ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics
Bachelor Economics and Business Economics
Bachelor thesis Strategy Economics

The Low-cost effect

The impact of entry of Low-cost Airlines and how Full-Service Airlines respond

October 20th, 2020

Author: L.R.T. Snoeks
Student ID Number: 484842

Supervisor: Dr. A.S. Bhaskarabhatla
Second Assessor: Dr. T.L.P.R. Peeters

The Low-cost effect

The impact of entry of Low-cost Airlines and how Full-Service Airlines respond

ERASMUS UNIVERSITEIT ROTTERDAM

STATEMENT OF ORGINALITY

This document is written by L.R.T. Snoeks who declares to take full responsibility for the contents of this document.

I declare that the text and the work presented in this document is original and that no sources other than those mentioned in the text and its references have been used in creating it.

The Erasmus school of Economics is responsible solely for the supervision of completion of the work, not for the contents.

L.R.T. Snoeks

ABSTRACT

At the moment the aviation industry is in a recession never witnessed before. Based on previous studies, post-crisis periods are accompanied by an increase in new routes entered by low-cost carriers (LCC) and therefore we expect a similar scenario after the COVID-19 crisis. This prospect leads to an increased interest in how full-service carriers (FSC) respond (in terms of ticket prices, passengers transported and capacity available) to actual new route entry and the threat of entry by LCCs. Based on data from the first quarter of 2008 to the fourth quarter of 2019, we found that FSCs respond by not only lowering the ticket fares from the moment of actual entry, but also when LCCs start threatening to enter. On the other hand, no evidence was found that FSCs increase their capacity as a response to entry or the threat of entry. Additionally, no prove was found for the direct effect of entry and the threat of entry on the number of passengers transported by the FSC on the threatened or entered route. Entry and the threat of entry seem to have an indirect positive effect – through the decreasing fares – on the number of passengers transported.

Keywords Aviation, United states domestic industry, Full-service carrier, FSC, low-cost carrier, LCC, entry, threat of entry, average ticket fares, passengers transported, seat capacity

TABLE OF CONTENTS

LIST OF FIGURES & TABLES

1. INTRODUCTION

Since the outbreak of the COVID-19 virus in December 2019, many scientists around the world tried the uncover the origin of the virus. Strong evidence suggests that it originated in bats and that the first infected person is from Wuhan, China (Mallapaty, 2020). Half a year after the outbreak the European Centre for Disease Prevention and Control (ECDC) (2020) reported over 11.5 million COVID-19 cases and more than 500.000 people died. The impact of the virus on the health system is notable, but also the financial consequences are significant.

The travel industry – and thus the aviation industry – are among the industries which got hit hardest. The demand for tickets dropped significantly which resulted in an unprecedented wave of cancellations by the airlines (Slotnick, 2020). KLM Royal Dutch Airlines cancelled 90% of their flights in April compared to the previous year (Hermanides, 2020) while American Airlines almost cancelled all its flights to Asia, 75% of its transatlantic flights and around 30% of its domestic flights (Reid, 2020). The main reason for this drop lies in governmental instructions, restrictions on unnecessary travel or even closure of the borders (Nicola et al., 2020).

As a result, the revenues dropped on average by 80% compared to the same period last year and many airlines struggle to survive. Air Canada announced to lay of 60% of its workforce (20,000 employees) (CBC News, 2020) and Norwegian Air laid off 7,300 employees (Solsvik, 2020). Some airlines even had to file for bankruptcy protection or bankruptcy. Among those airlines are both Full-Service Carriers (abbreviated as FSC) like Avianca (CH-Aviation, 2020), LATAM (Rochabrun, Cambero, & Bautzer, 2020) and South African Airways (Skiti, 2020) and Low-Cost Carriers (LCC) like the British FlyBe (Toh, 2020).

Although the COVID-19 recession is considered the worst crisis in aviation's history, the industry experienced multiple crises before. Oxley and Jain (2015) – two experts of the International Air Transport Association (IATA) – studied the impact of the four major shocks in aviation history. The Global recession in the early 1980s caused by the 1979 oil shock resulted in a drop of transported passengers and it took till 1987 before the growth of the industry was at the same level as before the oil crisis. A few years later, the industry experienced a drawback caused by the Gulf War in 1990 of which recovery took another 4 years. The third major crisis had actually three causes. The first cause was the dotcom bubble burst in 2000 and 2001. After an enormous growth of internet based companies in the late 1990s their stocks crashed resulting in a collapsing of the NASDAQ by 76% (Firestone, 2020). This had a negative impact on the aviation industry, which got intensified by the well-known 9/11 terrorist attacks and the SARS outbreak. The fourth and final major crisis studied had its origin in the financial crisis of 2008. During his crisis the fuel prices rose dramatically, resulting in the need to raise the ticket prices and consequentially a drop in passenger demand. Even though, the passenger drops of the last two crises were deeper compared to the first two crises, the recovery only took 4 years, after which the traffic continued to grow in line with the long-term trend.

When focusing on the period after the start of the crises, airlines had major problems surviving. Airlines all over the world filed for bankruptcy or ceased operations caused by the consequences of this crises. Looking at the dotcom-9/11-SARS crisis, multiple airlines like United Airlines, US airways and other national Airlines filed for bankruptcy due to their continued insolvency and the financial losses related to the crisis (Kim & Gu, 2004). During the crisis period, the number of new routes entered decreased, but from 2003 an increase in routes entered was observed (Hüschelrath & Müller, 2012). In the period before 2003, the majority of new routes was entered by FSC, while from 2003 more routes were opened by the low-cost carriers. This change happened because the low-cost carriers were able to keep the operating costs low by offering a surprisingly lean business model (Franke & John, 2011). Consequentially, these companies were able to focus on growth or expansion opportunities in an earlier stage, compared to their high-cost competitors. They were able to start flying the routes exited by the bankrupt airlines.

A similar scenario is observed in the period of the financial crisis in 2008. 13 United States Airlines have filed for bankruptcy (U.S. Department of Transportation, 2012) and because of the changing landscape, especially low-cost airlines were able to gain market share (CAPA, 2008). The low-cost carriers increased their number of entered routes in the period after the crisis compared to 2008, while the FSC started significantly less new routes (BTS, 2020).

At the moment the aviation industry is in a recession caused by the COVID-19 and several airlines went bankrupt. This bears resemblance to the previous two crises and therefore we expect a similar scenario in the recovery period of this crisis: a high number of routes entered by the low-cost carriers. But what implications does this increased number of entries have for the current incumbents of the routes? Do the incumbent FSCs change their ticket prices? Does the capacity of seats offered by the FSCs increase or decrease? Do they transport more or less passengers? Therefore, the following research question is put forward:

How do incumbent full-service carriers respond to entry and the threat of entry of new routes by low-cost carriers?

Several researches have been conducted to investigate the effect of entering a route on ticket fares and passengers transported, but the effect on capacity received considerably less attention. Investigating the effect on capacity is therefore also included in this thesis. Secondly, the threat of entry received little attention in existing literature. Only Goolsbee and Syverson (2008) focused on the threat of entry, but used rather outdated data for the research. In other papers we see also results based on relatively old data. Daraban and Fournier (2008) investigated the effect of entry by using data from the first quarter of 1993 to the third quarter of 2006. Windle and Dresner (1999) took data from the fourth quarter of 1993 to the third quarter of 1996. Goolsbee and Syverson (2008) used information from the first quarter of 1993 to the last quarter of 2004 and Asahi and Murakami (2017) used data of the fourth quarter of the years 2003 to 2010. Even though, Asahi and Murakami (2017) included the first two years after the crisis, none of these researches focused on the full post-financial crisis period. Performing a similar research with data from the first quarter of 2008 to the last quarter of 2019 gives a more reliable indication of how established airlines nowadays respond to the entry and the threat of entry by LCCs in (post-)crisis periods. This paper is therefore not only an addition to the current literature because of including capacity and the impact of the threat of entry, but also because more recent and post-crisis data is used.

In this research we will run several regressions to test the multiple hypotheses. Data regarding the United States domestic aviation market is used. This data is secondary data from two different databases collected by the Bureau of Transportation Statistics (BTS), a part of the United States Department of Transportation (DOT). These databases are considered from a trustworthy source and used in several previously conducted studies. The data used ranges from the first quarter of 2008 to the fourth quarter of 2019 and contains all the information required for this research, which makes it suitable even though it was not specifically collected for this study.

The results of this research are mostly similar to previous findings. We observed that incumbent airlines significantly lowered their average ticket fares on a route from the moment an LCC threatened to enter that route. The prices declined even further once the LCC actually entered the market. Increasing the capacity is considered a frequently used strategy to deter new participants from entry or force them to exit the route after entry has occurred. Based on this, we would expect an increase in FSC capacity when an LCC starts threatening to enter the route or actually enters the route. However, the results did not confirm such a relation. In line with the literature, we found an increase in the passengers transported by the FSC, although this effect does not seem to be directly caused by the actual entry or the threat of entry. Entry and the threat of entry seem to affect the number of passengers indirect through the decrease in average ticket fares.

This thesis is structured in the following way: In the next chapter relevant literature regarding the entry of new airlines is discussed. In Chapter 3 the theoretical framework with the hypotheses, based on the previously discussed literature, is presented. Chapter 4 addresses the data and methodology used to conduct this research, after which I present the results in Chapter 5. Finally, we end this thesis with the conclusion and discussion in Chapter 6.

2. LITERATURE REVIEW

In the following section, we discuss relevant literature on the subject. We will first focus on a short summary of the history of the united states aviation industry. Thereafter, the two types of market participants are analyzed. We conclude this chapter with literature on the effect of low-cost carrier entry.

2.1 The United States Aviation Industry

The airline industry we know today started in 1903 in Kitty Hawk, a small city in the state of North-Carolina. After extensive tests with different glider planes, the brothers Orville and Wilbur Wright performed on the 17th of December the first test flight with the Wright Flyer: the first engine-driven air machine which was heavier than air. On that particular day they performed four flights – each longer than the one before – resulting in a flight between 57 and 59 seconds and a distance flown of 284 meters (Crouch, 2014; Petrescu et al., 2017; World Digital Library, 2014).

In the 1920s and 1930s, several mergers between small transport airlines took place. These mergers led to the major united states air carriers, like United Airlines (Katz, 1988). During this period, there was little governmental regulation of the industry and therefore the federal Civil Aeronautics Authority (CAA) (later renamed the Civil Aeronautics Board (CAB)) was established in 1938. This authority started to control ticket fares, routes and entry of new airlines (Katz, 1988). By controlling these aspects, the profitability of the airlines was guaranteed, although at the expense of the passengers. It resulted in excessive fares and prevented innovative low-cost services (Freeman, 1978). The industry was dominated by the FSCs and it was impossible for LCCs to enter the market.

This all changed with the Airline Deregulation Act of 1978 (ADA). This act established an economic deregulation of the aviation industry and the transient dissolution of the CAA. In this period, entry into the industry was liberalized and the influence of the CAA on the fares reduced (Freeman, 1978). Subsequently, a movement from an 'all-FSC' market to a free and diversified market was observed, resulting in an industry with in general two types of participants.

