

# **The Evolution of Low-Cost Carrier Operational Strategies Pre- and Post-Recession**

Stephanie Atallah <sup>a</sup>, Susan L. Hotle <sup>b</sup>, Stacey Mumbower <sup>c</sup>

<sup>a</sup> Virginia Polytechnic Institute and State University, School of Civil and Environmental Engineering, 750 Drillfield Drive, Blacksburg, VA 24061-0002.  
Ph: (540) 230-9354, Email: asteph93@vt.edu

<sup>b</sup> Virginia Polytechnic Institute and State University, School of Civil and Environmental Engineering, 750 Drillfield Drive, Blacksburg, VA 24061-0002.  
Ph: (540) 231-7407, Email: shotle3@vt.edu (*corresponding author*)

<sup>c</sup> University of South Carolina, Darla Moore School of Business, 1014 Greene Street, Columbia, SC 29208.  
Ph: (803) 777-2941, Email: stacey.mumbower@moore.sc.edu

Declarations of interest: None

## **Research Highlights**

- Post-recession, operational trends show LCCs placed high priority on increasing the number of markets served while major carriers focused on increasing flight frequency share.
- Southwest Airlines depended more heavily on monopoly markets than the other three top LCCs (Frontier, JetBlue and Spirit Airlines) and consistently faced no incumbent major or LCC competition for about 60% of their markets.
- LCC market additions post-recession have occurred mainly in Large-Large and Large-Medium airport markets.
- On average, LCCs offer less frequent flight service than major carriers on competing markets. Additionally, this LCC flight frequency share has steadily decreased during the study period from 2005-2015.

## **Abstract**

This study presents an analysis of low-cost carrier (LCC) competition strategies for Continental US (CONUS) domestic markets. Using OAG schedule data from 2005-2015, pre- and post-recession trends in LCC flight offerings were analyzed and compared with their major carrier counterparts in terms of number of markets served, flight frequency, and competition structures of served markets. Results show that LCCs are increasing the number of markets served to/from large airports and are entering highly-competitive markets. The results further suggest that LCCs and major carrier strategies evolved differently during the study period, where LCCs outpaced major carriers in terms of markets entered while major carriers have gained a greater flight frequency share in the markets they already serve. Results clearly indicate that overall LCCs are still growing in terms of O-D markets served and increasing competition with major carriers. However, evidence suggests that each of the top four LCCs adopted different operating strategies as part of their business model during the study period.

*Keywords:* Market Share, Competition Structures, Low-Cost Carriers, CONUS-Domestic Markets

## **1. Introduction**

In the past two decades, LCCs have become an increasingly popular alternative to air travel consumers by providing a cost-effective option to price-sensitive customers. According to the Bureau of Transportation Statistics (2016), the share of passengers carried by network carriers declined from 62.0% to 50.2% between 2003 and 2015 whereas the share of LCCs' passengers has been increasing. This shift in demand to LCCs has been seen even in Europe where low-cost flights increased by 61% from 2007 to 2016 while traditional carriers' flights declined by 10% during the same time period (Eurocontrol, 2017).

In the United States, much of the initial growth in popularity of LCCs was generated after the 2001 downturn, with LCCs winning over major carrier customers through offering reduced fares and creating new demand that was not satisfied by the existing airline service (Franke and John, 2011). Specifically, LCCs were able to generate new demand from infrequent price-sensitive fliers by offering them no-frills reduced fare flights (Maidenberg, 2017) as well as attract passengers who were willing to drive to nearby airports served by LCCs to benefit from their services (Spitz et al., 2015). As LCCs increasingly competed on overlapping markets with network carriers, the latter were forced to respond by implementing new business strategies (Pearson et al., 2015; Babicé and Kalicé, 2018). One strategy included network carriers establishing low-cost carrier offshoots or what is also known as the “no frills” divisions within the airline such as Song by Delta in 2003 and Ted by United in 2004. However, major carriers were unsuccessful in their attempts to respond to rising competition from LCCs through these offshoots as they were unable to reduce their unit costs to Southwest levels (Morrell, 2005). Consequently, airline divisions Song and Ted ceased operations by 2006 and 2009, respectively (Pearson and Merkert, 2014).

Much has been hypothesized about the operational future of LCCs and how they compete with major carriers in recent literature. For example, Abda et al. (2012) predicted the unconstrained growth of LCCs in the top 200 US airports was approaching an end by stating, “The well-known impacts of LCCs on air travel markets of lower average fares and higher passenger volumes are evident over the entire period of our study from 1990 to 2008. However, several more specific trends suggest that the unbridled growth of LCCs in US domestic markets may be ending.” Similarly, de Wit and Zuidberg (2012) predicted a slowdown to LCC growth in the upcoming years in face of route density problems and continental market saturation. They hypothesized that for future growth, LCCs will need to adopt new business strategies such as shifting operations to primary airports and creating new alliances. This was further discussed in Dobruszkes et al. (2017), which found that LCCs are increasingly competing from major airports while continually growing and expanding. Hence, “the largest cities' traditional airports will not be sanctuaries for traditional airlines anymore” as direct competition between low-cost carriers and major carriers is increasing.

The purpose of this study is to analyze the evolution in LCC operations and competitive strategies as they have gained popularity compared with their major carrier counterparts. This study contributes to literature as it is market-based (i.e. which origin-destination pair markets are served) and current literature is predominately airport-based (i.e. focuses on the origin and destination airports served). Specifically, the research questions to be addressed in this paper include 1) have LCCs altered operational strategies with regard to the markets and airports they serve and 2) have LCCs changed the competitive dynamics in which they compete (i.e. how they interact with major carriers) pre- and post- recession<sup>1</sup>. The rest of this paper is structured as

---

<sup>1</sup> The great recession began in December 2007 and ended in June 2009, lasting 18 months (BLS, 2012). During the first three quarters of 2008, the U.S. passenger airline industry lost \$4.3 billion mainly caused by the increase in fuel prices (GAO-09-393).

follows: Section 2 describes the data and methodology used to study the operational evolution of LCCs over the years. Section 3 presents the analysis results for LCC competition strategies over the study period. Specifically, results are presented in three different subsections: 1) service and competition structures, 2) flight share frequency and 3) LCC presence by market size. Finally, Section 4 highlights the conclusions of this study and provides recommendations regarding the future research direction.

