerous to be considered outliers. Only one of the sixteen airports with the largest values for tourism percent supported ULCC service in 2019. Airport markets including Aspen (ASE), Key West (EYW), and Grand Canyon, Arizona (GCN) had tourism values exceeding 20% of the local economy but did not have ULCC air service.

Comparatively, some of the lowest-ranked airports for tourism such as Idaho Falls (IDA), Tyler, Texas (TYR), and Fayetteville, Arkansas (XNA) feature ULCC service despite possessing tourism shares under 8%. It is difficult for a binary regression analysis to overcome the extremes of this variable, and may lend cause to the significant relationship for tourism established by the linear regression where quantity of service was the dependent variable.

Likewise, the insignificance of the tourism variable in this case may indicate that there are fundamental differences between airports that ULCCs operate to and from. Airports on both ends of a route do not necessarily need to be tourist-focused. There is evidence to suggest that ULCCs tend to pair tourism-low origins and tourism-high destinations together in ways that would detract from a binary regression analysis. The binary logistic equation employed to analyze the data in this research is left to predict whether service exists among airports that appear to be similarly lacking in tourism, despite the importance of other variables which may inform why some small or rural airports receive service and others do not. For example, Idaho Falls, Idaho is served by a ULCC despite having a similar tourism percentage value (7.40%) to that of Waco, Texas (8.75%), Sun Valley, Idaho (7.31%), or Eau Claire, Wisconsin (7.66%), each of which receives only a minimal amount of regular commercial service on any carrier and no ULCCs. There were no added means for the regression model to account for the normal distribution of tourism percentage values that existed in the data while predicting ULCC service to a seemingly random selection of airports at the lower extreme of the tourism variable. Perhaps Idaho Falls is not a true origin market despite its low tourism percentage; the airport is in as similar proximity to Yellowstone National Park as another ULCC airport at Jackson Hole, Wyoming. Still, a true and extant origin and destination pair such as Grand Island, Nebraska to Las Vegas, Nevada probably could not have been predicted through the binary logistic regression analysis.

The model did, however, indicate potent significance across the EAS, border proximity, distance, and population variables. The deeply negative relationship between Essential Air Service and ULCC service is not surprising as few carriers would seek to compete with subsidized operations. Proving that ULCCs have found a niche when they can capture foreign travelers, the positive strength of the border proximity variable indicates that border airports are sought after. The sample size and practicality of this variable is small, however, and may not be relevant for many other existing airports. The results for the major city distance and population variables track with the hypotheses that closer and larger populations tend to warrant ULCC service. A strong coefficient beta value was evident for the logarithmic population. The distance to ULCC airport variable was weakly positive but highly significant, furthering the claims that ULCCs are dually targeting hub airports as well as outlying airports. The binary logistic regression made many important findings for the research and solidifies some hypothesized outcomes.

The final section viewed these constructs through the lens of three airport case studies, using qualitative analysis to understand the complex nature of ULCC business models and decision-making for relevant aviation markets. The case of Bellingham, Washington, outlined how impactful the combination of ULCC operations and border proximity can be for an airport. Enplanements at BLI have increased by 40% net passengers since the commencement of Allegiant operations in 2008, though during the summer 2012 peak enplanements were 120% higher than 2008 (*Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports - Previous Years – Airports*, n.d.).

However, the airport has also shown that there are risks from relying too heavily on foreign tourist passengers and that there is a risk for stagnation of service as small market airports. In Waco, Texas, the most significant challenge for airport managers is attracting new service. Falling outside the catchment areas of Dallas and Houston, yet within a conceivable driving distance for most passengers to those airports, Waco struggles to attract consistent commercial air service, much less a ULCC. Also contributing are relatively low tourism figures. Waco has a local tourism employment share of 9%, comparable to Yuma, Arizona, or Carbondale, Illinois. Cumulatively, Waco does not perform well in any of the variables found to be significant in the regression analysis and may struggle to attract a ULCC for the near future. Finally, Lincoln, Nebraska, presents a case of a market that was conducive to ULCC service at one time but is no longer viewed as attractive. Airport management points to a dual effect of being too close to a major airport in Omaha and too close to a smaller airport with lower costs at Grand Island, which features EAS service aboard American Eagle to the heavily demanded Dallas-Fort Worth market. This tracks closely with the variable of distance to an existing ULCC airport, but is confounding in relation to the effects of EAS service as a barrier to ULCC service. Allegiant Air indicated upon service removal in 2008 that high fuel costs and unfavorable competition with Omaha's Southwest Airlines service were to blame (*Allegiant Dropping Lincoln Flights to Las Vegas | Business | Journalstar.Com*, n.d.). In 2019, Allegiant operated to both Omaha and Grand Island. Lincoln suffers due to proximity to these two alternative airports despite theoretically having an advantage over both in terms of competition.

A theme across all three case studies was one of cost. Fuel costs, overnighting costs, and landing fees are part of a slew of relevant airport costs that were not effectively covered by this research. While many of these can be negotiated by a carrier to make service justifiable, the case studies seem to indicate that cost is the basic threshold in deciding when ULCC operations are feasible from a business perspective.

This analysis has provided documentation of ULCC business priorities, statistically analyzed the preferences and criteria which promote the airport-ULCC relationship, and provided context to their significance, each of which can each be used to guide future development at U.S airports. This research constitutes the first comprehensive analysis of ULCC airport choice factors in the United States and serves as a starting point for further studies into these fast-evolving practices which drive commercial aviation forward.

Impact of COVID-19 Pandemic

The results and conclusions of this study were based on data and assumptions from 2019, a year in which the COVID-19 pandemic had yet to impact the U.S. domestic aviation economy. While the subject analysis of the relationship between ultra low-cost carriers and airport choice factors is expected to remain relevant for years to come, it is important to address possible changes to the intricate working of ULCC business models following the upheaval of domestic aviation witnessed throughout 2020.