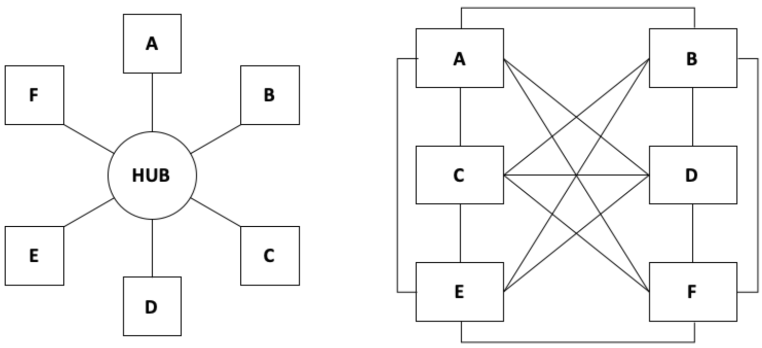
2.2 The market participants

In the current United States aviation industry, we distinguish two types of airlines: The Full-Service Carriers (abbreviated from now as FSC) and the Low-Cost Airlines (abbreviated as LCC). The Deutsches Zentrum für Luft- und Raumfahrt (DLR) (2008) defines an FSC (or network carrier) as an airline that focusses on providing a wide range of connecting flights, pre-flight and onboard services.

The definition of an LCC is a more complicated. Štimac, Vince and Vidović (2012) state that there is no unified definition of an LCC. Nonetheless, there exists a public understanding of what an LCC is based on certain characteristics we associate with a low-cost business model. Based on this, Akpur and Zengin (2019) describe an LCC as airline with cheap tickets and no free catering. According the DLR (2008) an LCC is an airline that focusses on cost reduction to implement a price leadership strategy on the markets they serve. The International Civil Aviation Organization (ICAO) (2016) defines an LCC as follows:

> *'A Low-Cost Carrier generally refers to an air carrier that has a relatively low-cost structure in comparison with other comparable carriers and offers low fares or rates. Such a carrier may be independent, the division or subsidiary of a major carrier or, in some instances, the ex-charter arm of an airline group.'*

This low-cost structure can be achieved in a number of ways. First, even though LCCs are increasingly attracted to primary airports (CAPA, 2019b), the LCCs normally operates from regional, secondary airports for three different reasons (Štimac et al., 2012). These airports experienced a substantial lack of passengers, resulting in significant lower commercial revenues. The LCCs were able to supply these passengers and negotiated lower aeronautical charges in exchange (Lei & Papatheodorou, 2010). Besides the lower charges, the aircraft handling at small airports is more efficient. This results in shorter ground time of the planes and a better utilization of the fleet. The third reason is that LCCs offer direct flights by means of a point-to-point model and do not offer transfers. This does not require a complex network and the use of primary airports. For FSCs the use of these secondary airports is less interesting primarily because these airlines do offer connecting flights and therefore operate a hub-and-spoke model (DLR, 2008). Using this model creates a much more efficient network with less routes required to connect all the airports. As can be seen in figure 1 and derived by equation (1). In a hub-and-spoke network only six routes are required to connect all the 6 airports via the hub airport, while a point-to-point network needs 15 routes to connect 6 airports with each other (see Figure 1 and equation (2)). the disadvantages of this hub-and-spoke network are the higher charges and slow aircraft handling at the hub airport. But for FSC the advantage of the route efficiency outweighs these disadvantages.



$$N_{routes\ hub-and-spoke} = n_{airports} - 1 \quad (1)$$

$$N_{routes\ point-to-point} = \frac{n_{airports}\,(n_{airports} - 1)}{2} \quad (2)$$

Figure 1: schematic visualization and equations of a Hub-and-spoke network and a point-to-point network

The second major difference between the LCCs and the FSCs is the type of aircrafts used. In general, LCC make use of a single type of aircraft (Akpur & Zengin, 2019). This results in cheaper aircraft financing, a less costly maintenance program, less spare parts required and lower crew training costs. This in contrast to the FSCs, who use different type of airplanes to conduct short-, medium- and long-haul flights. Next, the FSCs offer multiple classes (e.g. economy class, business class), while the LCCs normally offer only an economy class to avoid additional costs related to service differences (Akpur & Zengin, 2019). FSCs normally offer free services, like catering, seat reservation, an entertainment-on-board system, free check-in baggage and a loyalty program. The services are also offered by the LCC, but charged with an additional fee (Štimac et al., 2012). Finally, a difference in the salary structure of employees can be observed. The salaries of FSC employees have a high fixed component, while variable income of LCC employees is up to 40% (Štimac et al., 2012). The LCC wages are lower because of the lack of union activity (Akpur & Zengin, 2019). An overview of the main differences between the FSCs and the LCCs is provided in Table A1 in Appendix A.

2.3 The effect of low-cost carrier entry

As stated above, FSCs dominated the aviation industry till 1978. 40 years later, they lost a significant part of their market share to the low-cost carriers after the deregulation. If we base the market share on revenue passenger kilometers[1], the combined market share of the LCCs is approximately 25% in 2020 (IATA, 2020). If we focus solely on transported passengers worldwide, this percentage grew by 15% from 16% to 31% (OAG, 2019; Wall & Carey, 2017)(See Appendix B for the graph).

In the United States Domestic market, we observe slightly different percentages. Given the fact that this market is a more mature market and had no LCC start-up activity in last decade, the market had a slower LCC growth rate compared to the other regions. Based on seat capacity the United States LCCs had a market share of 32% in 2018 compared to 28% in 2009 (CAPA, 2019a)(See Figure 2).

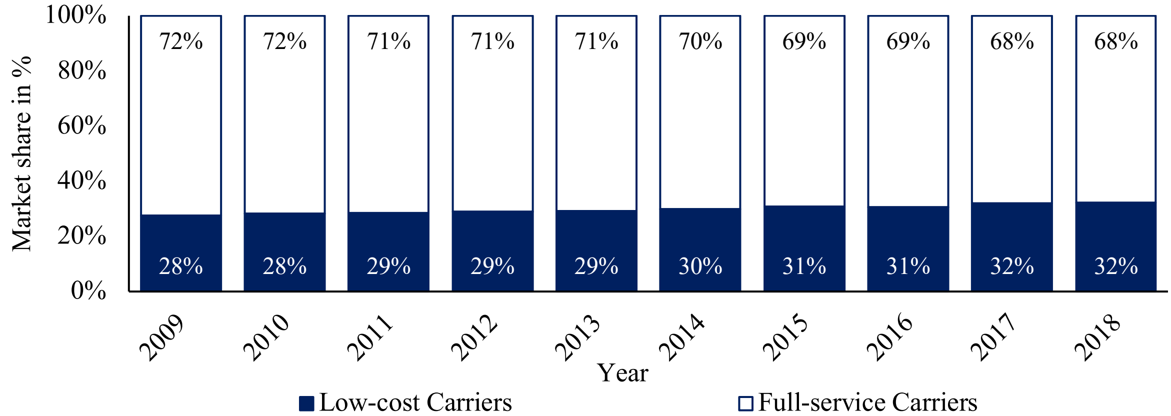


Figure 2: Seat Capacity market share of Full-service carriers and Low-cost carriers.
Source: CAPA, 2019

[1] Revenue passenger kilometers (RPK) is an indicator commonly used in the transportation industry. It shows the number of kilometers traveled by passengers and can be calculated by multiplying the number passengers by the distance in kilometers these passengers traveled.

The movement from an 'all-FSC' market to a market where both FSCs and LCCs are active, is considered an interesting field of research and therefore many academics studied this change of market composition. The majority of the papers focuses on how incumbents reacted on the entry of an LCC in terms of change in ticket fares. Numerous parties have stated that incumbents aggressively lower their ticket fares as an answer to LCC entry (Ito & Lee, 2011). In these papers, the assumption that this change in ticket prices is accompanied by a change in passengers transported is observed often. Accordingly, most of these studies have a similar structure where researchers examine the variation in fares and passenger transported caused by LCC route entry (e.g. Goolsbee & Syverson, 2008; Whinston & Collins, 1992; Windle & Dresner, 1995)

Whinston & Collins (1992) investigated the effect of LCCs on the average ticket prices, sales quantity and schedule changes. They focused specifically on the entry of People Express Airlines. This Low-Cost Airline started operating out of Newark airport in 1980 and merged with Continental Airlines in 1987. They compared both ticket prices and tickets sold of the first quarters of 1984, 1985 and 1986. A significant percentual drop in the mean ticket prices up to 35% was found on the entered routes, while this entry was associated with 108% more tickets sold.

Windle and Dresner wrote multiple articles with the entry of LCC as subject. In 1995 they wrote a paper on the short and long run effects of entry on the U.S. domestic air routes. Based on data for the period 1991 to 1994 they found a 48% decline in ticket fares when Southwest Airlines entered the route. Another finding was that the number of passengers increased by 32% upon entry rising to 74% in the fourth quarter after entry.

Dresner, Lin and Windle (1996) continued on the subject investigating not only the effect on the route of entry, but also its effect on competitive routes. For their researched they defined competitive routes as routes where either the origin airport or destination airport differs from the airports of the entered route and that the alternative airport lies within a 50 miles radius of the primary city airports. For example, Washington-Chicago would be the competitive route of Baltimore-Chicago, since Baltimore is less than 50 miles away from Washington. To estimate the most realistic model, they included several control variables in their model. One of these variables was the Herfindahl index which indicates the degree of competition on a route. The authors expected the Herfindahl index to have a significant positive effect on the yields. Furthermore, they corrected for yield changes over time by controlling for time (year and quarter). They found that the presence of an LCC on US domestic routes causes a significant increase of the passengers transported on entered route, but also on competitive routes. On some competitive routes, the impact was of the same magnitude as the impact on the entered route. In addition, they found that the entry of an LCC in general contributed to an average yield reduction of 38% on the route of entry and a reduction between 0 and 41% on the competitive routes. When focusing only on the entry of Northwest, the impact was even more substantial. The yields dropped by 43%, while the yields on the competitive routes went down up to 45%.

Windle and Dresner (1999) continued studying this effect and investigated the response of Delta Air Lines when the LCC ValueJet started operating to and from Atlanta; Delta's main hub and the primary hub of the southeastern part of the United States. They were not only interested in the change in ticket fares of the entered route and the competitive routes, but also in the changes on non-competitive routes. This was considered interesting since the United States Department of Transportation (DOT)(1996) claimed that entry of an LCC not always results in lower ticket fares on the competitive routes. Additionally, the DOT stated that in some cases the established carriers may increase the ticket fares on non-competitive routes to offset the loss on the entered routes. The results of Windle and Dresner provided evidence that Delta lowered the ticket prices on the entered route and the competitive routes, but no change in prices was observed on the non-competitive routes. This conflicts with the findings of the DOT and implies that carriers do not offset the decline in revenue by increasing the prices on the non-competitive routes.

Similar findings on mean ticket prices were published by Vowles (2000). He also used regression techniques to estimate a model, which explains the variance in ticket fares. He included the control variable Hub in the model, since Hub formations appears to result in higher ticket fares (Borenstein, 1989). The effect of both Southwest Airlines' presence and LCC presence in general was investigated. Presence of an LCC in general caused a decrease of the average fares by \$45.47 (26.7%), while the presence of Southwest caused a drop of \$77.61 (45.6%). Considering the average fare price of \$170.20, the decrease caused by presence of Southwest Airlines or any other LCC is notable.

In similar fashion Goolsbee and Syverson (2008) investigated the effect of entry of the low-cost carrier Southwest Airlines by using data from the first quarter of 1993 through the fourth quarter of 2004. They examined how incumbents change their ticket fares and how passengers transported on that route changes when a competitor enters. Additionally, they were interested in the effect of the threat if entry on ticket prices and transported passengers. This aspect was mainly overlooked in previous literature, due to the problem of identifying the threat of entry. Goolsbee and Syverson described the threat of entry in the following way: The threat of entry arises when Southwest establishes presence in both the endpoint airports. This can be explained by using Figure 3. Consider three different airports: New York's John F. Kennedy international airport (JFK), Hartsfield-Jackson Atlanta international airport (ATL) and Miami International Airport (MIA). At time T_i Southwest Airlines performs flights from ATL to JFK. At a later moment T_j, Southwest Airlines start flying between JFK and MIA. Although, Southwest Airlines does not (yet) have a direct route between ATL and MIA, the threat that the LCC will start flying this route arises. The company already operates from ATL and MIA, so establishing a direct route between these two airports is likely.