## **2. Data and Methodology**

To evaluate the competitive strategies of LCCs over time in comparison to their major carrier counterparts, this study utilized OAG flight schedules data, which provides carrier, flight number, origin, destination, aircraft equipment, and scheduled departure/arrival times for scheduled flights. This study uses service information indicated in the OAG schedules from 2005-2015 for nonstop continental US (CONUS) directional origin-destination (OD) airport markets. For example, in this study ATL-LAX and LAX-ATL were considered as two different markets. Directional OD airport markets were considered to capture markets with different market competition structure in each route direction. For example, in 2007, Southwest was the only significant operating carrier in the market departing from LAS and arriving at BUR. However, for flights departing from BUR and headed to LAS, both US Airways and Southwest Airlines competed on this route. Only non-stop service was considered as air passengers value a non-stop itinerary “up to 8 times more than a connecting itinerary” (Emrich and Harris, 2008) as well as to stay consistent with previous literature that only considered non-stop flights (e.g. de Wit and Zuidberg, 2012; Reynolds-Feighan, 2001; Spitz et al., 2015; Zhang et al., 2018). This analysis uses the third week of July for each year, which is a notably high-demand time of year, to reduce any impacts of seasonality on market offerings.

Table 1 shows the LCC and major carriers included in the analysis, which were categorized as either major or low-cost, consistent with the classification using existing literature (Abda et al., 2012; Spitz et al., 2015; USDOT, 2012). Select studies classify carriers that are not major or LCC as “Other” (Abda et al., 2012), but these carriers were outside the scope of this study as the objective is to determine how major carriers and LCCs have interacted over time<sup>2</sup>.

Table 1: Airline classification by type.

<b>Major Carriers</b>	<b>Low-Cost Carriers</b>
Alaska Airlines	Airtran Airway
American Airlines	Allegiant Air
Continental Airlines	America West Airlines
Delta Air Lines	Ata Airlines, Inc.
Northwest Airlines	Frontier Airlines Inc.
United Airlines	Independence Air
US Airways	JetBlue Airways Corporation
	Midwest Airlines Op By Republic A/L
	Southwest Airlines
	Spirit Airlines
	Sun Country Airlines
	USA 3000 Airlines
	Virgin America

In this study, an airline was considered a significant operating competitor (i.e. a probable customer choice) on a market if it operated at least 7 non-stop flights during the third week of July (i.e. an average of one a day), with an average of at least 20 seats per flight. An OD pair market was said to be served if it had at least one significant operating competitor from Table 1. It is

<sup>2</sup> Upon conducting a sensitivity analysis, it was found that the number of markets with significant service from a regional carrier, as defined earlier in the methodology section, is very minimal. The number of markets with significant presence by a regional carrier (at least 7 non-stop flights during the third week of July and operating flights with a seating capacity greater than 20 seats/flight) include: Great Lakes Aviation (14 markets in 2006, 2009, 2012; 6 markets in 2015), Republic Airlines (1 market in 2006), Mesaba Airlines (2 markets in 2009), Shuttle America (1 market in 2009, 2012), Penair (6 markets in 2012, 2015) and ViaAir (2 markets in 2015). Therefore, this study excludes regional carriers and only considers major and low-cost carriers in the analysis.

important to note that competitors in this study were operating carriers and did not include codeshares.

In addition to using OAG Schedules, which provided market competition structures and flight frequency, airport size was incorporated into the study through the annual FAA Airport Classification (FAA, 2014)<sup>3</sup>. These classifications are based on the number of annual passenger boardings and label an airport as either large, medium, small, non-hub, or non-primary. This study classifies both primary non-hub and non-primary non-hub airports as “non-hub” and therefore any airport with less than 10,000 passenger boardings per year or less than 0.05% of annual passenger boardings fall in the same classification. The airport classification was used for each year, therefore an airport could be labeled small one year and medium the next if annual passengers increased.

### **3. Results**

The following sections present different dimensions to LCC competition strategies in comparison to major carriers during the study period. The results include the analyses and sections in the following order: 1) market service and competition structures, 2) flight frequency, and 3) OD airport sizes.

#### **3.1. Market Service and Competition Structures**

As a result of the recession, airlines implemented several cost-cutting strategies which included increasing load factors (Garrow et al., 2012), but they also decreased the total number of OD pair markets served within the U.S. As shown in Table 2, in 2005 there were 4,656 non-stop,

---

<sup>3</sup> FAA defines a primary airport as commercial service airports with more than 10,000 passenger boardings each year. Primary airports are classified as large, medium, small or non-hub. Large hub airports have 1% or more of annual passenger boardings. Medium hub have at least 0.25% of annual passenger boardings. Small hub have at least 0.05% of annual passenger boarding and non-hub have more than 10,000 annual passenger boardings. Non-Hub nonprimary airports have at least 2,500 annual passengers boardings (FAA, 2014).



CONUS-domestic markets served by at least one of the airlines listed in Table 1. By 2015, the total of number of non-stop markets had decreased to 4,199 (a 9.82% decrease). This decrease in markets served was not uniformly seen across all market competition structures. This is seen in Table 2, which presents the number of markets served and the year-over-year percent change in market offerings for three competition structures: 1) markets with major carrier competitors only, 2) markets with LCC competitors only, and 3) markets with both LCC and major competitors. Taking a look at the markets served only by LCC competitors shows that there were 782 markets in 2005. By 2015, the number of markets served only by LCCs grew to 976 markets, indicating a 24.8% increase. Additionally, markets with both LCC and major carrier presence (i.e. at least one LCC and at least one major carrier competitor) increased by 102 markets (corresponding to a 16.1% market increase) during the same time period.

On the other hand, markets served only by major carrier competitors decreased by 753 markets (23.2% market decrease) during that time period. It is interesting that during post-recession years, markets with only major carriers competing decreased steadily while markets with an LCC presence increased. That is, the number of markets served by major carriers only remained in somewhat steady decline between years 2010 and 2014 (decreasing by around 2-3% annually) and then decreased by 6.4% between 2014 and 2015. During that same time period (2010-2015), markets with an LCC and major carrier presence increased by 25.8% and markets with only LCCs increased by 11.4%. These post-recession findings suggest that the LCC business strategies of catering to the increasing price-sensitive market segment during the recession made LCC service more resilient to national economic trends.

Table 2: OD pair CONUS markets served by year.