Carriers across the aviation industry are focused on regaining passengers after a year in which enplanements dropped to their lowest levels since 1984 (*U.S. Airline Passenger Traffic Fell Last Year to Lowest Number since 1984 - DOT | Reuters*, n.d.). A large proportion of resurgent passengers are expected to be leisure travelers. The probability of business travelers returning in pre-pandemic numbers seems unlikely as most employers have shifted to a remote work environment that seems unlikely to change soon. As a result, many airlines have begun testing new flights to tourism destinations while cutting back on the frequency of service between major cities. Southwest Airlines has announced new flight operations beginning in summer 2021 to many destinations favored by ULCCs including Myrtle Beach (MYR), Bozeman (BZN), Destin-Fort Walton Beach (VPS), and Santa Barbara (SBA). Each of these airports' features at least one existing ULCC carrier and serves a catchment area with above average tourism employment, indicating the strength of tourism in the region. Clearly the move by Southwest seeks to use its frequent flier base and brand recognition to stimulate new travel demand to new destinations for the airline, poaching potential travelers from ULCCs in the process. In turn, Allegiant Air has offered new service to Jackson Hole (JAC), Key West (EYW), and Portland, OR (PDX). Legacy carriers are jumping into tourist markets for the summer of 2021 as well. American Airlines announced a number of new route expansions for seasonal service including Idaho Falls, Grand Junction, and Bozeman among others. Service is also expanded to Daytona Beach and Saint George, Utah. Overall, with so many carriers pursuing the same group of fliers, the landscape of commercial aviation will continue to evolve as the world emerges from COVID-19 restrictions.

CHAPTER 8

CONCLUSIONS

The aim of this paper was to visually represent and analyze the domestic aviation markets served by ultra low-cost carriers, and to determine which market factors are the most conducive for enabling the expansion of these carriers. Based on previous research and a preliminary review of ULCC business patterns, it was hypothesized that ULCC operations are heavily dependent on tourist passengers to stimulate air service, but that there are many factors that may influence ULCC service especially at smaller airports. Through a comprehensive examination of literature, documentation of existing conditions for ULCC operations, regression analysis, and qualitative case studies, several conclusions can be drawn in regards to the relationship between ultra low-cost carriers and airport choice factors.

The regression analyses yielded strong ties between the population of an airport's catchment area and both the presence and weight of ULCC operations to the market. The share of the local economy dedicated to tourism also appears to be significant to ULCCs from a volume standpoint but was not a significant variable for explaining the existing of ULCC service. However, several variables including proximity to a major city and to a border crossing were significant in predicting whether or not ULCC service exists. A lack of EAS service and a location further from other ULCC competition also favored airports to receive ULCC service. Variables for climate, airport delays, population income, and airport labor wages were either inconsistent or proved less likely to relate to ULCC service or enplanements. A summary of case studies showed that costs are an important factor for ULCC operators, which was a variable largely unaccounted for in the regression models.

Ultimately the research recognizes the diversity of ULCC business models and the complex nature of commercial air service decision-making. The intent of this study is to shed light on a unique and developing subset of domestic commercial airlines within the United States that has not received warranted attention from researchers. The ULCC-airport choice relationship will continue to evolve with the growth of the domestic aviation market. With increased attention paid to leisure travelers in the post-COVID-19 era of aviation, the implications of this research should become clearer. The research raises additional questions related to ULCCs to be investigated, still an unprecedented and thorough review of the ULCC-airport choice relationship is provided in this report.

Opportunities for Further Study

While the research produced compelling results for the patterns of ultra low-cost carriers and airport choice factors, opportunities remain for further study. The arrangement of many ULCC flights from cold winter origin markets to warmer tourism destinations seems to be a clear trend in existing operations, yet the regression analysis did not indicate that the climate variable examined was relevant to service or enplanements. Further research may examine other variables which may capture climate as a solid driver of demand for tourist travel. The pattern may also indicate the extent to which airport markets viewed as tourism origins and tourism destinations that are paired for ULCC service. This study was not able to analyze this hypothesis, and ultimately no tourism-related independent variable was identified as significant through the binary logistic regression. The case studies in particular gave indication that airports costs such as fuel prices, landing fees, and overnight charges are a critical factor in determining ULCC service as well as its growth, imploring further research for definitive conclusions. The lack of an accessible data source for airport costs and delays that covered the entirety of the airports studied in this research disabled a robust analysis of airport costs, but a smaller sample or regional focus could affirm the influences of costs.

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APPENDIX A

2019 ULCC ENPLANEMENTS DATA

Airport Identifier (Loc Id)	State	Associated City	2019 ULCC Enplanements	2019 Total Enplanements (Domestic Carriers)	% ULCC of Total
1G4	ARIZONA	PEACH SPRINGS		N/A	
ABE	PENNSYLVANIA	ALLENTOWN	170,417	434,007	39%
ABI	TEXAS	ABILENE		81,813	
ABQ	NEW MEXICO	ALBUQUERQUE	47,175	2,641,450	2%
ABR	SOUTH DAKOTA	ABERDEEN		29,564	
ABY	GEORGIA	ALBANY		41,268	
ACK	MASSACHUSETTS	NANTUCKET		134,830	
ACT	TEXAS	WACO	80	62,907	0%
ACV	CALIFORNIA	ARCATA/EUREKA		86,147	
ACY	NEW JERSEY	ATLANTIC CITY	520,566	529,773	98%
ADK	ALASKA	ADAK ISLAND		3,159	
ADQ	ALASKA	KODIAK		85,655	
AEX	LOUISIANA	ALEXANDRIA		141,832	
AFW	TEXAS	FORT WORTH		3,509	
AGS	GEORGIA	AUGUSTA		330,495	
AHN	GEORGIA	ATHENS		1	
AIA	NEBRASKA	ALLIANCE		3,065	
AKN	ALASKA	KING SALMON		44,244	
ALB	NEW YORK	ALBANY	136,615	1,496,492	9%
ALN	ILLINOIS	ALTON/ST LOUIS		N/A	
ALO	IOWA	WATERLOO		23,503	
ALW	WASHINGTON	WALLA WALLA		49,220	
AMA	TEXAS	AMARILLO		353,124	
ANB	ALABAMA	ANNISTON		N/A	
ANC	ALASKA	ANCHORAGE	32,081	2,713,843	1%
AND	SOUTH CAROLINA	ANDERSON		13,854	
AOO	PENNSYLVANIA	ALTOONA		3,656	
APF	FLORIDA	NAPLES		N/A	
APN	MICHIGAN	ALPENA		12,523	
ARA	LOUISIANA	NEW IBERIA		7,498	
ART	NEW YORK	WATERTOWN		22,512	
ASE	COLORADO	ASPEN		308,143	
ATL	GEORGIA	ATLANTA	2,046,238	53,505,795	4%
ATW	WISCONSIN	APPLETON	73,449	386,737	19%
ATY	SOUTH DAKOTA	WATERTOWN		11,681	
AUS	TEXAS	AUSTIN	947,029	8,507,410	11%
AVL	NORTH CAROLINA	ASHEVILLE	389,149	810,548	48%
AVP	PENNSYLVANIA	WILKES-BARRE/SCRANTON		288,973	
AZA	ARIZONA	PHOENIX	864,355	881,855	98%
AZO	MICHIGAN	KALAMAZOO		151,254	
BAF	MASSACHUSETTS	WESTFIELD/SPRINGFIELD		4,393	
BAK	INDIANA	COLUMBUS		N/A	
BDL	CONNECTICUT	WINDSOR LOCKS	310,985	3,323,614	9%
BDR	CONNECTICUT	BRIDGEPORT		N/A	
BED	MASSACHUSETTS	BEDFORD		N/A	
BET	ALASKA	BETHEL		160,874	
BFD	PENNSYLVANIA	BRADFORD		4,293	
BFF	NEBRASKA	SCOTTSBLUFF		17,707	
BFI	WASHINGTON	SEATTLE		30,568	
BFL	CALIFORNIA	BAKERSFIELD		129,669	
BFM	ALABAMA	MOBILE	21,434	22,852	94%
BGM	NEW YORK	BINGHAMTON		38,091	
BGR	MAINE	BANGOR	56,350	325,160	17%