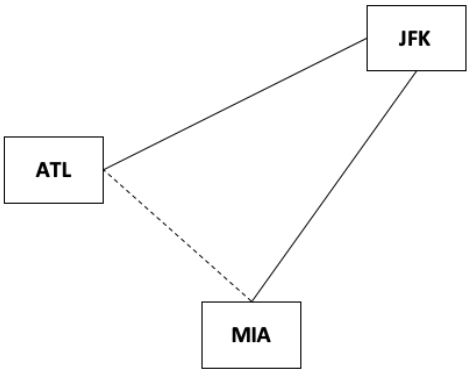


Figure 3: Threat of entry
Source: Goolsbee & Syverson (2008)

Goolsbee and Syverson found that incumbents react on this threat by lowering the fares by 17% compared to the average prices in the baseline period (period between 2 and 3 years prior to presence establishment). This price continues falling to over 21% by the time Southwest actually enters. Regarding the passengers transported, they found a positive, although not significant, effect of both the threat of entry and the actual entry. The increase in passengers transported seems not to be a direct result of (the threat of) entry, but a result of the decrease in average ticket fares.

Asahi and Murakami (2017) investigated the effect of Southwest Airlines' entry in the period 2003 – 2010. Compared to previous literature, they used more recent data, but found similar results. They concluded that incumbent airlines set competitive lower prices after Southwest's entry.

To a lesser extent, researchers focused on the effect of entry on the capacity offered by incumbents. This while capacity expansion is considered a basic strategy to deter entry or to force new participants to exit (Barbot, 2008). Multiple papers claim that – besides lowering the ticket prices – incumbents increase their capacity aggressively as an answer to LCC entry. This to deter entry or force exit by depriving the new entrants from passengers and revenues (Ito & Lee, 2011). Capacity expansion happens in forms of increasing the frequency of the flights or by redeployment of larger aircrafts on the existing flights (Morrison, 2004). The model of Dixit (1980) shows that preemptive expansion of the capacity can be in the incumbents interest when a potential competitor is threatening to enter a route. Ito and Lee (2011) investigated 370 market entry events between 1991 and 2002 and compared the price and capacity changes between the incumbent and the entrant. Evidence was found for capacity expansion by incumbents, although the incumbent's increase in capacity was rarely higher than the capacity of the new entrant. Therefore, aggressive capacity expansion of incumbent is more the exception than the rule.

3. THEORETICAL FRAMEWORK

In the following section the hypotheses for this research will be addressed. These hypotheses are constructed to answer the research question and are based on the findings in previous literature, supplemented with economic theories. These hypotheses will be discussed and explained in the following sections.

3.1 LCC's entry and Ticket Fares

Whinston and Collins (1992), Vowles (2000), Goolsbee and Syverson (2008) all found a negative significant effect of LCC's entry on ticket fares on a specific route. although, the magnitude of the effect seems to weaken over time. Whinston and Collins (1992) found 35% lower average ticket fare, while Vowles' research (2000) resulted in a 26.7% lower price, Goolsbee and Syverson (2008) found a decrease of the ticket fares 21.3% in the first two quarters after the entry. Even though the effect seems to weaken over time, we expect the average ticket fares on a specific charged by the FSCs route to decrease when an LCC starts competing on that route, which result in the following hypothesis:

H.1a *All other things being equal, FSCs lower their ticket fares on a specific route when an LCC starts flying that same route.*

In general, preemptive actions are considered irrational. Incumbents should not respond until they actually face competition of a new entrant and should therefore not lower their ticket fares before the LCC actually entered. The incumbents should ignore the threat of entry, since responding causes lower profits in the short run and has no effect in the long run (Goolsbee & Syverson, 2008). Still, aggressively lowering the ticket prices is a widely used strategy to deter LCCs from entry (Ito & Lee, 2011). Goolsbee and Syverson (2008) found significant evidence that incumbents already lower their fares when the threat of entry arises. Possible explanations for this behavior might be trying to deter actual entry or to weaken the new entrant once it enters. Hence, we expect that if an LCC threatens to fly a specific route the FSC already lower their fare prices on that route. This results in the following hypothesis:

H.1b *All other things being equal, FSCs lower their ticket fares on a specific route when an LCC threatens to fly that same route*

3.2 LCC's entry and capacity

By expanding their capacity incumbents try to force new entrants to exit the market. (Barbot, 2008). Multiple papers claim that this strategy is widely used as an answer to LCC entry and evidence was found that incumbents increase their capacity (Ito & Lee, 2011) We expect the capacity of the FSC to increase when an LCC starts flying the route, which results in the following hypothesis:

H.2a *All other things being equal, FSCs increase the total capacity (expressed in number of seats) on that route when an LCC starts flying that specific route.*

Because of its irrational character, preemptive actions should be avoided (Goolsbee & Syverson, 2008). Despite the irrationality, capacity increase is widely used as a basic strategy by incumbents to deter the LCCs from entry (Barbot, 2008). It can be in the best interest of the incumbent to expand its capacity when a new market participant is threatening to enter the route (Dixit, 1980). Therefore, we expect the number of seats on a route offered by the FSC to increase if the threat of LCC entry arises. The following hypothesis is put forward:

H.2b *All other things being equal, FSCs increase the total capacity (expressed in number of seats) when an LCC threatens to fly that specific route*

3.3 LCC's entry and transported passengers

Multiple papers linked the change in passengers transported to the change in ticket prices caused by the entry of an LCC. The decrease in ticket prices of 35% caused by the entry of the LCC People Express Airlines found by Whinston and Collins (1992) was associated with 108% more tickets sold, which they used as a proxy for the number of passengers transported. In line with these findings, Windle and Dresner's (1995) decrease in ticket prices up to 48% was accompanied by an 32% increase of passengers transported directly after LCC entry and rose up to 74% in the fourth quarter after the entry. Dresner, Lin and Windle's (1996) outcome indicated a dramatically rise of passenger traffic up to 400% on routes where Southwest Airlines entered. Finally, Goolsbee and Syverson (2008) included the entry effect on the passengers transported in their research. The regression outcome also showed positive coefficients for the effect of entry on the number of passengers, but none of these coefficients where significant and therefore not enough evidence was provided that LCC entry caused an increase of passengers transported by FSC on the entered route. Despite the insignificant outcome of Goolsbee and Syverson (2008), the majority of the papers showed us a credible increase in the number of passengers transported as a consequence of LCC entry. Therefore, we put the following hypothesis forward:

H.3a *All other things being equal, the number of passengers transported by an FSC on a route increases when an LCC starts flying that specific route.*

On the threat of entry, less literature is available. The threat of entry causes a decrease in average ticket fares (Goolsbee & Syverson, 2008). Additionally, a decrease in ticket fares is accompanied by an increase in passenger traffic (Whinston & Collins, 1992; Windle & Dresner, 1995) and therefore the passenger traffic by an FSC on a route is expected to increase when an LCC start threating to enter that specific route. In line with this expectation, the analysis of Goolsbee and Syverson (2008) returned positive values for the effect of the threat of Southwest Airlines' entry on the passengers transported by the incumbent FSC(s). However, caused by the lack of significance, the used data did not provide enough evidence to conclude that the effect of the threat of entry on the number of passengers transported is significantly different from zero. Despite the lack of significance, we still expect that the threat of entry has a positive effect on the number of passengers transported on the threatened route by an FSC. This is based on the findings that all Goolsbee and Syverson's (2008) ‘threat-coefficients’ had a positive value and that majority of the available literature stats that decreasing ticket fares, which are a result of the threat of entry, are accompanied by an increase in passenger traffic. This results in the following hypothesis:

H.3b *All other things being equal, the number of passengers transported by an FSC on a route increases when an LCC threatens to fly that specific route.*

As stated by multiple researches, the change in passenger traffic seems to be caused by the change in ticket prices, which results from the (threat of) entry of an LCC (Goolsbee & Syverson, 2008; Whinston & Collins, 1992; Windle & Dresner, 1995). These assumptions can be based on the economic law of demand. The lower the price, the higher the demand for a certain good or service. In this case, this implies that the lower the average ticket fares, the higher the demand for tickets and thus the more passengers are transported by the FSC. This results in the final hypothesis:

H.3c *All other things being equal, the ticket fares of FSCs on a route negatively contributes to the total number of passengers transported by the FSC on that route.*

4. DATA AND METHOD

This chapter focusses on the usage of the data and the methodological approach used for this research. It discusses first the data used for this research and the modifications applied. Thereafter the dependent variables, the independent variables and the control variables are mentioned and explained. Finally, the methods to test the hypotheses and answer the research question are discussed.

4.1 Data

For this research data of the United States domestic aviation market is used. The data is collected via the Bureau of Transportation Statistics (BTS), a part of the United States Department of Transportation (DOT). This institute collects information on multiple aspects of transportation to provide context to decision makers and the public for understanding transportation statistics. The BTS publishes several aviation datasets which are freely available. Two of these datasets are used for this research.

The first set is the DB1BMarket set from the Airline Origin and Destination Survey (DB1B) database. this dataset is a 10% sample of airline tickets from reporting carriers. The set contains data regarding the departure and arrival airport, the operating carrier, prorated ticket fares and distance. The data is published on a quarterly basis and available from the first quarter of 1993 to the fourth quarter of 2019. The second dataset is the T-100 Domestic Segment (U.S. Carriers) dataset from the Air Carrier Statistics (Form 41 Traffic) – U.S. carriers' database. The Air carrier Statistics database contains domestic and international market and segment data. Carriers report on a monthly basis traffic information by using the T-100 form. The T-100 Domestic segment dataset contains data regarding domestic non-stop flights. From this database information regarding the number of passengers transported and the seat capacity is subtracted.

Since the period after the financial crisis is studied, relevant data from the first quarter of 2008 to the fourth quarter of 2019 is extracted and merged into one dataset. We take into account only the 9 airlines with a domestic market share – based on revenue passenger miles [2] – higher than 2% in 2019 (Statista, 2020). 5 out of these 9 airlines are FSCs, while the other 4 are LCCs. An overview of these airlines is displayed in Table 1 (please refer to Appendix C for the overview including the corresponding market shares). Please note that SkyWest Airlines is somewhat different carrier than the other 4 FSCs. It is a regional airline which performs flights for the other major airlines via contracts. It operates flights for Alaska Airlines (as Alaska SkyWest), American Airlines (as American Eagle), Delta Air Lines (as Delta Connection) and United Airlines (United Express). Since SkyWest Airlines performs flights for the other 4 investigated FSCs and not for any of the investigated LCCs, SkyWest is included as an FSC in this research.

---

[2] Revenue passenger miles (RPM) is an indicator commonly used in the transportation industry. It shows the number of miles traveled by passengers and can be calculated by multiplying the number passengers by the distance these passengers traveled.

Table 1: Airline overview

Airline (FSC)	IATA-code	Airline (LCC)	IATA-code
Alaska Airlines	AS	Frontier Airlines	F9
American Airlines	AA	JetBlue Airways	B6
Delta Air lines	DL	Southwest Airlines	WN
SkyWest Airlines	OO	Spirit Airlines	NK
United Airlines	UA		

On the left-hand side are the investigated FSCs and corresponding IATA-code displayed and on the right-hand side the LCCs. The selection of these airlines is based on their market share on the United States domestic market in 2019.
Source: Statista, 2020

Extracting the previously discussed data results in a panel dataset on a city pair – operating carrier level (e.g. Route New York – Miama executed by Delta Airlines). Because of several reasons, however, the dataset still requires adjustments to be suitable for this research. Since the data is extracted from two datasets, these sets need to be merged. This results in city pair – operating carrier observations with missing data on one or more of the relevant variables. These observations are listwise deleted from the sample.