Year	Total Number of Markets	Percentage of Markets			Year-over-Year Change		
		Major Carrier Only Markets	LCC Only Markets	Major Carrier & LCC Markets	Major Carrier Only Markets	LCC Only Markets	Major Carrier & LCC Markets
<b>2005</b>	4,656	69.6%	16.8%	13.6%	-	-	-
<b>2006</b>	4,588	69.9%	16.9%	13.3%	-1.0%	-1.0%	-4.1%
<b>2007</b>	4,726	70.0%	15.5%	14.5%	3.2%	-5.4%	12.7%
<b>2008</b>	4,734	69.2%	16.6%	14.2%	-1.0%	7.7%	-2.2%
<b>2009</b>	4,436	68.0%	18.0%	13.9%	-7.9%	1.5%	-7.8%
<b>2010</b>	4,404	66.8%	20.0%	13.3%	-2.6%	9.9%	-5.3%
<b>2011</b>	4,410	64.9%	21.0%	14.1%	-2.7%	5.1%	6.7%
<b>2012</b>	4,304	64.7%	21.1%	14.3%	-2.7%	-1.9%	-1.6%
<b>2013</b>	4,269	64.0%	20.9%	15.1%	-1.8%	-1.5%	4.9%
<b>2014</b>	4,193	63.4%	21.1%	15.5%	-2.8%	-0.9%	1.2%
<b>2015</b>	4,199	59.2%	23.2%	17.5%	-6.4%	10.4%	12.9%
<b>Total percent change 2015 vs 2005</b>					<b>-23.2%</b>	<b>24.8%</b>	<b>16.1%</b>

Figure 1 provides a more disaggregate view of these evolving operational strategies, showing the market offerings of the four top LCCs that served the most markets in 2015 (i.e. Southwest, Frontier, JetBlue, and Spirit) compared with the four top major carriers (i.e. Delta, United, American, and US Airways)<sup>4</sup>. As can be seen, each of the four top LCCs individually increased the number of markets served, where the overall LCC growth has been driven predominately by Southwest's expansion. It is important to note that much of Southwest's growth in markets between 2012-2015 was due to its merger with AirTran. Of 178 markets served by AirTran in 2012 with no Southwest presence, 116 markets (65.17%) were still in service by Southwest in 2015. Another point to consider is that Southwest was already competing in nearly 23.9% of the markets in which AirTran competed back in 2012. The large overlap in markets between these two LCCs prior to its merger is not observed in the case of mergers between major

<sup>4</sup> Carriers such as AirTran Airways, Northwest Airlines and Continental Airlines are not illustrated in Figure 1 as the top four carriers were selected based on the number of markets served in year 2015, therefore requiring the carriers to operate during that year.

carriers. In fact, when the merger between Delta and Northwest was announced in 2008, Delta was only serving 2.8% of the markets that were already being served by Northwest. Similarly, when the merger between United and Continental was announced in 2010, United was only serving 4.9% of the markets that were already being served by Continental.

Three years after its merger with Northwest, Delta entered 566 markets out of the 704 markets (80.4%) that were previously served by Northwest in 2008 with no Delta presence. Furthermore, United Airlines added 382 new markets by 2013, three years after its merger with Continental was announced, adding up to 89.7% of the markets that were previously served by Continental back in 2010. This effect can be seen in Figure 1, where there is an increase in the markets served by the remaining carrier of a merger or acquisition (i.e. Delta-Northwest in 2008 and United-Continental in 2010).

However, 2015 results show the long-term impacts of consolidation that have taken effect. That is, for each merger between major carriers, the initial increase in markets is followed by a service discontinuity to a portion of the newly acquired markets. In 2015, Delta discontinued service to 172 markets of the 566 markets that were added in 2011 and therefore only 56% of the markets that used to benefit from Northwest service in 2008 were served by Delta in 2015. This finding is validated by Memphis (MEM) airport where concerns were raised as flights were continuously reduced after the Delta-Northwest merger followed by Delta's "de-hubbing" of MEM in 2013 (Mutzabaugh, 2013). Additionally, United Airlines discontinued service to 67 markets of the 382 markets that were added to its network in 2013 and therefore only 73.9% of markets previously served by Continental Airlines in 2010 were served by United in 2015.