BHB	MAINE	BAR HARBOR		10,088	
BHM	ALABAMA	BIRMINGHAM	30,281	1,516,075	2%
BIL	MONTANA	BILLINGS	55,767	468,888	12%
BIS	NORTH DAKOTA	BISMARCK	75,497	311,618	24%
BJC	COLORADO	DENVER		N/A	
BJI	MINNESOTA	BEMIDJI		30,886	
BKG	MISSOURI	BRANSON	27,383	25,362	108%
BKL	OHIO	CLEVELAND		N/A	
BKW	WEST VIRGINIA	BECKLEY		8,646	
BLI	WASHINGTON	BELLINGHAM	216,737	335,616	65%
BLV	ILLINOIS	BELLEVILLE	152,900	153,753	99%
BMG	INDIANA	BLOOMINGTON		-	
BMI	ILLINOIS	BLOOMINGTON/NORMAL	67,469	209,156	32%
BNA	TENNESSEE	NASHVILLE	432,293	8,935,654	5%
BOI	IDAHO	BOISE	46,673	2,057,750	2%
BOS	MASSACHUSETTS	BOSTON	844,718	20,699,377	4%
BPT	TEXAS	BEAUMONT/PORT ARTHUR		29,068	
BQK	GEORGIA	BRUNSWICK		40,730	
BQN	PUERTO RICO	AGUADILLA	111,476	369,924	30%
BRD	MINNESOTA	BRAINERD		22,551	
BRO	TEXAS	BROWNSVILLE		129,407	
BRW	ALASKA	BARROW		46,289	
BTL	MICHIGAN	BATTLE CREEK		N/A	
BTM	MONTANA	BUTTE		25,946	
BTR	LOUISIANA	BATON ROUGE		399,591	
BTV	VERMONT	BURLINGTON	21,504	687,436	3%
BUF	NEW YORK	BUFFALO	142,342	2,459,199	6%
BUR	CALIFORNIA	BURBANK	37,190	2,988,720	1%
BWG	KENTUCKY	BOWLING GREEN		N/A	
BWI	MARYLAND	BALTIMORE	1,553,726	13,284,687	12%
BZN	MONTANA	BOZEMAN	66,167	785,585	8%
CAE	SOUTH CAROLINA	COLUMBIA		642,028	
CAK	OHIO	AKRON	62,166	407,646	15%
CCR	CALIFORNIA	CONCORD		N/A	
CDB	ALASKA	COLD BAY		8,004	
CDC	UTAH	CEDAR CITY		24,252	
CDV	ALASKA	CORDOVA		19,388	
CEC	CALIFORNIA	CRESCENT CITY		9,144	
CEF	MASSACHUSETTS	SPRINGFIELD/CHICOPEE		N/A	
CGI	MISSOURI	CAPE GIRARDEAU		11,838	
CHA	TENNESSEE	CHATTANOOGA	32,179	553,142	6%
CHO	VIRGINIA	CHARLOTTESVILLE		387,922	
CHS	SOUTH CAROLINA	CHARLESTON	97,476	2,375,868	4%
CIC	CALIFORNIA	CHICO		N/A	
CID	IOWA	CEDAR RAPIDS	150,032	672,193	22%
CIU	MICHIGAN	SAULT STE MARIE		24,390	
CKB	WEST VIRGINIA	CLARKSBURG	20,312	41,802	49%
CLE	OHIO	CLEVELAND	1,144,179	4,894,541	23%
CLL	TEXAS	COLLEGE STATION		83,832	
CLT	NORTH CAROLINA	CHARLOTTE	344,233	24,199,688	1%
CMH	OHIO	COLUMBUS	278,215	4,172,067	7%
CMI	ILLINOIS	CHAMPAIGN/URBANA		105,559	
CMX	MICHIGAN	HANCOCK		24,954	
CNM	NEW MEXICO	CARLSBAD		5,224	
CNY	UTAH	MOAB		16,522	
COD	WYOMING	CODY		41,221	
COE	IDAHO	COEUR D'ALENE		N/A	
COS	COLORADO	COLORADO SPRINGS	214,589	828,429	26%