Next, an adjustment is required because of multiple (major) airline mergers that took place in the observed time period. First, Delta Airlines and Northwest Airlines started reporting jointly in January 2010 under the name Delta Airlines and therefore city pair – operating carrier observations of both airlines will be denoted as Delta Airlines (DL) in the data. Secondly, Flights of Continental Micronesia, Continental Airlines and United Airlines will be displayed as United Airlines (UA) Because of the joint reporting since January 2012. Southwest Airlines announced the merged with AirTran Airways in 2011 and started reporting together from January 2015 under Southwest Airlines' brand. Finally, Alaska Airlines and Virgin America started joint reporting as Alaska Airlines from April 2018 (BTS, 2020).

Additionally, we exclude some observations from the dataset. We are interested in the effect of LCCs' entry on FSCs' prices, passenger numbers and capacity and therefore the following observations are erased from the dataset. First, we remove all city pair observations where only one airline is operative during the observed period. This can be justified because in this case no effect of entry can be analyzed. Secondly, we identify the city pairs were only LCCs and no FSCs are active. For these city pairs we cannot analyze the effect on FSCs, and these observations are therefore removed. The routes where only FSCs are active and no LCCs enter are also deleted from the sample. We cannot analyze the effect of entry on FSC if no LCC start operating that specific route. Finally, we remove the city pair from the sample if the time of the first LCC observation on that city pair corresponds with the time of the first observation of that city pair in general.

4.2 Variables

In this section we discuss the variables used for this research. To test the hypotheses, multiple dependent, independent variables and control variables are used. information regarding these variables is supplied, like how to interpret them, how they are derived and if transformations are applied.

4.2.1 Dependent variables

The main goal of this research is to investigate the effect of LCC entry on the dependent variables. For this research, the dependent variables are the average ticket fares, the passengers transported end the seat capacity.

4.2.1.1 Average Ticket Fares

The *Average Ticket Fares* are the first dependent variable for this research. The variable is continuous and denoted as the average ticket price on a city pair – operating carrier level at time = T_i. The prices are the average of a one-way ticket in either direction. It covers the prices for First class, business class and economy class and does not take into account free tickets (e.g. free tickets received via a frequent flyer program). Because of the positive skew of the data, this variable is converted to the natural logarithm (*ln).*

4.2.1.2 Passengers

The second dependent variable is the *Passengers* expressed in the number of passengers transported. This are the passengers transported on a City pair – operating carrier level at time = T_i and is also considered a continuous variable. No distinction is made between the direction of travel. The number of passengers travelling from A to B are added to the passengers travelling from B to A. The total number of passengers is subsequently assigned to city pair A-B. e.g. take city pair New York – Washington. The number of passengers from New York to Washington is added to the number of passengers traveling from Washington to New York. The total number of passengers can be found under city pair New York – Washington. Because of the skewness to the right (positive) this variable is also converted to the natural logarithm (*ln*).

4.2.1.3 Seat Capacity

The third and final dependent variable is the *seat capacity*, which is expressed in the number of seats an airline has available on a specific route at time = T_i. The number of seats per city pair – operating carrier is derived similar to the described ‘passenger method’ above. Therefore, no further explanation is given. Finally, conversion to the natural logarithm (*ln*) took please because of the positive skewness.

4.2.2 Independent variables

For this research, we investigate the effect of the independent variables on the dependent variables. We are interested in the effect of LCC entry and the threat of entry on the dependent variables discussed above. Therefore, LCC entry and the threat of LCC entry are our independent variables.

4.2.2.1 LCC entry

To identify the effect of entry by an LCC on the average ticket fares, the total passengers and the capacity, an *LCC entry* variable is required. Unfortunately, no such variable is readily available in the subtracted data, however this variable can be constructed based on the data in the dataset. Therefore, a dummy variable is created with a value of 1 in the year and quarter an LCC starts flying a specific route. This dummy variable and derivations of this variable can be used to study the effect before, at and after the moment of entry by an LCC.

4.2.2.2 LCC threatens to enter

Just like the LCC entry, no variable for an LCC who threatens to enter a particular route is readily available. Thus, this variable needs to be created as well. As discussed in the Chapter 2, FSCs feel threatened if the probability of an LCC entering a specific route increases. To define the threat of entry by an LCC we use the definition of Goolsbee and Syverson (2008). Entering is more likely when an LCC is already operating flights from both endpoints of a certain route. Therefore, a dummy variable is generated with a value of 1 at the first moment (year and quarter) the LCC operates in both endpoints. This definition is based on the definition given by Goolsbee and Syverson (2008).

4.2.3 Control variables

Besides dependent and independent variables, we also need to consider control variables. Omitting these variables might bias the effect of the independent variables. The decision to include the following variables as control variable is based on previous literature.

4.2.3.1 Distance

The first control variable is *Distance*. This continuous variable is measured as the distance in miles between the two airports of a city pair and is provided by the datasets. This control variable is used since distance is expected to have a positive significant effect on the average ticket fares (S. Field, 2016).

4.2.3.2 HUB route

The next variable is called *Hub route*. Some of the routes in the dataset starts or ends at a Hub of one of the FSCs. Since hubs have a significant positive effect on the ticket prices (Borenstein, 1989) not including this factor could bias the effect of (the threat of) LCC entry. The information regarding hubs is not readily available in the data and therefore this variable needs to be constructed manually. Based on information provided by American Airlines, Alaska Airlines, Delta Air Lines and United Airlines we can construct an overview of all the hubs (refer to Table 2). Based on this overview, The *HUB route* dummy variable can be created which returns a value of 1 when the route starts or ends at one of the FSC's hubs and a 0 if the route does not start or end at a hub.

Table 2: Airlines (FSC) and their HUBs

Airline	HUB	IATA-code	HUB	IATA-code
American Airlines	Charlotte	CLT	Miama	MIA
	Washington	DCA/IAD	Chicago O'Hare	ORD
	Philadelphia	PHL	Dallas/ Forth Worth	DFW
	Newark	EWR	Phoenix Sky Harbor	PHX
	New York	JFK/LGA	Los Angeles	LAX
Alaska Airlines	Seattle-Tacoma	SEA	San Francisco	SFO
	Portland	EWR	Los Angeles	LAX
	Ted Stevens Anchorage	ANC		
Delta Air Lines	Seattle-Tacoma	SEA	Cincinnati	CVG
	Salt Lake City	SLC	Atlanta	ATL
	Los Angeles	LAX	Boston	BOS
	Minneapolis/St. Paul	MSP	New York	JFK/LGA
	Detroit	DTW		
United Airlines	San Francisco	SFO	Chicago O'Hare	ORD
	Los Angeles	LAX	Washington	IAD
	Denver	DEN	Newark	EWR
	Houston	IAH		

Source: Alaska Airlines, 2019; American Airlines, 2020; Delta Air lines, 2020; United Airlines, 2020

4.2.3.3 Herfindahl-Hirschman index

On general, the stronger the competition, the lower the ticket prices (Alderighi, Cento, Nijkamp, & Rietveld, 2012), which requires taking market concentration into account. *The Herfindahl-Hirschman index (HHI)*, better known as the Herfindahl index, is an index to measure the market concentration. The HHI is the sum of the squared market shares of all market participants, as shown in the equation below.

$$HHI = \sum_{i=1}^{n} (MS_i)^2 \tag{3}$$

$$MS_i = Market\ share\ of\ Airline\ i$$

$$= \frac{Passangers\ transported\ by\ airline_i\ on\ route_x}{total\ passangers\ transported\ on\ route_x} \tag{4}$$

The resulting outcome range between zero and 10,000 (Dresner et al., 1996; Rhoades, 1993) or zero and 1 (Alderighi et al., 2012) depending on the notation of the market share (percentual or decimal). In This research, a decimal notation is used. An outcome close to zero implies an almost perfect competition while and outcome of 1 represents a perfect monopoly with only one market participant. This implies that the *HHI* has a positive effect on the ticket prices. For this research the *average HHI* per route is used.

4.2.3.4 Year

As stated in chapter 2, the effect of entry and the threat of entry seems to weaken over time. A possible explanation of this lies in the change of price, capacity and passenger traffic over time. Therefore, the variable *year* (2008 till 2019) is used as a categorical variable to control for these variances over time.

4.2.3.5 Quarter

The quarters of the year are also important to take into account. In general, the revenues, and thus the ticket prices and the number of passengers transported, of United States airlines are the highest in the second quarter of the year, while the first quarter of the year generates the lowest revenues. This assumption is based on financial reports of multiple airlines like American Airlines and Delta Airlines. These reports reveal that this similar pattern is visible during the last several years, which endorse the importance of controlling for yearly quarters. Therefore, *quarter* as a categorical variable is included.

4.3 Method

To answer the research question, the hypotheses as constructed in the Theoretical Framework section will be tested. To test these hypotheses, we conduct event studies to analyze the effect of the threat of entry and the effect of actual entry on ticket fares, passengers transported and seat capacity. As shown in chapter 3, the hypotheses are divided in sub-hypothesis *a* and *b* (with exception of hypothesis 3, which has a *c* sub question): in sub-hypothesis *a* we look at the effect of actual entry of an LCC, while sub-hypothesis *b* focusses on the effect of the threat of entry. Considering those two events as independent events we observe 6 different periods: 1) the period before the threat of entry, 2) the moment the LCC starts operating from both endpoints and so starts to threat to enter the route t_0, 3) the period after the LCC start threatening to enter the route, 4) the period before the LCC actually starts flying the route, 5) the moment the LCC start flying the route t_e and 6) the period after the LCC started flying the route. However, on most of the routes where the LCC threats to enter, it will eventually enter that route, resulting in an overlap of period 3 and 4. To solve this problem, we combine period 3 and 4, resulting in 5 different periods as shown in the Figure 4.

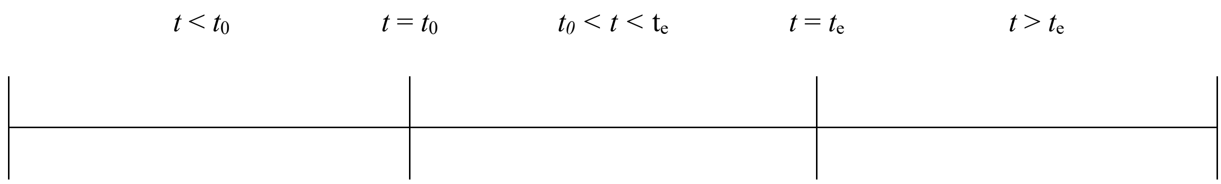


Figure 4: Schematic overview of the different periods

Because of the relation between the threat of entry and actual entry, we construct models including both events, resulting in the following baseline model based on Goolsbee and Syverson (2008):

$$y_{ri,t} = \alpha_{ri} + \gamma_{it} + \sum_{t=-8}^{t_e-1} \beta_t \,(LCC\ threatens\ to\ enter)_{r,t_0+t} + \sum_{t=t_e}^{8} \beta_t \,(LCC\ flying\ the\ route)_{r,t_e+t}\ \mathrm{X}_{ri,t} + \varepsilon_{ri,t} \quad (5)$$

With observations from periods t: $t_{0-12} \leq t \leq t_{e+8}$

In this equation $y_{ri,t}$ is the variable of interest (e.g., *ln(average ticket fares, ln(passengers)* or *ln(seats))* for the operating carrier *i* flying route *r* in quarter *t*. *LCC threatens to enter*$_{r,t0+t}$ are time dummies surrounding the period when the LCC is present in both endpoints of a certain route, without flying that route (yet). *LCC flying the route* $_{r,te+t}$ are time dummies which takes a value of 1 when the LCC actually starts flying the route. The time dummies are mutually exclusive meaning the effect given by the different time dummy coefficients are not additive. α_{ri} is the operating carrier–route fixed effect, while γ_{it} is the operating carrier–time fixed effect. $\mathrm{X}_{ri,t}$ are control variables (if included) and $\varepsilon_{ri,t}$ is the error term. Standard errors are clustered by operating carrier–route since the observation within the clusters are related to each other.