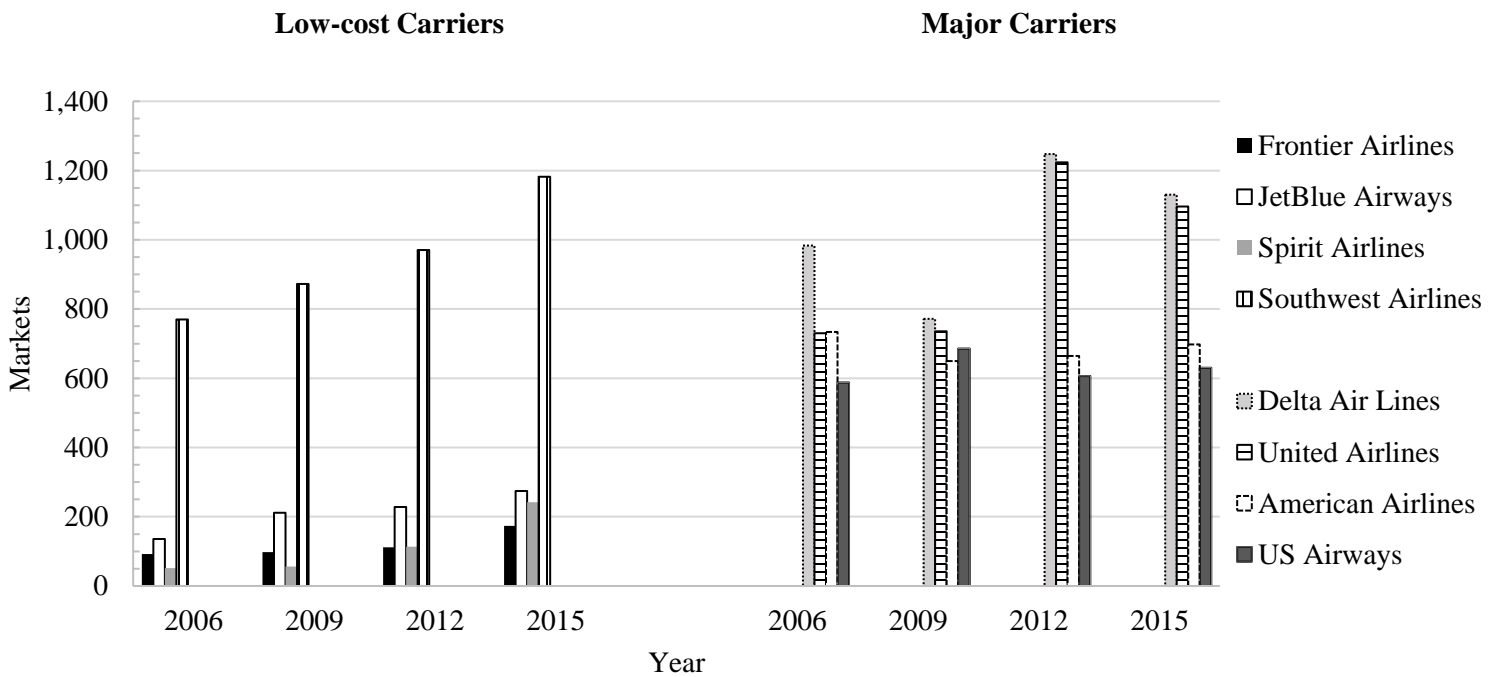


Figure 1: Markets served by the top four LCCs and major carriers

Not only have LCCs expanded the number of OD pairs served, but the competition structures of the markets that LCCs compete in have shifted over the years as shown in a further analysis of the markets served by at least one LCC. Figure 2 shows the distribution of markets served with at least one LCC (i.e. LCC presence) competing across different market competition structures. As shown in Figure 2 (percentages for each year add to 100%), 48.2% of the non-stop markets with an LCC presence in 2006 were LCC monopolies and by 2012 LCC monopolies had increased to 54.7% of the total non-stop markets with an LCC presence. This indicates that pre-recession, LCCs were focused on developing new, previously unserved markets, therefore leading to an increase in LCC monopolies. This trend reached its peak near the end of the recession in 2012, and by 2015 LCC monopolies had decreased slightly to 53.2% of the total non-stop markets with an LCC presence.

Although one may hypothesize the growth in LCC monopolies is simply the result of major carriers exiting markets where they compete with an LCC, further analysis of changes in market structure suggests otherwise. In 2006, the total number of markets with 1 major carrier and LCC presence was 516 markets. By 2012, all carriers dropped from 102 of these markets whereas the remaining 414 markets were still being served by 1 major carrier and at least 1 LCC. Similarly, out of the 832 monopoly markets served by 1 LCC in 2012, 224 of these markets were not served by any carrier in 2006. The remaining 608 markets that were in service between 2006 and 2012 did not change competition structures and continued to be an LCC monopoly. Consequently, it can be said that the increase in LCC monopolies is not the direct effect of major carriers leaving the competition, but rather the result of LCCs expanding their networks.

Post-recession, however, the growth of LCCs has led to more overlap with major carrier networks as seen in Figure 2. Between 2012 and 2015, the majority of the LCC shift in competition structures did not occur in OD pairs with just one other competitor (i.e., 1 major carrier + LCC presence, or 2 LCCs), but rather markets with several airlines already competing. That is, LCCs relied less on markets with few competitors and instead shifted towards competing in markets with multiple competitors over the years. For example, out of all the markets with an LCC presence in 2006, only 0.4% of these markets were served by 3 major carriers and at least 1 LCC. By 2015, LCC increased their presence in markets also served by 3 major carriers, making up 2.6% of all markets with LCC presence. This is consistent with existing literature, which states that one of the most important factors in determining low-cost entry to a market is pre-entry passenger demand (Ito and Lee 2003). These markets would be correlated with high-demand markets.

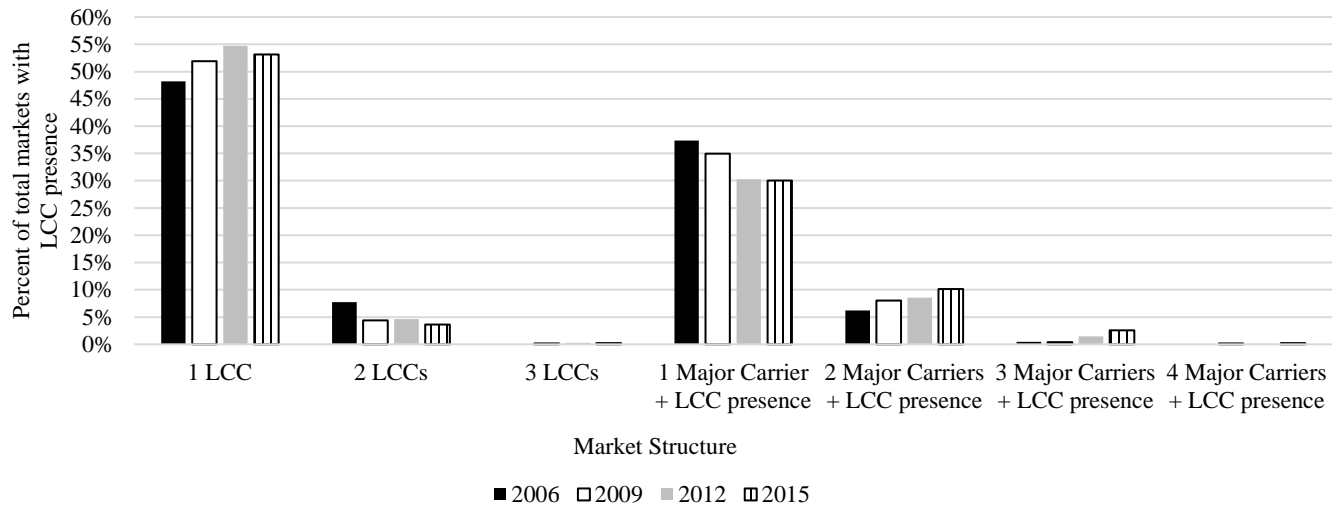


Figure 2: Market competition structure with LCC presence

Among the top four LCCs, competition structures across markets served were not uniform as the operating strategies differed both pre- and post-recession. Figure 3 shows the percentage of each airline's total number of markets in each of three market competition structures: 1) monopoly markets, 2) markets with a major carrier presence, and 3) markets with another LCC present. A single market with both a major carrier competitor and another LCC competitor present shows up in both of the two last categories. For this figure, percentages do not add up to a 100% each year as, for example, a market with 1 major carrier and 2 LCCs will be featured in both "markets with major carrier presence" and "markets with another LCC present" categories.