COU	MISSOURI	COLUMBIA		129,643	
CPR	WYOMING	CASPER		97,359	
CPS	ILLINOIS	CAHOKIA/ST LOUIS		N/A	
CRP	TEXAS	CORPUS CHRISTI		328,109	
CRQ	CALIFORNIA	CARLSBAD		N/A	
CRW	WEST VIRGINIA	CHARLESTON	4,294	226,834	2%
CSG	GEORGIA	COLUMBUS		52,351	
CVG	KENTUCKY	COVINGTON	973,681	4,413,457	22%
CVN	NEW MEXICO	CLOVIS		5,335	
CWA	WISCONSIN	MOSINEE		141,123	
CWF	LOUISIANA	LAKE CHARLES		N/A	
CYS	WYOMING	CHEYENNE		16,696	
DAB	FLORIDA	DAYTONA BEACH		340,815	
DAL	TEXAS	DALLAS		8,080,506	
DAY	OHIO	DAYTON	24,906	845,776	3%
DBQ	IOWA	DUBUQUE		38,036	
DCA	DIST. OF COLUMBIA	WASHINGTON	165,148	11,595,454	1%
DDC	KANSAS	DODGE CITY		4,948	
DEC	ILLINOIS	DECATUR		8,561	
DEN	COLORADO	DENVER	4,870,655	33,592,945	14%
DFW	TEXAS	DALLAS-FORT WORTH	1,677,641	35,778,573	5%
DGG	ALASKA	RED DOG		N/A	
DHN	ALABAMA	DOTHAN		58,860	
DIK	NORTH DAKOTA	DICKINSON		23,835	
DLG	ALASKA	DILLINGHAM		35,486	
DLH	MINNESOTA	DULUTH		155,531	
DOV	DELAWARE	DOVER		N/A	
DRO	COLORADO	DURANGO		195,220	
DRT	TEXAS	DEL RIO		22,439	
DSM	IOWA	DES MOINES	175,649	1,427,035	12%
DTW	MICHIGAN	DETROIT	1,953,269	18,143,040	11%
DUJ	PENNSYLVANIA	DUBOIS		5,835	
DUT	ALASKA	UNALASKA		27,232	
DVL	NORTH DAKOTA	DEVILS LAKE		6,916	
EAR	NEBRASKA	KEARNEY		21,305	
EAT	WASHINGTON	WENATCHEE		64,619	
EAU	WISCONSIN	EAU CLAIRE		24,268	
ECP	FLORIDA	PANAMA CITY		621,406	
EFD	TEXAS	HOUSTON		N/A	
EGE	COLORADO	EAGLE		191,377	
EKO	NEVADA	ELKO		19,979	
ELM	NEW YORK	ELMIRA/CORNING	44,600	156,440	29%
ELP	TEXAS	EL PASO	52,605	1,745,770	3%
ENA	ALASKA	KENAI		95,239	
ENV	UTAH	WENDOVER		N/A	
ERI	PENNSYLVANIA	ERIE		106,720	
ESC	MICHIGAN	ESCANABA		19,063	
EUG	OREGON	EUGENE	70,719	596,156	12%
EVV	INDIANA	EVANSVILLE	18,918	242,425	8%
EWB	MASSACHUSETTS	NEW BEDFORD		4,321	
EWN	NORTH CAROLINA	NEW BERN		114,123	
EWR	NEW JERSEY	NEWARK	905,513	23,160,763	4%
EYW	FLORIDA	KEY WEST		497,656	
FAI	ALASKA	FAIRBANKS		562,420	
FAQ	AMERICAN SAMOA	FITIUTA VILLAGE		2,144	
FAR	NORTH DAKOTA	FARGO	106,445	480,776	22%
FAT	CALIFORNIA	FRESNO	96,348	966,607	10%
FAY	NORTH CAROLINA	FAYETTEVILLE		216,842	

FCA	MONTANA	KALISPELL	29,570	355,802	8%
FHU	ARIZONA	FORT HUACHUCA SIERRA VISTA		N/A	
FKL	PENNSYLVANIA	FRANKLIN		1,669	
FLG	ARIZONA	FLAGSTAFF		119,864	
FLL	FLORIDA	FORT LAUDERDALE	3,837,077	17,950,989	21%
FLO	SOUTH CAROLINA	FLORENCE		42,876	
FMN	NEW MEXICO	FARMINGTON		N/A	
FNL	COLORADO	FORT COLLINS/LOVELAND		N/A	
FNT	MICHIGAN	FLINT	98,839	302,606	33%
FOD	IOWA	FORT DODGE		8,328	
FOE	KANSAS	TOPEKA		11,573	
FRG	NEW YORK	FARMINGDALE		N/A	
FSD	SOUTH DAKOTA	SIOUX FALLS	128,232	576,354	22%
FSM	ARKANSAS	FORT SMITH		91,960	
FTW	TEXAS	FORT WORTH		N/A	
FWA	INDIANA	FORT WAYNE	93,074	402,400	23%
FYV	ARKANSAS	FAYETTEVILLE		N/A	
GCC	WYOMING	GILLETTE		29,497	
GCK	KANSAS	GARDEN CITY		25,073	
GCN	ARIZONA	GRAND CANYON		250,990	
GEG	WASHINGTON	SPOKANE	34,715	1,944,393	2%
GFK	NORTH DAKOTA	GRAND FORKS	30,935	117,482	26%
GFL	NEW YORK	GLENS FALLS		N/A	
GGG	TEXAS	LONGVIEW		27,160	
GJT	COLORADO	GRAND JUNCTION	25,405	250,016	10%
GNV	FLORIDA	GAINESVILLE		273,253	
GON	CONNECTICUT	GROTON (NEW LONDON)		N/A	
GPT	MISSISSIPPI	GULFPORT	18,583	378,638	5%
GRB	WISCONSIN	GREEN BAY	15,264	347,263	4%
GRI	NEBRASKA	GRAND ISLAND	36,125	70,509	51%
GRK	TEXAS	FORT HOOD/KILLEEN		176,630	
GRO	N MARIANA ISLANDS	ROTA ISLAND		11,372	
GRR	MICHIGAN	GRAND RAPIDS	334,197	1,786,803	19%
GSN	N MARIANA ISLANDS	SAIPAN ISLAND		569,512	
GSO	NORTH CAROLINA	GREENSBORO	79,491	1,076,876	7%
GSP	SOUTH CAROLINA	GREER	97,428	1,276,678	8%
GST	ALASKA	GUSTAVUS		11,130	
GTF	MONTANA	GREAT FALLS	31,377	175,613	18%
GTR	MISSISSIPPI	COLUMBUS/W		51,682	
GUC	COLORADO	GUNNISON		36,183	
GUM	GUAM	GUAM		1,850,921	
GYH	SOUTH CAROLINA	GREENVILLE		N/A	
GYY	INDIANA	GARY		N/A	
HDN	COLORADO	HAYDEN		106,007	
HEZ	MISSISSIPPI	NATCHEZ		N/A	
HGR	MARYLAND	HAGERSTOWN	26,303	29,105	90%
HIB	MINNESOTA	HIBBING		18,293	
HKY	NORTH CAROLINA	HICKORY		N/A	
HLN	MONTANA	HELENA		118,518	
HNL	HAWAII	HONOLULU	39,716	9,988,678	0%
HOB	NEW MEXICO	HOBBS		27,774	
HOM	ALASKA	HOMER		46,367	
HOT	ARKANSAS	HOT SPRINGS		4,877	
HOU	TEXAS	HOUSTON		7,069,614	
HPN	NEW YORK	WHITE PLAINS		872,023	
HRL	TEXAS	HARLINGEN	45,801	335,381	14%
HSA	MISSISSIPPI	BAY ST LOUIS		N/A	
HSV	ALABAMA	HUNTSVILLE	39,383	702,574	6%