For clarity of the model, we included a single dummy for multiple time periods: we included a single dummy for the period between two and three years prior to t_0 (t_{0-12} to t_{0-9}) and use this period as the baseline period. Because of the operating carrier–route fixed effects all the reported coefficients indicate the relative size of the variable of interested compared to its average value in the baseline period. For the period between one and two years prior to t_0 (t_{0-8} to t_{0-5}) and between one year prior to t_0 and t_0 (t_{0-4} to t_{0-1}) we also include a single dummy. Another dummy is used for the moment the LCC establishes presence in both endpoints of the threatened route. We also include a single dummy for the period between the presence establishment in both endpoints and the actual entry (t_{0+1} to t_{e-1}). Subsequently, we use a dummy for the moment the LCC actually starts flying the route t_e. Finally, we use single dummies for the quarter after entry to one year after entry (t_{e+1} to t_{e+4}) and the period between one and two years after entry (t_{e+5} to t_{e+8}). Please refer to Table 3 for an overview. All observations outside these periods are not taken into account.

Additionally, we exclude the routes where the moment of establishing presence in both endpoints is equal to the moment when the LCC actually starts flying the route (t_0 = t_e), since for that routes no threat of entry was presence. Furthermore, we only focus on the effect on FSCs and exclude the LCC in the analyses. Finally, we restrict our analyses to the routes where only one LCC enters, since the model is not suited for multiple entries. Including routes with multiple entries on a route will give a biased result caused by the limitations of the model.

Table 3: Overview of periods used for event study

Period	Description	Notation used
Baseline	Period between two and three years prior to t_0	t_{0-12} to t_{0-9}
1	Period between one and two years prior to t_0	t_{0-8} to t_{0-5}
2	Period between one year prior to t_0 and t_0	t_{0-4} to t_{0-1}
3	Moment of establishing presence in both endpoints t_0	t_0
4	Period between the presence establishment in both endpoints t_0 and the actual entry t_e	t_{0+1} to t_{e-1}
5	Moment of actual Entry t_e	t_e
6	Period between quarter after entry to one year after entry t_e	t_{e+1} to t_{e+4}
7	Period between one and two years after entry t_e	t_{e+5} to t_{e+8}

For hypothesis 3c we use a slightly different model in the following form:

$$y_{ri,t} = \alpha_{ri} + \gamma_{it} + \beta_1 \ln(average\ ticket\ fares)_{ri,t} + \mathrm{X}_{ri,t} + \varepsilon_{ri,t} \quad (6)$$

Where $y_{ri,t}$ is the variable of interested (*ln(passengers transported)*) for the operating carrier *I* flying route *r* in quarter *t*. $\ln(average\ ticket\ fares)_{ri,t}$ is the natural logarithm of the average ticket fares for operating carrier *I* flying route *r* in quarter *t.* again α_{ri} and γ_{it} are used as respectively the operating carrier–route fixed effect and the operating carrier–time fixed effect. $\mathrm{X}_{ri,t}$ are control variables and $\varepsilon_{ri,t}$ is the error term. Standard errors are clustered by operating carrier–route.

Before we perform the analyses, we assess if the data is suitable. This is done by checking for normality, multicollinearity, independency. These results will be discussed in Chapter 5 after which we continue with the regression models. Because of the use of both operating carrier–time and operating carrier–route fixed effects, the standard xtreg,fe and areg command are not suitable. We therefore perform the analyses by using the Reghdfe – command in STATA/MP 15.1. This command is a generalization of the xtreg and areg command and performs a linear regression, absorbing multiple levels of fixed effects, by implementing the estimator of Correia (2016). This command automatically drops singleton observations which are common in regressions with multiple levels of fixed effects. Not dropping these observations understates the standard error and the statistical significance will be overstated. This model with both the operating carrier–time and operating carrier–route fixed effects and control variables is constructed for every dependent variable with cleaned and validated data. The results will be presented and discussed in Chapter 5.

5. RESULTS

In this chapter we focus on the statistical outcomes of the analyses as described in the methodology section. It starts with investigating if the probability of entry is in fact greater if an LCC threatens to enter the route by establishing presence in both endpoints, as claimed by (Goolsbee & Syverson, 2008). Thereafter, we checked the data for normality. This check is performed by means of histograms, spike plots, boxplots and Quantile-Quantile plots. Several variables showed a non-normal distribution, caused mainly by skewness. In this dataset the variables that are skewed, all show a positive skewness. Therefore, these variables are converted to their natural logarithm (*ln*). next, Extreme outliers are identified by using the earlier described plots and by analyzing their z-score (A. Field, 2013). Values with a *z*-score bigger than 3.29 or lower than -3.29 are listwise removed from the dataset, resulting in a sample with 699 different routes and 15,446 operating carrier–route observations. The descriptive statistics of these observations will be displayed and discussed. Next, we analyze the independency and the multicollinearity to check if there are any limitations for our model. Finally, we present and discuss the results of the analyses.

5.1 Probability of entering the route

According Goolsbee and Syverson (2008) airport presence is a well-known predictor to predict if airlines start flying a new route. Instead of accepting this as the truth, we conduct such research ourselves. For the dataset is investigated of the probability of entry is higher if the LCC started operating in both endpoints in the previous quarter, compared to if it only started operating in one endpoint. The probabilities of entering a route depending on the presence in one or both of the endpoints are shown in Table 4 and discussed below.

Table 4: Probability of new route entry

LCC started operation in one endpoint in the previous quarter	1.57%
LCC started operation in one endpoint in the previous two quarters	2.72%
LCC started operating in both endpoints in the previous quarter	4.46%
LCC started operating in both endpoints in the previous two quarters	8.87%
N	699

In the observed period, the LCCs started flying 699 unique new routes. When looking at the probability of entering a new route, we observe that in 1.57% (11 of the total 699 entries) of the new routes, the LCC was only present in one of the endpoints in the quarter before it started the new route. When the LCC established presence in both endpoints the quarter before entry, this number increases by a factor 2.3 and results in 25 new entries in the following quarter. This corresponds with 3.58% of the total new routes.

In similar Fashion, we observe the probabilities when concentrating on the previous two quarters before entry. In 19 of the 699 new routes, the LCC started operating in either one of the endpoints in the two quarters before it actually entered, which is equal to 2.72%. When the LCC started operating in both endpoints in the previous two quarters, we observe 62 entries fulfilling the conditions, equal to 8.87% of the total entries. Again, comparing these numbers implies 3.25 times more entries if the LCC was present in both endpoints.

5.2 Descriptive statistics

After the check on normality and outliers, our dataset is prepared for the analysis. But, before we start discussing the performed analyses, the descriptive statistics of the variables used in this research are presented. Because of positive skewness Average ticket fares, Passengers, Seats and distance are natural log transformed. These statistics can be found in Table 5.

Table 5: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Average ticket fares$^{\alpha}$	15,446	5.1073	0.4655	3.0906	6.7776
Passengers$^{\alpha}$	15,446	8.2384	2.8343	0	13.0420
Seats Capacity$^{\alpha}$	15,446	8.5110	2.7687	3.4012	13.1846
Distance$^{\alpha}$	15,446	6.7839	0.6771	4.7875	7.9073
Average HHI	15,446	0.8355	0.1515	0.2676	1
HUB route	15,446	0.9029	0.2961	0	1
t_{0-9} to t_{0-12}	15,446	0.0164	0.1269	0	1
t_{0-5} to t_{0-8}	15,446	0.0276	0.1640	0	1
t_{0-1} to t_{0-4}	15,446	0.0800	0.2713	0	1
t_0	15,446	0.0341	0.1814	0	1
t_{0+1} to t_{e-1}	15,446	0.5448	0.4980	0	1
t_e	15,446	0.0388	0.1931	0	1
t_{e+1} to t_{e+4}	15,446	0.1318	0.3383	0	1
t_{e+5} to t_{e+8}	15,446	0.1265	0.3324	0	1

$^{\alpha}$ natural log transformed

First, we observe the dependent variables *average ticket fares*, *passengers* and *seat capacity*. Because of the positive skewness, these variables are all transformed to the natural logarithm (ln transformed). This results in a transformed mean of 5.1073 and a standard deviation of 0.4655 for the *average ticket fares*. Analyzing the *passenger* variable, we observe a natural log transformed mean of 8.2384 with a standard deviation of 2.8343. The *seat capacity* variable expressed in total seats has a natural log transformed mean of 8.5110 and a standard deviation of 2.7687.

The means if the time variables, which are our independent variables, need to be interpreted differently. The mean of the t_{0-9} to t_{0-12} variable is 0.0164. This implies that 1.64% of all the observations contains data of the period between 2 and 3 years before the LCC established presence in both endpoints. In similar fashion the other time variables can be interpreted.

Similar to the dependent variables the control variable distance is natural log transformed because of skewness. The mean of this natural log transformed variable is 6.7839 and the standard deviation is 0.6771. The *average HHI* ranges from 0 to 1 and has a mean of 0.8368 with a standard deviation of 0.1515. The *HUB route* variable is also a dummy variable with a value of 1 if one of the endpoints of the route is a hub of a major airline, while a 0 implies that none of the endpoints is a hub of one of the FSCs. The mean value of this variable is 0.9020 implying that 90.20% of the observations contains a route between at least one major airline hub as endpoint. The standard deviation of this variable is 0.2131.

5.3 Correlations and multicollinearity

To test the relation between the different variables, we are interested in the correlation. These correlations are retrieved by conducting the Pearson's correlation test and displayed in Table 6. By definition, the correlation ranges between minus one and plus one.

When using multiple variables simultaneously in the same model we should consider multicollinearity. Multicollinearity refers to the linear relation among two or more variables (Alin, 2010). According Field (2013) the problem of multicollinearity arises when the absolute value of the correlation between the variables is higher than 0.7 ($\rho_{x,y} > 0.7$ or $\rho_{x,y} < -0.7$). In this case the two variables should not be used in the same model. Looking at Table 6, we find this the case for the variables passengers and seats. Using these variables in the same model should be avoided to account for possible multicollinearity.

Table 6: Pearson's correlation test

		1	2	3	4	5	6
1	Average ticket fares	1					
2	Passengers	-0.4925*	1				
3	Seat capacity	-0.4993*	0.9945*	1			
4	Distance	0.1469*	0.0455*	0.0265*	1		
5	Average HHI	-0.1103*	0.2642*	0.2665*	0.0592	1	
6	HUB route	0.1487*	-0.1267*	-0.1286*	-0.0036*	-0.1388*	1

* $p < 0.01$

5.4 Analysis Results

The analyses will test if the hypotheses 1, 2, and 3 need to be rejected or not. In the following section, the results of the analyses are displayed and explained. For every analysis we mention the coefficients and its standard errors of the different variables in the tables. We consider outcomes with $p < 0.10$ as statistically significant and provide the coefficients with one or more asterisks depending on the significance level (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$). the exact *p*-values are not displayed in the tables, but they are included in the textual explanation of the regression results. Furthermore, we include the number of observations (N) and the adjusted R^2. The adjusted R^2 is an indication of the explanatory power of the regression model. This number ranges between 0 and 1, where an R^2 of 0 implies that the variance of the dependent variable is not explained at all by the independent variable(s), while an R^2 of 1 states that the independent variables explain the variance of the dependent variable for 100%. Finally, the F-statistic (including the asterisks) is given to analyze the joint significance of the independent variables and thus the overall significance of the complete model. A significant F-statistic implies that at least one of the independent variables is not equal to zero and affects the dependent variable (Moore, McCabe, Alwan, & Craig, 2016).