As can be seen in Figure 3, Southwest Airlines depends more heavily on monopoly markets than the other three top LCCs, where it is the only competitor in 60% of its markets. Further analysis shows that some of Southwest's increase in monopoly markets can be attributed to other LCCs exiting markets in which they compete with Southwest Airlines. For example, in 2006 there were 97 markets served by 2 LCCs. By 2009, 34 of those markets became monopolies only served by Southwest Airlines indicating the other competing LCCs dropped out. However, post-recession Southwest has increased direct competition with major carriers as the percent of markets with

major carrier presence increased from 29.9% in 2012 to 33.3% in 2015 out of the total number of markets where Southwest competes.

In contrast, the distribution of Frontier Airlines is especially unique compared to the other three carriers in that Frontier Airlines' markets are extremely competitive. Its percentages show that in 2015, 55.2% of total markets served by Frontier were also served by at least one other LCC and 81.6% were also served by at least one major carrier. Overall, trends show that post-recession, Southwest and Spirit are increasing dependence on markets with major carrier competition, while JetBlue is competing more with other LCCs. For example, the percent of JetBlue markets with major carriers' presence dropped from 58.8% to 52.6% between 2006 and 2015 while the percent of markets with other LCC presence increased from 11.8% to 24.1%. It is also worth mentioning trends show that Spirit is competing more with both major carriers and LCCs.

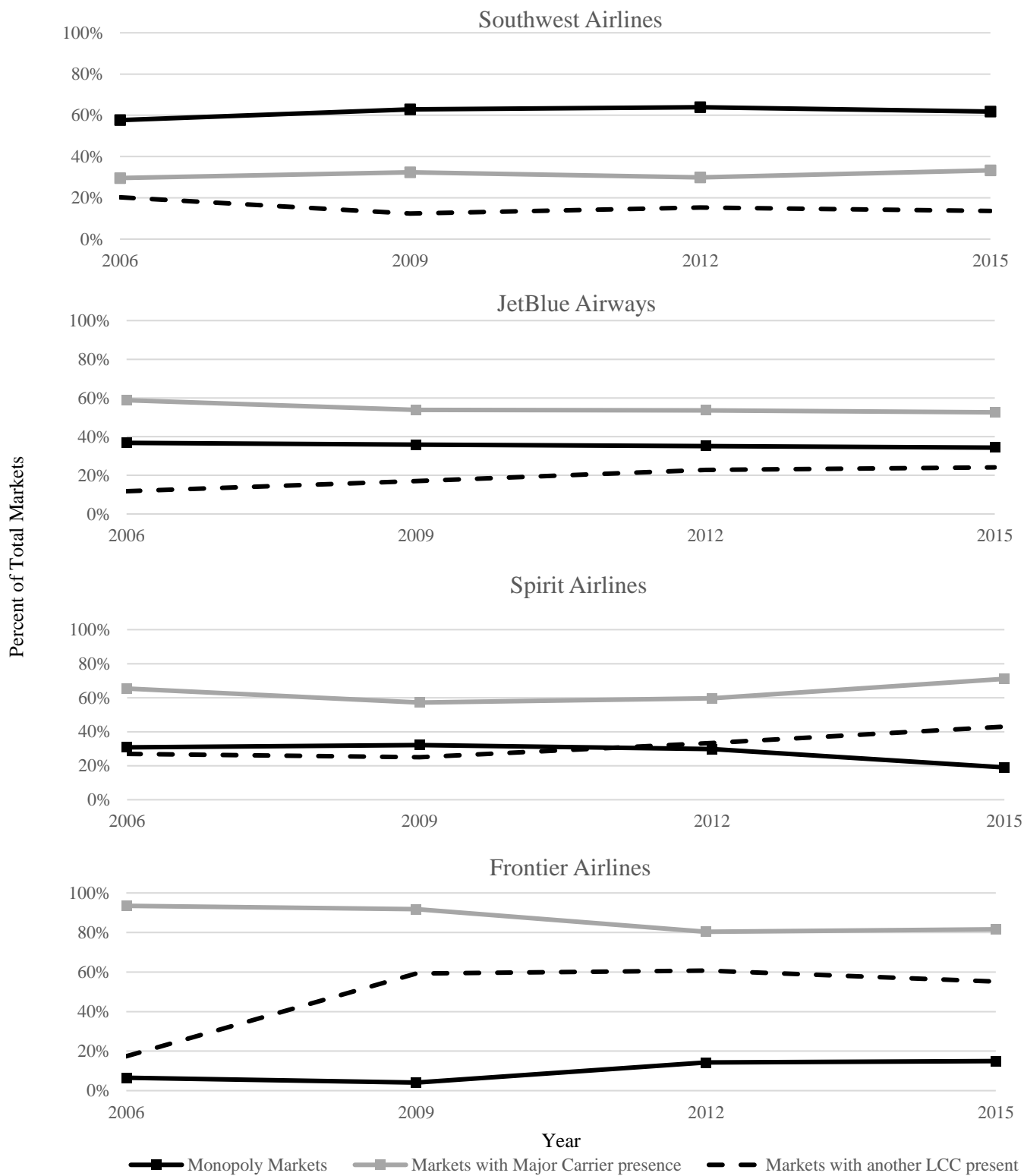


Figure 3: Market competition structures for the top four LCCs



### 3.2. Flight Frequency

This section looks at the frequency of LCC operations in CONUS domestic markets as compared to major carriers. Figure 4 shows the percent of flights on average served by an LCC for each competition structure, where only competition structures containing at least 10 markets are shown for comparison. For example, in 2006 when a single LCC competed with one major carrier, the LCC on average served 42.21% of the flights on the market (and major carriers served the remaining 57.79% of flights). The threshold line at 50% shows market structures in which the flight market share, or the average number of operations, by LCCs exceeds the flight market share of major carriers. It is important to note that in 2009, a single LCC did not serve markets in which 3 major carriers competed, which explains the 0% flight market share.