HTS	WEST VIRGINIA	HUNTINGTON	72,738	108,515	67%
HUF	INDIANA	TERRE HAUTE		N/A	
HVN	CONNECTICUT	NEW HAVEN		48,860	
HXD	SOUTH CAROLINA	HILTON HEAD ISLAND		110,608	
HYA	MASSACHUSETTS	HYANNIS		24,465	
HYS	KANSAS	HAYS		14,758	
IAD	DIST. OF COLUMBIA	WASHINGTON	151,794	11,884,117	1%
IAG	NEW YORK	NIAGARA FALLS	122,017	122,065	100%
IAH	TEXAS	HOUSTON	1,328,614	21,905,309	6%
ICT	KANSAS	WICHITA	63,299	856,088	7%
IDA	IDAHO	IDAHO FALLS	45,984	175,549	26%
IFP	ARIZONA	BULLHEAD CITY		134,498	
IGM	ARIZONA	KINGMAN		N/A	
ILG	DELAWARE	WILMINGTON		N/A	
ILM	NORTH CAROLINA	WILMINGTON		539,454	
ILN	OHIO	WILMINGTON		N/A	
IMT	MICHIGAN	IRON MOUNTAIN KINGSFORD		22,221	
IND	INDIANA	INDIANAPOLIS	486,203	4,709,183	10%
INL	MINNESOTA	INTERNATIONAL FALLS		17,744	
INT	NORTH CAROLINA	WINSTON SALEM		N/A	
IPL	CALIFORNIA	IMPERIAL		20,442	
IPT	PENNSYLVANIA	WILLIAMSPORT		20,256	
IRK	MISSOURI	KIRKSVILLE		5,244	
ISO	NORTH CAROLINA	KINSTON		N/A	
ISP	NEW YORK	NEW YORK	282,666	774,374	37%
ITH	NEW YORK	ITHACA		109,252	
ITO	HAWAII	HILO		582,919	
IWD	MICHIGAN	IRONWOOD		5,121	
JAC	WYOMING	JACKSON	7,090	444,047	2%
JAN	MISSISSIPPI	JACKSON	27,969	549,007	5%
JAX	FLORIDA	JACKSONVILLE	364,175	3,479,923	10%
JFK	NEW YORK	NEW YORK	1,891	31,036,655	0%
JHM	HAWAII	LAHAINA		34,102	
JHW	NEW YORK	JAMESTOWN		N/A	
JLN	MISSOURI	JOPLIN		48,005	
JMS	NORTH DAKOTA	JAMESTOWN		11,176	
JNU	ALASKA	JUNEAU		459,191	
JST	PENNSYLVANIA	JOHNSTOWN		6,309	
JVL	WISCONSIN	JANESVILLE		N/A	
KOA	HAWAII	KAILUA/KONA		1,929,553	
KTN	ALASKA	KETCHIKAN		137,090	
LAF	INDIANA	LAFAYETTE		6,363	
LAL	FLORIDA	LAKELAND		N/A	
LAN	MICHIGAN	LANSING		166,976	
LAR	WYOMING	LARAMIE		18,995	
LAS	NEVADA	LAS VEGAS	5,703,513	24,728,361	23%
LAW	OKLAHOMA	LAWTON		52,410	
LAX	CALIFORNIA	LOS ANGELES	1,821,871	42,939,104	4%
LBB	TEXAS	LUBBOCK		520,181	
LBE	PENNSYLVANIA	LATROBE	155,422	158,253	98%
LBF	NEBRASKA	NORTH PLATTE		16,120	
LBL	KANSAS	LIBERAL		10,743	
LBX	TEXAS	ANGLETON/LAKE JACKSON		N/A	
LCH	LOUISIANA	LAKE CHARLES		62,057	
LCK	OHIO	COLUMBUS	151,495	153,850	98%
LEX	KENTUCKY	LEXINGTON	116,655	706,957	17%
LFT	LOUISIANA	LAFAYETTE	19,616	265,559	7%
LGA	NEW YORK	NEW YORK	859,579	15,393,601	6%