5.4.1 LCC's entry and Ticket Fares

Hypothesis 1 (a and b) are both tested by means of model 1 presented in Table 7. This model represents an event study and shows both the effect of the threat of entry and the effect of actual entry on the average ticket price. As stated in the Chapter 4.3, the reported coefficients indicate the relative size of the dependent variable compared to its average value in the baseline period (t_{0-12} to t_{0-9}). The overall output of Model 1 is significant ($F_{7, 1274} = 4.24$, $p = 0.000$) and the model explains the variation in the natural log of the average prices for 71.19% ((adjusted) $R^2 = 0.7119$).

For hypothesis 1a we are interested on the effect of actual LCC entry on the ticket prices and therefore look at the coefficients of the variables *LCC flying route:* t_e, *LCC flying route:* t_{e+1} *to* t_{e+4} and *LCC Flying route:* t_{e+5} *to* t_{e+8}. In the quarter of LCC entry, we observe a drop in the FSC average ticket fares of 9.9% (*exp*(-0.1038) = 0.901) compared to the baseline average, significant at a 1% level ($p = 0.007$). in the four quarters after the entry of an LCC, the price went down 13.4% (*exp*(-0.1442) = 0.866), while in the period between one and two years after the entry, the average price was 13.2% (*exp*(-0.1416) = 0.868) lower. Again, both coefficients are significant at a 1% significance level (respectively $p = 0.000$ and $p = 0.001$).

For hypothesis 1b we are specifically interested in the period shortly before the LCC establishes presence in both endpoints, the moment it actually does establish this present and the period after. This is shown in model 1 by the variables *LCC in both airports (no flight):* t_{0-1} *to* t_{0-4}, *LCC in both airports (no flight):* t_0 and *LCC in both airports (no flight):* t_{0+1} *to* t_{e-1}. In the year before the LCC established presence in both endpoints, we see a not significant ($p = 0.100$) drop of 4.7% in average ticket prices. The results show us that at the moment the LCC is present in both endpoints, prices fall 8.4% below the baseline and continue falling to over 9.9% in the period after the establishment. In contrary to the period before presence, these both coefficients are significant at a 1% significance level (respectively $p = 0.007$ and $p = 0.004$).

as model 1 suggests, we conclude that FSC lower their ticket fares when an LCC enters the route and that these prices stay low in the following two years. FSCs also preemptively decrease the prices when an LCC threatens to enter the route. These findings support both hypothesis 1a and 1b.

Table 7: Incumbent FSCs responses on actual entry and the threat of entry

	Dependent Variables		
	Ln(Price)	**Ln(Seats)**	**Ln(Passenger)**
	Model 1	**Model 2**	**Model 3**
LCC in both airports (no flight):	-0.0660**	0.0340	0.0236
t_{0-5} to t_{0-8}	*(0.0295)*	*(0.1144)*	*(0.1186)*
LCC in both airports (no flight):	-0.0485	0.0006	0.0418
t_{0-1} to t_{0-4}	*(0.0294)*	*(0.1201)*	*(0.1265)*
LCC in both airports (no flight):	-0.0881***	0.0488	0.1005
t_0	*(0.0329)*	*(0.1339)*	*(0.1416)*
LCC in both airports (no flight):	-0.1041***	0.1263	0.1742
t_{0+1} to t_{e-1}	*(0.0361)*	*(0.1607)*	*(0.1709)*
LCC flying route:	-0.1038***	0.1274	0.1847
t_e	*(0.0383)*	*(0.1732)*	*(0.1822)*
LCC flying route:	-0.1442***	0.2231	0.2871
t_{e+1} to t_{e+4}	*(0.0389)*	*(0.1773)*	*(0.1868)*
LCC Flying route:	-0.1416***	0.2428	0.3200
t_{e+5} to t_{e+8}	*(0.0412)*	*(0.1932)*	*(0.2016)*
Observations (N)	15,446	15,446	15,446
(adjusted) R^2	0.7119	0.8588	0.8552
F-Statistic	4.24***	1.09	1.17

Notes: Standard errors are in parentheses and clustered by operating carrier–route. The models include all routes where one LCC entered the route between 2008-Q1 and 2019-Q4. Routes where no threat is present (routes where the establishment of LCC presence at both airports corresponds with the actual entry on that route) are excluded. Operating carrier-route and operating carrier-time fixed effects are included. Please refer for the explanations of the dummy variables to Table 7 Chapter 4.3.
* < 0.10, ** $p < 0.05$, *** $p < 0.01$.

5.4.2 LCC's entry and capacity

For testing hypothesis 2a and 2b we use Model 2 displayed in Table 7. given the low F-statistic ($F_{7,\,1274} = 1.09$) this model is not significant overall ($p = 0.3675$). on the other hand, is the explanatory power of the model rather high: 85.88% ((adjusted) $R^2 = 0.8588$).

The coefficients of interest to test the effect of entry on the capacity are *LCC flying route:* t_e*, LCC flying route:* t_{e+1} *to* t_{e+4} and *LCC Flying route:* t_{e+5} *to* t_{e+8}. In the quarter of entry, the coefficient suggests a 13.6% (*exp*(0.1274) = 1.136) increase in capacity, however not significant ($p = 0.462$). This means we cannot conclude the coefficient is unequal to zero. Similar interpretation can be given to the other two coefficients of interested. The period one year after entry and the period between one and two years after the entry show coefficients of respectively 0.2231 (25% increase) and 0.2428 (27.5%). Comparable to the moment of entry, these coefficients are not significant (respectively $p = 0.208$) and $p = 0.209$).

To test hypothesis 2b the focus lies again on the period shortly before the LCC establishes presence in both endpoints (*LCC in both airports (no flight):* t_{0-1} *to* t_{0-4}), the moment it actually does establish this presence (*LCC in both airports (no flight):* t_0*)* and the period after (*LCC in both airports (no flight):* t_{0+1} *to* t_{e-1}). In the period before entry, we observe an negligible increase of 0.1% (*exp*(0.0006) = 1.001) in capacity compared to the baseline average capacity. As expected, this coefficient is not significant (p = 0.996). for hypothesis 2b to accept, we require positive significant coefficients for the period of establishing presence in both endpoints and the period afterwards. For these periods we observe an increase of 5% (*exp*(0.0488) = 1.050) and 13.5% (*exp*(0.1263) = 1.135). The requirement of significance cannot be met: both coefficients are not significant (respectively p = 0.716 and p = 0.432).

As expected by the literature, the coefficients related to the actual entry and the threat of entry all show a positive relation with the capacity. But, due to the lack of significance we cannot conclude that these coefficients differ from zero and really have a positive effect on the capacity. This automatically implies we have to reject both hypothesis 2a and 2b.

5.4.3 LCC's entry and transported passengers

Model 3 (refer to Table 7) is used for testing hypotheses 3a and 3b. for the interpretation of the coefficients and the effect, a similar approach as discussed above is used. Although the overall model is not significant ($F_{7, 1274}$ = 1.17, p = 0.3164), it has a high explanatory power of 85.52% ((adjusted) R^2 = 0.8552).

For hypothesis 3a we again focus on the coefficients of the variables *LCC flying route:* t_e*, LCC flying route:* t_{e+1} *to* t_{e+4} and *LCC Flying route:* t_{e+5} *to* t_{e+8}. In the quarter of LCC entry, the coefficient implies a rise in the number of passengers transported of 20.3% (*exp*(0.1847) = 1.203). But, since this coefficient is not significant (p = 0.311), there is not enough evidence in this sample to conclude that this coefficient is unequal to zero. In similar fashion do the two periods after the entry show a positive coefficient. In the first year after entry, the coefficient would suggest 33.3% (*exp*(0.2871) = 1.333) rise, while the second year after entry the number of passengers transported would be 37.7% (*exp*(0.3200) = 1.377) higher compared to the baseline. Just like the coefficient of the quarter of entry, these coefficients are neither significant (respectively p = 0.125 and p = 0.113).

For hypothesis 3b we are again interested in the period around the establishment of presence. This period is shown in model 3 by the variables *LCC in both airports (no flight):* t_{0-1} *to* t_{0-4}*, LCC in both airports (no flight):* t_0 and *LCC in both airports (no flight):* t_{0+1} *to* t_{e-1}. In the year before the LCC established presence in both endpoints, the coefficient suggests an increase of 4.3% in passenger traffic compared to the baseline average. However, this increase is not considered significant (p = 0.741). the variable *LCC in both airports (no flight):* t_0 has a coefficient of 0.1005, which is equal to an increase of 10.6%. the coefficient of the *LCC in both airports (no flight):* t_{0+1} *to* t_{e-1} variable equals an increase of 19.0% ($exp(0.1742) = 1.190$) in passenger traffic. Again, these two variables are not considered significant (respectively $p = 0.308$ and $p = 0.311$).

All of the discussed coefficients had a positive value, which is in line with the literature. But, since none of the coefficients in model 3 are significant, there is not enough evidence to conclude that entry or the threat of entry has a direct significant effect on the number of passengers transported. These findings do not support hypothesis 3a and 3b and therefore we reject these hypotheses.

For the hypothesis 3c, we need a different model as discussed in the previous chapter. We expected the number of passengers affected by the change in ticket fares and not directly by the entry or threat of entry of an LCC. The results of the model are presented in Table 8. the overall output of the model is significant ($F_{7, 1274} = 137.03$, $p = 0.000$) and the explanatory power is 86.53% ((adjusted) $R^2 = 0.8653$). We observe a negative coefficient of the average ticket variable. If the natural logarithm of this variable increases by one, the natural logarithm of the number of passengers will decrease by 1.1496. This coefficient is significant at a 1% significance level ($p = 0.000$).

The outcome supports hypothesis 3c and is therefore in line with previous literature. The decrease in average ticket prices caused by the entry and the threat of entry of LCCs, causes an increase of the passengers transported by the FSCs.

Table 8: Regression of the FSCs number of passengers on the average ticket fares

	Ln(Passangers) **Model 4**
Ln(average ticket fares)	-1.1496***
	(0.0982)
Constant	14.1095***
	(0.5015)
Observations (N)	15,446
(adjusted) R^2	0.8653
F-Statistic	137.03***

Notes: Standard errors are in parentheses and clustered by operating carrier–route. The models include all routes where one LCC entered the route between 2008-Q1 and 2019-Q4. Operating carrier-route and operating carrier-time fixed effects are included.
* < 0.10, ** $p < 0.05$, *** $p < 0.01$.

6. CONCLUSION AND DISCUSSION

At the moment the aviation industry is in a recession never witnessed before. Airlines struggle to survive and some already went bankrupt. No one dares to say for sure how long this crisis will last, but eventually a period of recovery will start. Based on previous studies, recovery periods are accompanied by an increase in new routes entered by LCCs and therefore we expect a similar scenario after the COVID-19 crisis. This prospect leads to an increased interest in the impact of entry by an LCC on the incumbent airlines in terms of ticket prices, passengers transported and capacity available. This resulted in the following research question:

How do incumbent full-service carriers respond to entry and the threat of entry of new routes by low-cost carriers?