It can be concluded that on average LCCs offer less frequent flight service than major carriers and the flight frequency shares for LCCs have been declining over time<sup>5</sup>. Therefore, while LCCs are gaining in terms of the number of markets served in recent years, major carriers are gaining flight share in the markets in which they already compete. It can be interpreted that LCCs are actively seeking to explore new markets while reallocating resources by decreasing market share in terms of the frequency of their flight offerings. One possible reason that may have hindered the ability of LCCs to match the flight frequency share of their rivals is the on-going slot control and gate constraints imposed by major carriers at the nation's busiest and largest airports (Stellin, 2010).

---

<sup>5</sup> A similar analysis was performed using LCCs seating capacity instead of flight frequency. Results show similar trends as the one found using LCCs flight frequency share.

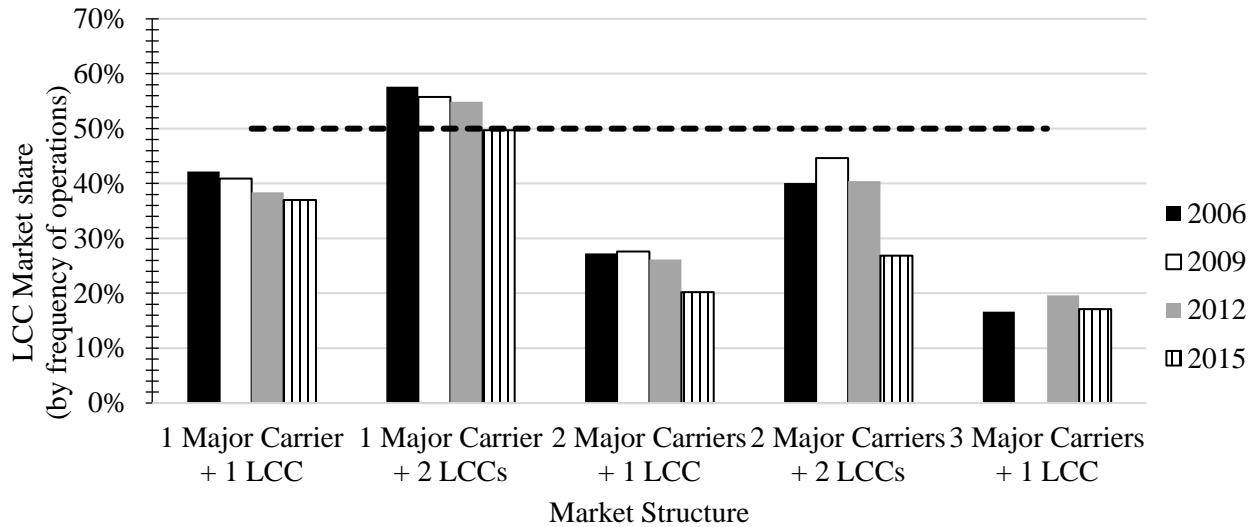
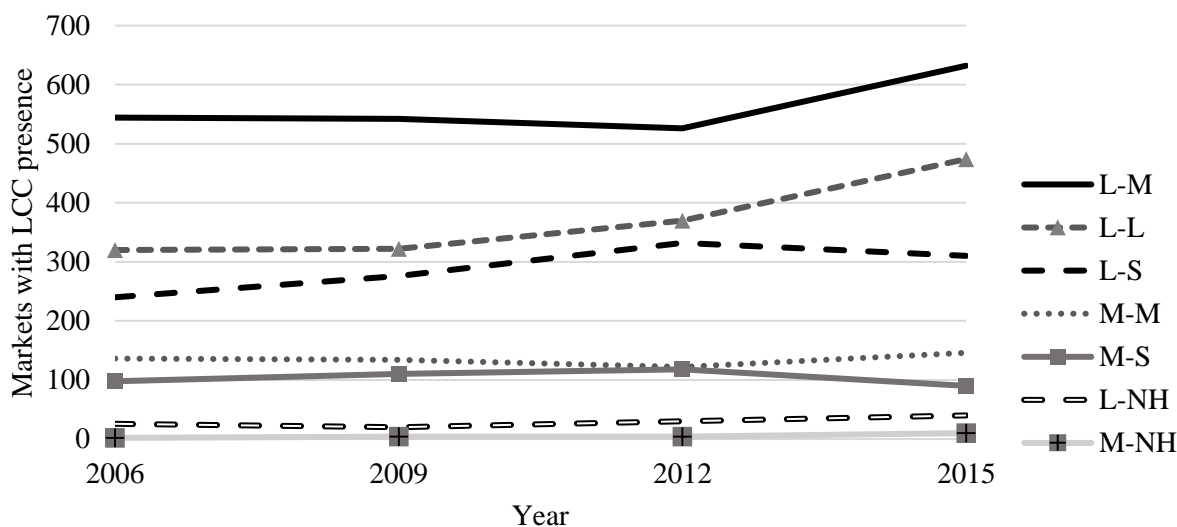


Figure 4: LCC market flight share by market structure

### 3.3. OD Airport Sizes

In addition to LCC competitive strategies changing post-recession, the size of OD airports served has also evolved. As shown in Figure 5, most market offerings focus on large and medium airports (FAA, 2015) as LCCs have mainly served Large-Large (L-L) and Large-Medium (L-M) markets pre- and post-recession. For example, 632 out of the 1,712 markets (37%) served by at least 1 LCC in 2015 were between a medium and a large hub airport. The increase in service to large airports is not only due to LCCs entering highly competitive markets as discussed in the previous section, but also due to increased service to/from secondary airports in multi-airport cities. For each of the years, about 50 (12%) of the Large-Large markets with an LCC presence were monopolies, typically connecting the secondary airports of two multi-airport cities. Counts for small markets are not shown (i.e. Small-Small, Small-Nonhub, Nonhub-Nonhub) as they were minimal.