LGB	CALIFORNIA	LONG BEACH		1,752,283	
LGU	UTAH	LOGAN		N/A	
LIH	HAWAII	LIHUE		1,657,766	
LIT	ARKANSAS	LITTLE ROCK	50,569	1,086,740	5%
LMT	OREGON	KLAMATH FALLS		N/A	
LNK	NEBRASKA	LINCOLN		166,711	
LNS	PENNSYLVANIA	LANCASTER		5,758	
LNY	HAWAII	LANAI CITY		48,556	
LRD	TEXAS	LAREDO	14,225	91,043	16%
LRU	NEW MEXICO	LAS CRUCES		N/A	
LSE	WISCONSIN	LA CROSSE		97,069	
LUK	OHIO	CINCINNATI		N/A	
LWB	WEST VIRGINIA	LEWISBURG		12,858	
LWS	IDAHO	LEWISTON		40,405	
LYH	VIRGINIA	LYNCHBURG		93,206	
MAF	TEXAS	MIDLAND		672,382	
MBL	MICHIGAN	MANISTEE		N/A	
MBS	MICHIGAN	SAGINAW		134,409	
MCI	MISSOURI	KANSAS CITY	327,014	5,759,419	6%
MCK	NEBRASKA	MC COOK		2,121	
MCN	GEORGIA	MACON	132	17,109	1%
MCO	FLORIDA	ORLANDO	5,181,972	24,562,271	21%
MCW	IOWA	MASON CITY		8,056	
MDH	ILLINOIS	CARBONDALE/MURPHYSBORO		N/A	
MDT	PENNSYLVANIA	HARRISBURG	149,732	746,369	20%
MDW	ILLINOIS	CHICAGO		10,081,781	
MDY	MIDWAY ATOLL	MIDWAY ATOLL		N/A	
MEI	MISSISSIPPI	MERIDIAN		19,765	
MEM	TENNESSEE	MEMPHIS	169,245	2,318,442	7%
MFD	OHIO	MANSFIELD		N/A	
MFE	TEXAS	MC ALLEN	70,590	422,434	17%
MFR	OREGON	MEDFORD	39,020	528,362	7%
MGM	ALABAMA	MONTGOMERY		194,990	
MGW	WEST VIRGINIA	MORGANTOWN		7,304	
MHK	KANSAS	MANHATTAN		81,307	
MHT	NEW HAMPSHIRE	MANCHESTER		852,321	
MIA	FLORIDA	MIAMI	301,159	21,421,031	1%
MIE	INDIANA	MUNCIE		N/A	
MKC	MISSOURI	KANSAS CITY		N/A	
MKE	WISCONSIN	MILWAUKEE	240,410	3,374,073	7%
MKG	MICHIGAN	MUSKEGON		19,728	
MKK	HAWAII	KAUNAKAKAI		51,251	
MKL	TENNESSEE	JACKSON		5,791	
MLB	FLORIDA	MELBOURNE		241,289	
MLI	ILLINOIS	MOLINE	64,263	355,626	18%
MLU	LOUISIANA	MONROE		115,593	
MMH	CALIFORNIA	MAMMOTH LAKES		17,248	
MOB	ALABAMA	MOBILE	150	328,245	0%
MOT	NORTH DAKOTA	MINOT	46,566	164,103	28%
MQY	TENNESSEE	SMYRNA		-	
MRY	CALIFORNIA	MONTEREY	14,164	233,967	6%
MSL	ALABAMA	MUSCLE SHOALS		6,124	
MSN	WISCONSIN	MADISON	91,523	1,162,024	8%
MSO	MONTANA	MISSOULA	57,342	453,754	13%
MSP	MINNESOTA	MINNEAPOLIS	2,119,105	19,192,917	11%
MSS	NEW YORK	MASSENA		5,056	
MSV	NEW YORK	MONTICELLO		N/A	
MSY	LOUISIANA	NEW ORLEANS	1,078,056	6,874,111	16%

MTH	FLORIDA	MARATHON		N/A	
MTJ	COLORADO	MONTROSE	2,081	158,198	1%
MTO	ILLINOIS	MATTOON/CHARLESTON		N/A	
MVN	ILLINOIS	MOUNT VERNON		N/A	
MVY	MASSACHUSETTS	VINEYARD HAVEN		52,792	
MWA	ILLINOIS	MARION		11,099	
MWH	WASHINGTON	MOSES LAKE		N/A	
MYR	SOUTH CAROLINA	MYRTLE BEACH	849,263	1,285,200	66%
NQA	TENNESSEE	MILLINGTON		N/A	
NYL	ARIZONA	YUMA		100,480	
OAJ	NORTH CAROLINA	JACKSONVILLE		163,703	
OAK	CALIFORNIA	OAKLAND	470,451	6,560,230	7%
OCF	FLORIDA	OCALA		N/A	
OGD	UTAH	OGDEN	15,546	16,164	96%
OGG	HAWAII	KAHULUI		3,791,807	
OGS	NEW YORK	OGDENSBURG	14,758	26,921	55%
OKC	OKLAHOMA	OKLAHOMA CITY	89,416	2,142,156	4%
OMA	NEBRASKA	OMAHA	134,124	2,455,274	5%
OME	ALASKA	NOME		65,087	
ONT	CALIFORNIA	ONTARIO	119,690	2,723,002	4%
ORD	ILLINOIS	CHICAGO	2,192,112	40,871,223	5%
ORF	VIRGINIA	NORFOLK	127,722	1,990,864	6%
ORH	MASSACHUSETTS	WORCESTER		97,090	
OSU	OHIO	COLUMBUS		N/A	
OTH	OREGON	NORTH BEND		13,393	
OTZ	ALASKA	KOTZEBUE		67,876	
OWB	KENTUCKY	OWENSBORO	13,237	18,615	71%
OXR	CALIFORNIA	OXNARD		N/A	
PAE	WASHINGTON	EVERETT		389,778	
PAH	KENTUCKY	PADUCAH		17,982	
PBG	NEW YORK	PLATTSBURGH	107,864	125,499	86%
PBI	FLORIDA	WEST PALM BEACH	227,878	3,460,429	7%
PDX	OREGON	PORTLAND	369,701	9,797,408	4%
PGA	ARIZONA	PAGE		41,579	
PGD	FLORIDA	PUNTA GORDA	821,528	821,557	100%
PGV	NORTH CAROLINA	GREENVILLE		54,285	
PHF	VIRGINIA	NEWPORT NEWS		211,487	
PHL	PENNSYLVANIA	PHILADELPHIA	1,579,036	16,006,389	10%
PHX	ARIZONA	PHOENIX	670,298	22,433,552	3%
PIA	ILLINOIS	PEORIA	110,610	341,064	32%
PIB	MISSISSIPPI	HATTIESBURG-LAUREL		11,638	
PIE	FLORIDA	ST PETERSBURG-CLEARWATER	1,119,067	1,143,483	98%
PIH	IDAHO	POCATELLO		43,626	
PIR	SOUTH DAKOTA	PIERRE		14,602	
PIT	PENNSYLVANIA	PITTSBURGH	479,233	4,715,947	10%
PKB	WEST VIRGINIA	PARKERSBURG		5,247	
PLN	MICHIGAN	PELLSTON		29,050	
PNS	FLORIDA	PENSACOLA	46,390	1,098,889	4%
POU	NEW YORK	POUGHKEEPSIE		N/A	
PPG	AMERICAN SAMOA	PAGO PAGO		59,246	
PQI	MAINE	PRESQUE ISLE		13,244	
PRC	ARIZONA	PRESCOTT		27,771	
PSC	WASHINGTON	PASCO	42,193	438,015	10%
PSE	PUERTO RICO	PONCE		102,913	
PSG	ALASKA	PETERSBURG		23,479	
PSM	NEW HAMPSHIRE	PORTSMOUTH	61,241	116,903	52%
PSP	CALIFORNIA	PALM SPRINGS	74,277	1,309,170	6%
PTK	MICHIGAN	PONTIAC		N/A	