Even though the impact of entry by low-cost carriers has received a lot of attention in the existing aviation literature, investigating this again is still of added value. Various papers investigated the effect of entry on the ticket prices and the passengers transported, but the effect on the capacity and the impact of the threat of entry is mainly overlooked. By not only investigating the impact of entry, but also the effect of the threat entry on ticket prices, capacity and passenger traffic, this thesis contributes to the existing literature. Besides including capacity and the threat of entry, the data used for the research is more recent. Therefore, the findings of this thesis are more relevant to serve as an indication for the current aviation industry, compared to previous literature.

First, we investigated the impact on the average ticket fares. We found that both the threat of entry and the actual entry had a significant negative effect on the average ticket prices. The threat caused the average prices to be lower up to 9.9%, while actual entry lowered the fares up to 13.4%. We observe a weaker effect compared to previous literature. Whinston and Collins (1992) found a 35% decrease, Vowles (2000) a 26.7% decrease and Goolsbee and Syverson (2008) a 21% decrease after entry. The effect of entry seems to weaken over time. The impact of the threat of entry can only be compared with Goolsbee and Syverson (2008). Again, the results show a weakening over time: 9.9% compared to 17%.

Between entry or the threat of entry and the number of passengers transported a positive relation is observed in our results, albeit not significant. These findings are in line with Goolsbee and Syverson (2008), but do not match the findings of Whinston and Collins (1992) and Windle and Dresner (1995). Goolsbee and Syverson (2008) found a positive, but not significant, effect of both entry and the threat of entry, while Whinston and Collins (1992) and Windle and Dresner (1995) found a significant increase of the passenger traffic after the entry of an LCC. Goolsbee and Syverson (2008) argued that the increase in passengers resulted from the decrease in average prices and not directly by the entry of an LCC. This was confirmed by our analysis of the relation between ticket prices and passenger traffic.

Regarding capacity (expressed in seats available), we expected an increase caused by the entry and threat of entry, but our analysis did not provide any convincing support for this. Although our analysis showed a positive effect of entry on the capacity, the coefficients were not significant. This in contrast to the statement that incumbents expand their capacity to deter entry and force new entrant to exit (Barbot, 2008) and the evidence found that incumbents increase their capacity – albeit not aggressively – after entry of a new carrier (Ito & Lee, 2011).

Based on these findings, we are able to answer the research question. We observed that FSCs respond on entry and the threat of entry by lowering their average ticket fares. No significant evidence was found that the FSCs increased their capacity and thus we cannot conclude that FSCs respond to entry or the threat of entry by means of capacity expansion.

This research goes hand in hand with certain limitations that limit the contribution of this thesis. One must be aware of these limitations when interpreting the implications. Some of these limitations can be resolved with further research. First, this research only focused on data of the United States domestic aviation industry, which is a different market compared to (for example) the European market or the Asian market. Even though the markets have approximately the same size, the European and Asian market are considered more complex, since these markets stretch over multiple countries. This implies different and often more regulations and more different market participants. Given these differences, one must keep in mind that the implications of the research do not automatically apply on markets other than the US domestic market. For further research, similar investigations for these different markets can provide a complete view on how incumbent airlines respond to entry and the threat of entry.

Next, only the 9 largest airlines (measured by market share in revenue passenger miles (RPM)) were included in this research. With their combined market share of 83.8% these companies are good for a significant part of the market, but still 16.2% of the market share is not accounted for. Among those 16.2% market share could be LCCs entering new routes as well, which are now per definition left out of the analysis. Changes in prices, capacity and passengers transported for which no reason was found, could be caused by the entry of an excluded LCC. Including all the market participants in next researches is a possible solution to resolve this limitation.

Additionally, by only investigating the 9 biggest companies based on market share, one of the airlines leaving the aviation industry can be ruled out. But LCCs can decide to exit certain routes. The model did not take this exit into account and the estimated effect of entry may therefore be biased. The model uses the first 8 quarters after entry to estimate the effect of entry, but if, for example, the LCC decides to exit the route 4 quarters after entry, the incumbent LCC might decide to increase the ticket prices again after the LCC exit. Since the model does not take into account exit, it will use these higher prices to estimate the effect for the fifth to eight quarters after entry. Considering our results already show a significant decrease in the ticket prices in the period after the entry, implementing route exit by an LCC is expected to enhance this decrease. Similar logic can be applied to determine the effect on passengers transported and the capacity, resulting in a lower capacity and less passengers transported, compared to our results.

Finally, we excluded all routes on which more than one LCC entered in the period between 2008 and 2019. This to avoid the potential biased results since our model was not suited to deal with multiple entries on one route. Resulting in various observations to be lost. But, because of the increasing market share of LCC, the number of routes where more than one LCC enters will increase and thus the effect on these routes will become increasingly relevant. Excluding routes with more than one LCC entry seems therefore contradictory. For further research, our model could be adjusted to be able to deal with multiple route entries. This resolves the problem of excluding the routes with multiple entries.

REFERENCES

Akpur, A., & Zengin, B. (2019). The Concept of Low-Cost Airline Transportation: Definition and Meaning. *Journal of Tourismology*, 73–91. https://doi.org/10.26650/jot.2019.5.1.0014

Alaska Airlines. (2019, March). Cities served. Retrieved September 23, 2020, from https://newsroom.alaskaair.com/cities-served

Alderighi, M., Cento, A., Nijkamp, P., & Rietveld, P. (2012). Competition in the European aviation market: the entry of low-cost airlines. *Journal of Transport Geography*, *24*, 223–233. https://doi.org/10.1016/j.jtrangeo.2012.02.008

Alin, A. (2010). Multicollinearity. *WIREs Computational Statistics*, *2*(3). Retrieved from https://doi-org.eur.idm.oclc.org/10.1002/wics.84

American Airlines. (2020). American Airlines Map. Retrieved August 23, 2020, from http://aa.fltmaps.com/en

Asahi, R., & Murakami, H. (2017). Effects of Southwest Airlines' entry and airport dominance. *Journal of Air Transport Management*, *64*, 86–90. https://doi.org/10.1016/j.jairtraman.2017.06.029

Barbot, C. (2008). Can low cost carriers deter or accommodate entry? *Transportation Research Part E: Logistics and Transportation Review*, *44*(5), 883–893. https://doi.org/10.1016/j.tre.2007.07.010

Borenstein, S. (1989). Hubs and High Fares: Dominance and Market Power in the U.S. Airline Industry. *The RAND Journal of Economics*, *20*(3), 344. https://doi.org/10.2307/2555575

BTS. (2020). Air Carrier Statistics. Retrieved July 17, 2020, from https://www.transtats.bts.gov/Tables.asp?DB_ID=110&DB_Name=Air Carrier Statistics %28Form 41 Traffic%29- U.S. Carriers&DB_Short_Name=Air Carriers

CAPA. (2008). LCC traffic and profits to boom in 2009 as legacy airlines suffer. Retrieved July 22, 2020, from https://centreforaviation.com/analysis/reports/lcc-traffic-and-profits-to-boom-in-2009-as-legacy-airlines-suffer-4781

CAPA. (2019a). LCCs: global market share gains led by emerging markets. Retrieved August 12, 2020, from https://centreforaviation.com/analysis/reports/lccs-global-market-share-gains-led-by-emerging-markets-459927

CAPA. (2019b, February 19). LCCs increasingly attracted to primary airports. Retrieved October 7, 2020, from https://centreforaviation.com/analysis/reports/lccs-increasingly-attracted-to-primary-airports-459531

CBC News. (2020). Air Canada to lay off 20,000 workers as pandemic collapses travel industry. Retrieved August 27, 2020, from https://www.cbc.ca/news/business/air-canada-layoffs-1.5572596

CH-Aviation. (2020). Avianca Holdings files for Chapter 11. Retrieved August 27, 2020, from https://www.ch-aviation.com/portal/news/90169-avianca-holdings-files-for-chapter-11

Correia, S. (2016). *A Feasible Estimator for Linear Models with Multi-Way Fixed Effects*. Retrieved from http://scorreia.com/research/hdfe.pdf

Crouch, T. (2014, January 2). First Flight? Retrieved September 8, 2020, from https://airandspace.si.edu/stories/editorial/first-flight

Daraban, B., & Fournier, G. M. (2008). Incumbent responses to low-cost airline entry and exit: A spatial autoregressive panel data analysis. *Research in Transportation Economics*, *24*(1), 15–24. https://doi.org/10.1016/j.retrec.2009.01.004

Delta Air lines. (2020). Delta & Partner Airport Locations. Retrieved August 23, 2020, from https://www.delta.com/us/en/airports/overview?mapPOI=us

Dixit, A. (1980). The Role of Investment in Entry-Deterrence. *The Economic Journal*, *90*(357), 95. https://doi.org/10.2307/2231658

DLR. (2008). *Analyses of the European Air Transport Market: Airline Business Models*.

Dresner, M., Lin, J.-S. C., & Windle, R. (1996). The Impact of Low-Cost Carriers on Airport and Route Competition. *Journal of Transport Economics and Policy*, *30*(3), 309–328. Retrieved from https://www-jstor-org.eur.idm.oclc.org/stable/20053709?seq=1#metadata_info_tab_contents

ECDC. (2020, July 7). COVID-19 situation update worldwide, as of 7 July 2020. Retrieved July 7, 2020, from https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

Field, A. (2013). Discovering Statistics using IBM SPSS Statistics. In *Discovering Statistics using IBM SPSS Statistics* (4th ed.). https://doi.org/10.1016/B978-012691360-6/50012-4

Field, S. (2016). Southwest Airlines and the Impact of Low-Cost Carriers On Airline Ticket Prices. *Fusio*, *1*(1), 24. Retrieved from https://www.eia.gov/dnav/pet/hist/LeafHandler

Firestone, K. (2020, February 29). Op-Ed: I’ve seen bubbles burst - this isn’t a bubble. Retrieved July 9, 2020, from CNBC website: https://www.cnbc.com/2020/02/28/op-ed-ive-seen-bubbles-burst---this-isnt-a-bubble.html

Franke, M., & John, F. (2011). What comes next after recession? - Airline industry scenarios and potential end games. *Journal of Air Transport Management*, *17*(1), 19–26. https://doi.org/10.1016/j.jairtraman.2010.10.005

Freeman, J. W. (1978). State Regulation of Airlines and the Airline Deregulation Act of 1978. *Journal of Air Law and Commerce*, *44*, 747–772. Retrieved from https://heinonline.org/HOL/Page?handle=hein.journals/jalc44&id=771&div=40&collection=journals

Goolsbee, A., & Syverson, C. (2008). How do Incumbents Respond to the Threat of Entry? Evidence from the Major Airlines. *Quarterly Journal of Economics*, *123*(4), 1611–1633. https://doi.org/10.1162/qjec.2008.123.4.1611

Hermanides, E. (2020, April 9). De luchtvaart zal opkrabbelen, maar doorgaan op de oude voet ligt niet voor de hand. Retrieved July 8, 2020, from Trouw website:

https://www.trouw.nl/economie/de-luchtvaart-zal-opkrabbelen-maar-doorgaan-op-de-oude-voet-ligt-niet-voor-de-hand~b6c1c7a6/

Hüschelrath, K., & Müller, K. (2012). Low Cost Carriers and the Evolution of the Domestic U.S. Airline Industry. *Competition and Regulation in Network Industries*, *13*. Retrieved from https://heinonline.org/HOL/Page?handle=hein.journals/netwin13&id=128&div=10&collection=journals

IATA. (2020). World Air Transport Statistics 2019. Retrieved September 16, 2020, from https://www.iata.org/contentassets/a686ff624550453e8bf0c9b3f7f0ab26/wats-2019-mediakit.pdf

ICAO. (2016). *Manual on the Regulation of International Air Transport (Doc 9626)*.