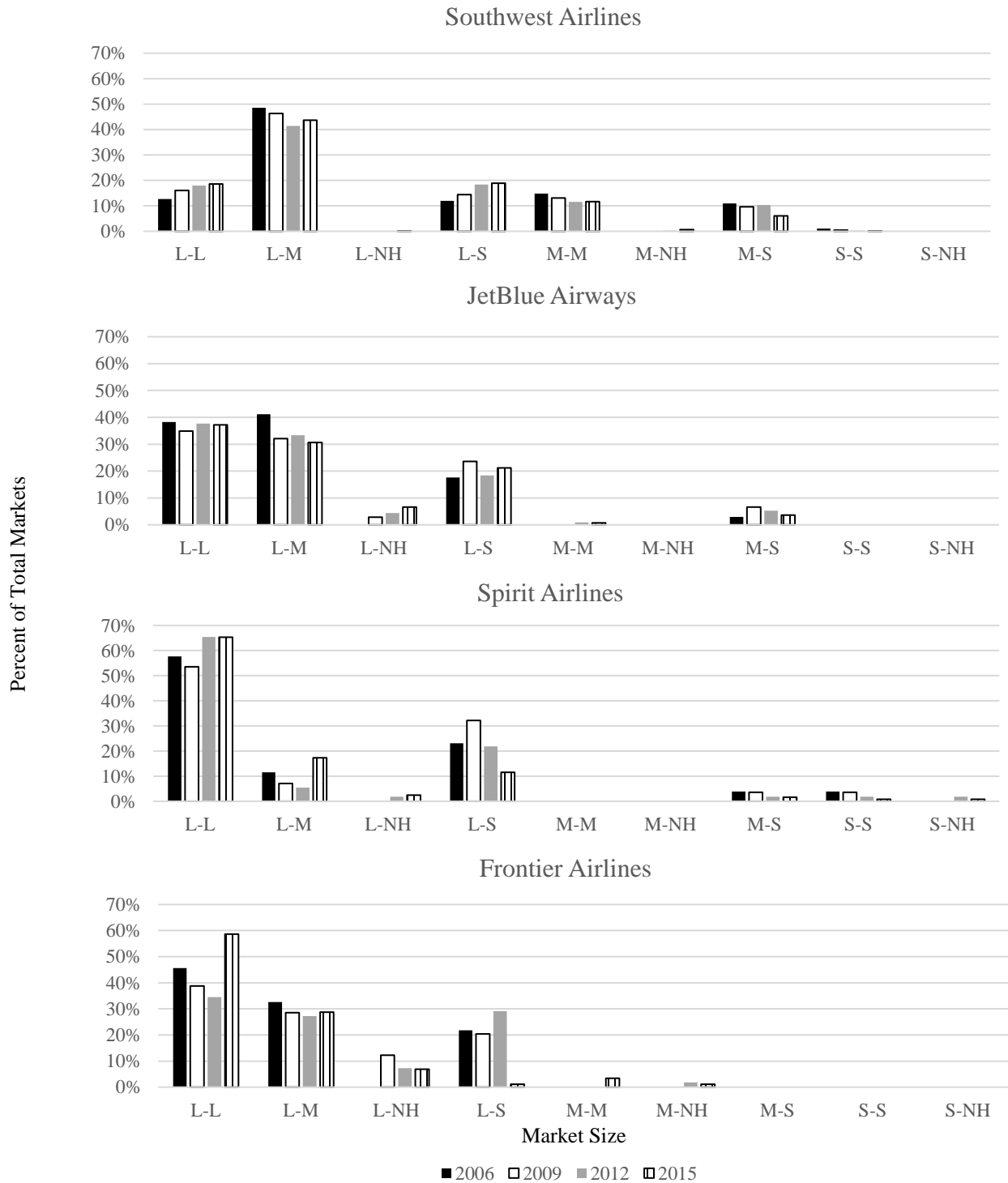


Notes:

1. Airport Size: L = Large Hub, M = Medium Hub, S = Small Hub, NH = Non-Hub (FAA, 2015)

Figure 5: Markets with an LCC presence by OD airport sizes

When comparing the strategies of the top four LCCs, Southwest has a lower percentage of Large-Large markets than others, but serves more Large-Large markets in count due to the high number of markets in general that it serves. Figure 6 illustrates the distribution of markets served by the top four LCCs in terms of market size. For example, 48.6% of markets served by Southwest Airlines in 2006 are between a large and a medium hub airport. The overall trends shown in Figure 5 apply to the majority of the four top LCCs, where post-recession Southwest, Spirit and Frontier have increased their percent of service to large airports to the detriment of smaller communities. This is due to both the loss of these small markets as well as market additions to large airports. For example, in Southwest's case, 92 of the 770 total markets served were between non-hub, small, and medium airports (i.e. M-NH, M-S, S-S, S-NH) in 2006 whereas 82 of the 1,182 total markets served were between these airport sizes in 2015. The only improvement in accessibility for small airport communities between 2006 and 2015 was the percent increase in Large-Small airports served by Southwest and JetBlue.



Notes:

1. Airport Size: L = Large Hub, M = Medium Hub, S = Small Hub, NH = Non-Hub (FAA, 2015)

Figure 6: Market OD airport size for top four LCC markets

#### **4. Conclusions and Future Research Direction**

This study provides an in-depth analysis of the evolving LCC operational strategies compared to their major carrier counterparts between 2005 and 2015. During the third week of July in these 11 years, we see contrasting strategies between LCCs and majors, where LCCs have outpaced major carriers in terms of markets entered while major carriers have gained a greater flight share in the markets they serve. In general, LCCs have gravitated more towards serving large markets (i.e. Large-Large and Large-Medium), including entering markets that already have 2 or 3 competitors present. Post-recession, LCCs have shown preference to competing with major carriers over other LCC airlines.

LCCs' expansion into the nation's largest airports is possible through changes in the LCC business model. For future research, it would be interesting to look into how business models have evolved for LCCs that have been successful at gradually shifting operations from secondary to primary large airports. Another research question to be addressed is how fares have been impacted in light of the trends found in this study. That is, literature has acknowledged that LCC-presence decreases average market fares, as demonstrated through the "Southwest Effect" (Vowles, 2001). Given LCCs show a decreasing average flight share over time in this study, knowledge of the minimum flight frequency or flight market share needed to retain this effect would be beneficial for future consumer welfare studies.

Another interesting research direction would be to quantify the amount of new demand that LCCs stimulate when they enter into a market, as well as their passenger market share growth over the years. For instance, Windle and Dresner (1995) looked at a time series between 1991 and 1994 and found that when Southwest entered a route, the average passenger traffic increased by 300% in the fourth quarter following entry compared to a 182% increase for the other carriers. Lastly, it would be interesting to use an airport-based approach (in contrast to our market-based approach)

to analyze LCC growth in the nation's airports in more recent years, possibly in terms of number of LCCs, flight frequency, and seating capacity share. For example, Abda et al. (2012) uses an airport-based approach using Origin and Destination Traffic Survey (DB1B) data for years between 1990 and 2008 and finds that as growth opportunities at the largest airports (top 50 airports) dwindled, LCCs started to shift to second, third and fourth tier airports. Abda et al. (2012) also projected that the unconstrained growth of LCCs at the top 200 U.S. airports may soon be ending. It would be interesting to update this study to take a look at airport trends in more recent years.

## Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## References

- Abda, M. B., Belobaba, P. P., & Swelbar, W. S. (2012). Impacts of LCC growth on domestic traffic and fares at largest US airports. *Journal of Air Transport Management*, 18(1), 21-25. <https://doi-org.ezproxy.lib.vt.edu/10.1016/j.jairtraman.2011.07.001>
- Babić, D., & Kalić, M. (2018). Modeling the selection of airline network structure in a competitive environment. *Journal of Air Transport Management*, 66, 42-52. <https://doi-org.ezproxy.lib.vt.edu/10.1016/j.jairtraman.2017.10.004>
- Bureau of Labor Statistics. (2012). The recession of 2007-2009. Retrieved from <https://www.bls.gov/spotlight/2012/recession/> (accessed 10 March 2018)
- Bureau of Transportation Statistics. (2016). Passenger Travel Facts and Figures 2016. Retrieved from [https://www.bts.gov/archive/publications/passenger\\_travel\\_2016](https://www.bts.gov/archive/publications/passenger_travel_2016) (accessed 5 December 2017)
- de Wit, J. G., & Zuidberg, J. (2012). The growth limits of the low cost carrier model. *Journal of Air Transport Management*, 21, 17-23. <https://doi.org/10.1016/j.jairtraman.2011.12.013>
- Dobruszkes, F., Givoni, M., & Vowles, T. (2017). Hello major airports, goodbye regional airports? Recent changes in European and US low-cost airline airport choice. *Journal of Air Transport Management*, 59, 50-62. <https://doi-org.ezproxy.lib.vt.edu/10.1016/j.jairtraman.2016.11.005>

- Emrich, R. M., & Harris, F. H. D. (2008). Share shift and airport substitution in origin-destination markets with low-cost entrants. *International Journal of Revenue Management*, 2(2), 109-122.
- Eurocontrol. (2017). The rapid rise of low-cost carriers. Retrieved from <http://www.eurocontrol.int/news/rapid-rise-low-cost-carriers> (accessed 25 March 2018)
- Federal Aviation Administration, (2015). Calendar Year 2014 Passenger Boardings at Commercial Service Airports. [https://www.faa.gov/airports/planning\\_capacity/passenger\\_allcargo\\_stats/passenger/media/cy14-commercial-service-enplanements.pdf](https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/cy14-commercial-service-enplanements.pdf)
- Franke, M. & John, F. (2011). What comes next after recession? Airline industry scenarios and potential end games. *Journal of Air Transport Management* 17, 19e26.
- GAO, Airline Industry Contraction Due to Volatile Fuel Prices and Falling Demand Affects Airports, Passengers, and Federal Government Revenues, GAO-09-393 (Washington, DC.: April 23, 2009).
- Garrow, L. A., Hotle, S., & Mumbower, S. (2012). Assessment of product debundling trends in the US airline industry: Customer service and public policy implications. *Transportation Research Part A: Policy and Practice*, 46(2), 255-268.
- Ito, H., & Lee, D. (2003). Low cost carrier growth in the US airline industry: Past, present, and future, Working Paper, Brown University, Department of Economics, No. 2003-12, Brown University, Department of Economics, Providence, RI. <http://hdl.handle.net/10419/80113>
- Maidenberg, M. (2017). How Low-Cost Airlines Alter the Economics of Flying, The New York Times. Retrieved from <https://www.nytimes.com/2017/09/01/business/budget-airlines-ticket-prices.html> (accessed 10 July 2018)
- Morrell, P. (2005). Airlines within airlines: An analysis of US network airline responses to Low Cost Carriers. *Journal of Air Transport Management*, 11(5), 303-312.
- Mutzabaugh, B. (2013). Delta to pull plug on Memphis hub after labor day, USA Today. Retrieved from <https://www.usatoday.com/story/todayinthesky/2013/06/04/delta-air-lines-to-pull-plug-on-memphis-hub/2390515/> (accessed 20 March 2018)
- Pearson, J., & Merkert, R. (2014). Airlines-within-airlines: a business model moving East. *Journal of Air Transport Management*, 38, 21-26. <https://doi-org.ezproxy.lib.vt.edu/10.1016/j.jairtraman.2013.12.014>
- Pearson, J., O'Connell, J. F., Pitfield, D., & Ryley, T. (2015). The strategic capability of Asian network airlines to compete with low-cost carriers. *Journal of Air Transport Management*, 47, 1-10. <https://doi-org.ezproxy.lib.vt.edu/10.1016/j.jairtraman.2015.03.006>

- Reynolds-Feighan, A. (2001). Traffic distribution in low-cost and full-service carrier networks in the US air transportation market. *Journal of Air Transport Management*, 7(5), 265-275.  
[https://doi-org.ezproxy.lib.vt.edu/10.1016/S0969-6997\(01\)00021-7](https://doi-org.ezproxy.lib.vt.edu/10.1016/S0969-6997(01)00021-7)
- Spitz, W., O'Connor, M., Mills, R., Carroll, M., & Murray, S. (2015). *Effects of Airline Industry Changes on Small-and Non-Hub Airports* (No. Project 03-29).
- Stellin, S. (2010). Seeking a Place at Airports, The New York Times. Retrieved from <https://www.nytimes.com/2010/01/26/business/26slots.html> (accessed 10 April 2018)
- U.S. Department of Transportation. (1996). The Low Cost Airline Service Revolution, Washington D.C.
- U.S. Department of Transportation. (2012). Aviation Industry Performance: A review of the Aviation Industry, 2008-2011, CC-2012-029.
- Vowles, T. M. (2001). The “Southwest Effect” in multi-airport regions. *Journal of Air Transport Management*, 7(4), 251-258.
- Windle, R. J., & Dresner, M. E. (1995). The short and long run effects of entry on US domestic air routes. *Transportation Journal*, 14-25.
- Zhang, S., Derudder, B., Fuellhart, K., & Witlox, F. (2018). Carriers’ entry patterns under EU-US open skies agreement. *Transportation Research Part E: Logistics and Transportation Review*, 111, 101-112.