PUB	COLORADO	PUEBLO		12,230	0%
PUW	WASHINGTON	PULLMAN/MOSCOW		70,560	
PVD	RHODE ISLAND	PROVIDENCE	166,250	1,969,775	8%
PVU	UTAH	PROVO	108,381	110,279	98%
PWM	MAINE	PORTLAND	77,959	1,088,728	7%
RAP	SOUTH DAKOTA	RAPID CITY	44,278	342,794	13%
RDD	CALIFORNIA	REDDING		51,639	
RDG	PENNSYLVANIA	READING		N/A	
RDM	OREGON	REDMOND	8,527	482,676	2%
RDU	NORTH CAROLINA	RALEIGH/DURHAM	711,384	6,919,429	10%
RFD	ILLINOIS	CHICAGO/ROCKFORD	113,962	116,767	98%
RHI	WISCONSIN	RHINELANDER		27,203	
RIC	VIRGINIA	RICHMOND	146,066	2,190,907	7%
RIW	WYOMING	RIVERTON		6,912	
RKS	WYOMING	ROCK SPRINGS		24,056	
RME	NEW YORK	ROME		N/A	
RNO	NEVADA	RENO	65,490	2,162,250	3%
ROA	VIRGINIA	ROANOKE	38,409	361,131	11%
ROC	NEW YORK	ROCHESTER	19,864	1,276,643	2%
ROW	NEW MEXICO	ROSWELL		60,217	
RST	MINNESOTA	ROCHESTER		183,187	
RSW	FLORIDA	FORT MYERS	1,123,215	5,044,024	22%
RUT	VERMONT	RUTLAND		5,488	
RWI	NORTH CAROLINA	ROCKY MOUNT		N/A	
SAF	NEW MEXICO	SANTA FE		142,774	
SAN	CALIFORNIA	SAN DIEGO	657,122	12,648,692	5%
SAT	TEXAS	SAN ANTONIO	261,544	5,022,980	5%
SAV	GEORGIA	SAVANNAH	181,980	1,461,360	12%
SAW	MICHIGAN	MARQUETTE		59,056	0%
SBA	CALIFORNIA	SANTA BARBARA	23,581	510,141	5%
SBD	CALIFORNIA	SAN BERNARDINO		-	
SBN	INDIANA	SOUTH BEND	102,238	416,140	25%
SBP	CALIFORNIA	SAN LUIS OBISPO		267,924	
SBY	MARYLAND	SALISBURY		70,111	
SCC	ALASKA	DEADHORSE		71,822	
SCE	PENNSYLVANIA	STATE COLLEGE	4,647	190,976	2%
SCK	CALIFORNIA	STOCKTON	94,514	101,156	93%
SDF	KENTUCKY	LOUISVILLE	151,478	2,043,525	7%
SDP	ALASKA	SAND POINT		4,385	
SDY	MONTANA	SIDNEY		10,202	
SEA	WASHINGTON	SEATTLE	479,277	25,001,762	2%
SFB	FLORIDA	ORLANDO	1,491,669	1,601,614	93%
SFO	CALIFORNIA	SAN FRANCISCO	335,978	27,779,230	1%
SGF	MISSOURI	SPRINGFIELD	119,261	585,164	20%
SGJ	FLORIDA	ST AUGUSTINE		N/A	
SGU	UTAH	ST GEORGE	2,010	102,297	2%
SHD	VIRGINIA	STAUNTON/WAYNESBORO/HARRI		8,044	
SHR	WYOMING	SHERIDAN		17,584	
SHV	LOUISIANA	SHREVEPORT	25,060	325,399	8%
SIT	ALASKA	SITKA		90,839	
SJC	CALIFORNIA	SAN JOSE	62,986	7,688,152	1%
SJT	TEXAS	SAN ANGELO		66,390	
SJU	PUERTO RICO	SAN JUAN	721,860	4,590,117	16%
SLC	UTAH	SALT LAKE CITY	242,141	12,840,841	2%
SLE	OREGON	SALEM		N/A	
SLK	NEW YORK	SARANAC LAKE		4,830	
SLN	KANSAS	SALINA		16,026	
SMF	CALIFORNIA	SACRAMENTO	158,537	6,454,413	2%