Ito, H., & Lee, D. (2011). Incumbent Responses to Lower Cost Entry: Evidence from the U.S. Airline Industry. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.724161

Katz, M. A. (1988). The American Experience under the Airline Deregulation Act of 1978-an Airline Perspective. *Hofstra Labor Law Journal*, *6*, 87–100. Retrieved from https://heinonline.org/HOL/Page?handle=hein.journals/hlelj6&id=93&div=&collection=

Kim, H., & Gu, Z. (2004). Impact of the 9/11 terrorist attacks on the return and risk of airline stocks. *Tourism and Hospitality Research*, *5*(2), 150–163.

Lei, Z., & Papatheodorou, A. (2010). Measuring the effect of low-cost carriers on regional airports' commercial revenue. *Research in Transportation Economics*, *26*(1), 37–43. https://doi.org/10.1016/j.retrec.2009.10.006

Mallapaty, S. (2020, May 18). Animal source of the coronavirus continues to elude scientists. https://doi.org/10.1038/d41586-020-01449-8

Moore, D. S., McCabe, G. P., Alwan, L. C., & Craig, B. A. (2016). *The Practice of Statistics for Business and Economics* (4th ed.). New York: W.H. Freeman & Company.

Morrison, W. G. (2004). Dimensions of predatory pricing in air travel markets. *Journal of Air Transport Management*, *10*(1), 87–95. https://doi.org/10.1016/j.jairtraman.2003.10.004

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., … Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery*, *78*, 185–193. https://doi.org/10.1016/j.ijsu.2020.04.018

OAG. (2019, December 27). Decade Delights: Ten Years of Aviation Development. Retrieved September 16, 2020, from https://www.oag.com/blog/decade-delights-ten-years-of-aviation-development

Oxley, D., & Jain, C. (2015). Global Air Passenger Markets: Riding Out Periods of Turbulence. In *World Economic Forum*. Retrieved from www.iata.org/pax-forecast.

Petrescu, V., Aversa, R., Akash, B., Bucinell, R., Corchado, J., Apicella, A., … Victoria Virgil Petrescu, R. (2017). History of Aviation-A Short Review. *Journal of Aircraft and Spacecraft Technology*, *2017*(1), 30–49. https://doi.org/10.3844/jastsp.2017.30.49

Reid, J. (2020, March 16). Coronavirus: Delta, United and American Airlines slash transatlantic capacity – Business Traveller. Retrieved July 8, 2020, from Business Traveller website: https://www.businesstraveller.com/business-travel/2020/03/16/coronavirus-delta-united-and-american-airlines-slash-transatlantic-capacity/

Rhoades, S. A. (1993). The Herfindahl-Hirschman Index. *Federal Reserve Bulletin*, *79*, 188–189. Retrieved from https://heinonline.org/HOL/Page?handle=hein.journals/fedred79&id=376&div=&collection=

Rochabrun, M., Cambero, F., & Bautzer, T. (2020). LATAM becomes largest airline driven to bankruptcy by coronavirus.

Skiti, S. (2020). SAA rescuers give affected parties two options: Wind down or liquidate.

Slotnick, D. (2020, April 27). A stark photo of a packed American Airlines flight reveals that airlines are ignoring social distancing, even though they say they're blocking seats and spacing out passengers. Retrieved July 7, 2020, from Business Insider website: https://www.businessinsider.nl/crowded-flights-airlines-coronavirus-masks-photo-2020-4/

Solsvik, T. (2020). Norwegian Air to cancel 85% of flights and lay off 90% of staff. Retrieved August 27, 2020, from https://www.reuters.com/article/us-health-coronavirus-norwegianair/norwegian-air-to-cancel-85-of-flights-and-lay-off-90-of-staff-idUSKBN2132F7

Statista. (2020). • U.S. airline industry market share 2019. Retrieved July 17, 2020, from https://www.statista.com/statistics/250577/domestic-market-share-of-leading-us-airlines/

Štimac, I., Vince, D., & Vidović, A. (2012). *Effect of Economic Crisis on the Changes of Low-Cost Carriers Business Models*. Retrieved from https://www.researchgate.net/publication/269399843_Effect_of_Economic_Crisis_on_the_Changes_of_Low-Cost_Carriers_Business_Models

Toh, M. (2020). UK airline Flybe collapses as coronavirus crisis deals the final blow. Retrieved August 27, 2020, from CNN Business website: https://edition.cnn.com/2020/03/04/business/flybe-collapse-2020/index.html

U.S. Department of Transportation. (1996). *transportation Statistics Annual Report 1996*.

U.S. Department of Transportation. (2012). *Aviation Industry Performance: a Review of the Aviation Industry, 2008 - 2011*.

United Airlines. (2020). U.S. and International Route Maps. Retrieved August 23, 2020, from https://www.united.com/web/en-US/content/travel/route-maps.aspx

Vowles, T. M. (2000). The effect of low fare air carriers on airfares in the US. *Journal of Transport Geography*, *8*(2), 121–128. https://doi.org/10.1016/S0966-6923(99)00033-2

Wall, R., & Carey, S. (2017, August 23). How Budget Carriers Transformed the Airline Industry—in 14 Charts - WSJ. *The Wall Street Journal*. Retrieved from https://www.wsj.com/articles/how-budget-carriers-transformed-the-airline-industryin-14-charts-1503501624

Whinston, M. D., & Collins, S. C. (1992). Entry and Competitive Structure in Deregulated Airline Markets: An Event Study Analysis of People Express. *The RAND Journal of Economics*, *23*(4),

445. https://doi.org/10.2307/2555899

Windle, R. J., & Dresner, M. E. (1995). The Short and Long Run Effects of Entry on U.S. Domestic Air Routes. *Transportation Journal*, *35*(2), 14–25. Retrieved from https://www.jstor.org/stable/20713269?seq=1

Windle, R. J., & Dresner, M. E. (1999). Competitive responses to low cost carrier entry. *Transportation Research Part E: Logistics and Transportation Review*, *35*(1), 59–75. https://doi.org/10.1016/S1366-5545(98)00025-8

World Digital Library. (2014, September 22). Telegram from Orville Wright in Kitty Hawk, North Carolina, to His Father Announcing Four Successful Flights, 1903 December 17 - World Digital Library. Retrieved September 8, 2020, from https://www.wdl.org/en/item/11372/

APPENDICES

APPENDIX A

Table A1: Characteristics of FSCs and LCCs

	Full-Service Carriers (FSC)	**Low-Cost Carriers (LCC)**
Airports	Use primary airports and international HUB airports.	Mostly active at smaller, secondary regional airports.
Handling	Slow aircraft handling caused by the congestion at HUB airports.	Fast aircraft handling (25 minutes or less)
Type of flights	A mix of short-, medium- and long-haul flights with transfer of passengers. Hub-and-Spoke network	Direct point-to-point flights, no transfer of passengers and normally short-haul routes.
Type of aircrafts	Different types of aircrafts (varying fleet)	One model of aircraft (uniform fleet)
Travel class	Multiple classes (e.g. economy class, Business class, First class)	Normally single class (economy class)
services	Free catering, entertainment programs, seat reservation, free check-in baggage	Food and drinks for a fee, No free seat reservation, fee for check-in baggage
Salary structure of employees	High fixed salaries, low variable salaries (variable income less than 10%)	Low fixed salaries, high variable salaries (variable income up to 40%)

Source: Štimac, Vince & Vidović (2012)

APPENDIX B

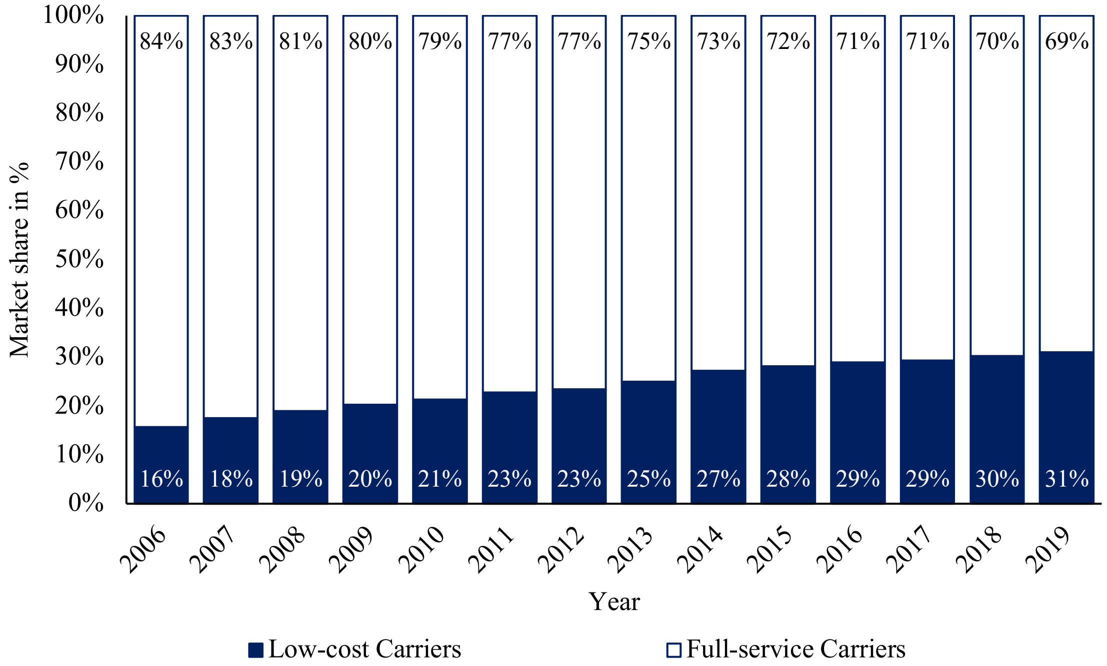


Figure A1: passengers transported market share of Full-service carriers and Low-cost carriers.

Source: IATA, 2020; ICAO, 2020

APPENDIX C

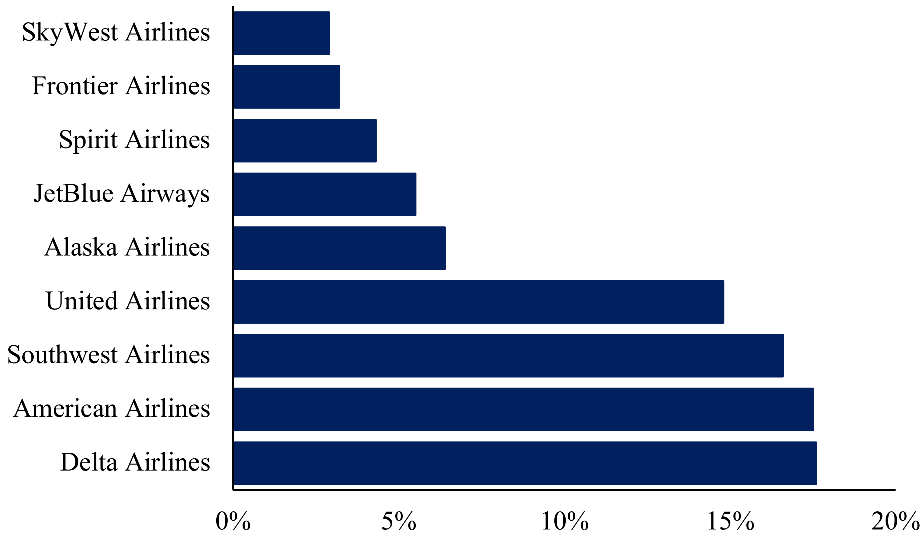


Figure A2: Market share in Revenue Passenger Miles (RPM) (2019)

Source: Statista, 2020