SMX	CALIFORNIA	SANTA MARIA	24,075	24,266	99%
SNA	CALIFORNIA	SANTA ANA	113,647	5,153,276	2%
SOW	ARIZONA	SHOW LOW		4,574	
SPI	ILLINOIS	SPRINGFIELD	17,138	75,407	23%
SPS	TEXAS	WICHITA FALLS		40,418	
SRQ	FLORIDA	SARASOTA/BRADENTON	211,559	977,530	22%
SRR	NEW MEXICO	RUIDOSO		N/A	
STC	MINNESOTA	ST CLOUD	20,275	21,767	93%
STJ	MISSOURI	ST JOSEPH		N/A	
STL	MISSOURI	ST LOUIS	273,526	7,773,759	4%
STS	CALIFORNIA	SANTA ROSA	6,684	239,859	3%
STT	VIRGIN ISLANDS	CHARLOTTE AMALIE	67,878	591,560	11%
STX	VIRGIN ISLANDS	CHRISTIANSTED	24,785	225,883	11%
SUN	IDAHO	HAILEY		89,317	
SUS	MISSOURI	ST LOUIS		N/A	
SUX	IOWA	SIOUX CITY		47,116	
SVC	NEW MEXICO	SILVER CITY		5,968	
SWF	NEW YORK	NEW YORK	53,344	268,083	20%
SWO	OKLAHOMA	STILLWATER		29,661	
SYR	NEW YORK	SYRACUSE	199,484	1,271,872	16%
TBN	MISSOURI	FORT LEONARD WOOD		5,404	
TCL	ALABAMA	TUSCALOOSA		N/A	
TEB	NEW JERSEY	TETERBORO		N/A	
TEX	COLORADO	TELLURIDE		5,519	
TIX	FLORIDA	TITUSVILLE		N/A	
TLH	FLORIDA	TALLAHASSEE		415,272	
TNI	N MARIANA ISLANDS	TINIAN ISLAND		41,254	
TOL	OHIO	TOLEDO	56,187	124,211	45%
TPA	FLORIDA	TAMPA	1,690,678	10,978,756	15%
TRI	TENNESSEE	BRISTOL/JOHNSON/KINGSPORT	20,894	220,827	9%
TTN	NEW JERSEY	TRENTON	461,596	462,173	100%
TUL	OKLAHOMA	TULSA	76,330	1,507,756	5%
TUP	MISSISSIPPI	TUPELO		15,271	
TUS	ARIZONA	TUCSON	38,725	1,849,081	2%
TVC	MICHIGAN	TRAVERSE CITY	9,726	287,012	3%
TVF	MINNESOTA	THIEF RIVER FALLS		5,100	
TWF	IDAHO	TWIN FALLS		51,406	
TXK	ARKANSAS	TEXARKANA		37,492	
TYR	TEXAS	TYLER	9,237	59,807	15%
TYS	TENNESSEE	KNOXVILLE	281,179	1,240,311	23%
UIN	ILLINOIS	QUINCY		10,033	
UOX	MISSISSIPPI	OXFORD		N/A	
USA	NORTH CAROLINA	CONCORD	179,120	179,126	100%
UTA	MISSISSIPPI	TUNICA		N/A	
VCT	TEXAS	VICTORIA		5,734	
VCV	CALIFORNIA	VICTORVILLE		N/A	
VDZ	ALASKA	VALDEZ		9,401	
VEL	UTAH	VERNAL		12,657	
VGT	NEVADA	LAS VEGAS		N/A	
VLD	GEORGIA	VALDOSTA		44,180	
VPS	FLORIDA	VALPARAISO/DESTIN-FT WALTON	267,171	813,600	33%
VPZ	INDIANA	VALPARAISO		N/A	
VRB	FLORIDA	VERO BEACH		7,698	
WRG	ALASKA	WRANGELL		14,776	
WYS	MONTANA	WEST YELLOWSTONE		8,988	
XNA	ARKANSAS	FAYETTEVILLE/SPRINGDALE/ROGE	74,927	891,237	8%
XWA	NORTH DAKOTA	WILLISTON		89,040	
YAK	ALASKA	YAKUTAT		12,808	

YIP	MICHIGAN	DETROIT		N/A	
YKM	WASHINGTON	YAKIMA	311	69,397	0%
YNG	OHIO	YOUNGSTOWN/WARREN		N/A	
Z08	AMERICAN SAMOA	OFU VILLAGE		891	

APPENDIX B

PEARSON CORRELATIONS TABLE

Correlations

		Existing ULCC Service (Category)	Lg10 Enplane	Lg10 Pop	EAS Service (2019)	Distance to Major City (Miles)	Distance to Other Airport (Miles)	Within 70 miles of a Border Crossing	Tourism Percent
Existing ULCC Service (Category)	Pearson Correlation	1	.[a]	.319**	-.310**	-.347**	-.063	.063	-.022
	Sig. (2-tailed)		.	<.001	<.001	<.001	.170	.171	.631
	N	474	179	474	474	474	474	474	472
Lg10 Enplane	Pearson Correlation	.[a]	1	.542**	-.153*	-.285**	-.211**	-.093	.193**
	Sig. (2-tailed)	.		<.001	.042	<.001	.005	.217	.010
	N	179	179	179	179	179	179	179	179
Lg10 Pop	Pearson Correlation	.319**	.542**	1	-.444**	-.693**	-.626**	-.085	-.175**
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	.063	<.001
	N	474	179	474	474	474	474	474	472
EAS Service (2019)	Pearson Correlation	-.310**	-.153*	-.444**	1	.521**	.194**	.055	-.145**
	Sig. (2-tailed)	<.001	.042	<.001		<.001	<.001	.228	.002
	N	474	179	474	474	474	474	474	472
Distance to Major City (Miles)	Pearson Correlation	-.347**	-.285**	-.693**	.521**	1	.407**	.151**	.113*
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001	.014
	N	474	179	474	474	474	474	474	472
Distance to Other Airport (Miles)	Pearson Correlation	-.063	-.211**	-.626**	.194**	.407**	1	.009	.073
	Sig. (2-tailed)	.170	.005	<.001	<.001	<.001		.838	.111
	N	474	179	474	474	474	474	474	472
Within 70 miles of a Border Crossing	Pearson Correlation	.063	-.093	-.085	.055	.151**	.009	1	-.028
	Sig. (2-tailed)	.171	.217	.063	.228	<.001	.838		.543
	N	474	179	474	474	474	474	474	472
Tourism Percent	Pearson Correlation	-.022	.193**	-.175**	-.145**	.113*	.073	-.028	1
	Sig. (2-tailed)	.631	.010	<.001	.002	.014	.111	.543	
	N	472	179	472	472	472	472	472	472

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

a. Cannot be computed because at least one of the variables is constant.

APPENDIX C

QUALITATIVE INTERVIEW QUESTIONS

Case Study Interview Questions

1. How would you describe the current status of your airport market?
    a. For example, types of travelers and carriers, origins and destinations, growth and decline, opportunities and constraints?

2. "My data shows you do/don't have ULCC service by airline X." Describe the history of your market specifically in relation to ULCCs.

3. What has your experience been negotiating with ULCCs?

4. Does your airport have features that lend themselves to ULCC service in particular?
    a. In your view, what are ULCCs looking for when considering an expansion of their networks?