

**THE EVOLUTION OF U.S. AIRLINES' PRODUCTIVITY AND COST
PERFORMANCE FROM 2004 TO 2012**

by

QIANNAN JIANG

B.S. Electrical and Computer Engineering
Cornell University (2009)

*Submitted to the Department of Aeronautics and Astronautics
in Partial Fulfillment of the Requirements for the Degree of*

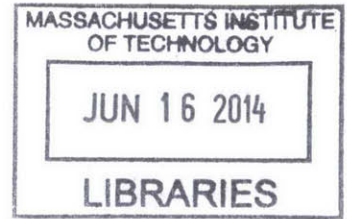
MASTER OF SCIENCE

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2014

ARCHIVES



© 2014 QianNan Jiang. All rights reserved

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part in any medium now known or hereafter created.

Signature redacted

Signature of Author

Department of Aeronautics and Astronautics
May 9, 2014

Signature redacted

Certified by

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

Signature redacted

Accepted by

Paulo C. Lozano
Associate Professor of Aeronautics and Astronautics
Chair, Graduate Program Committee

PAGE INTENTIONALLY LEFT BLANK

THE EVOLUTION OF U.S. AIRLINES' PRODUCTIVITY AND COST PERFORMANCE FROM 2004 TO 2012

BY
QIANNAN JIANG

MASTER OF SCIENCE IN AERONAUTICS AND ASTRONAUTICS

*Submitted to the Department of Aeronautics and Astronautics on May 9, 2014
in Partial Fulfillment of the Requirements for the Degree of*

Abstract

In the past decade, the U.S. airline industry has undergone tremendous transformation triggered by major events such as the surge in fuel prices and the economic recession. Network legacy carriers implemented drastic measures to reduce cost and increase productivity. Some filed bankruptcy protection to restructure, and others pursued mergers for consolidation and cost savings through operational synergies. Low cost carriers have been profitable but are now faced with higher costs stemming from increasing labor seniority and aging fleets. Recently, the emergence of ultra-low cost carriers has intensified the competition, as these newer airlines operate at extremely low costs and offer rock bottom low fares.

The main objective of this thesis is to examine the evolution of U.S. airlines' productivity and cost performance from 2004 to 2012. This thesis provides an in-depth analysis of unit costs, aircraft and employee productivity of 10 major U.S. passenger airlines, which are classified into three groups: network legacy carriers (NLCs), low cost carriers (LCCs), and ultra-low cost carriers (ULCCs). We compare the unit costs and productivity trends at industry aggregate and domestic operations level for these three groups. We also explore the underlying forces that drove these trends and the effect of stage length on unit cost and productivity.

The results indicate that the gaps between NLCs' and LCCs' unit cost excluding transport related and fuel expenses, labor unit cost, and employee and wage productivity have decreased from 2004 to 2012. Most notably, the gaps between their unit cost excluding fuel and transport related expenses and labor unit costs were reduced by 48% and 67%, respectively. NLCs performed dramatic cuts in labor in the 2000s and increased aircraft and employee productivity by shifting their focus to international markets. LCCs had the steepest increase in unit cost and maintained the highest aircraft utilization but are losing their traditional labor cost and productivity advantage to ULCCs. In 2012, ULCCs' labor unit cost was about half of NLCs' and LCCs', and their employee productivity was 34% greater than NLCs' and 20% greater than LCCs'. ULCCs have truly achieved lowest unit cost with highest labor efficiency in the industry.

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

PAGE INTENTIONALLY LEFT BLANK

Acknowledgements

I am very lucky to have Dr. Peter Belobaba as my advisor throughout my studies at MIT, and to begin, I would like to thank Peter for all of his guidance and support. Peter's 16.71: The Airline Industry was the first course I took at MIT, and it was 16.71 that sparked my research interest in the airline business. Without Peter's guidance, this would not be possible.

I would also like to thank Ken Gould of GE Aviation for being a great role model and technical mentor and allowing me the opportunity to attend MIT. I would like to thank my managers, colleagues, and friends at GE Aviation for their understanding and encouragement along the way.

Finally, I would like to thank my loving family and friends in the Boston area. I would not be where I am today without their constant support throughout my time at MIT. I dedicate this thesis to the loving memory of my grandfather and mother, whom have had profound influence in my life.

Contents

Chapter 1: Introduction	12
1.1 The U.S. Airline Industry Recent Trends 2000 to present	13
1.1.1 Bankruptcies.....	13
1.1.2 Mergers & Consolidations.....	13
1.1.3 The Successes and Evolution of the Low Cost Carriers.....	15
1.1.4 2008 Financial Crisis.....	16
1.1.5 A Profitable Future.....	16
1.2 Thesis Objective.....	17
1.3 Thesis Structure.....	18
Chapter 2: Definitions and Literature Review	19
2.1 Definitions.....	19
2.2 Literature Review	21
2.2.1 The Evolution of the Low Cost Business Model.....	21
2.2.2 Cost Comparisons of NLCs vs. LCCs.....	24
2.3 Sources and Dataset.....	27
2.4 Methodology	29
2.4.1 Airline Group Selection.....	29
2.4.2 Measures Computed.....	30
2.4.3 Aggregation Methods	31
2.4.4 Regression Analysis for Stage Length Adjustment.....	32
Chapter 3: Unit Cost Analysis	35
3.1 Unit Cost Adjustments and Break Down	35
3.2 System Aggregate Industry CASM.....	36
3.2.1 Aggregate Industry CASM comparisons for NLCs, LCCs, and ULCCs	36
3.2.2 System Aggregate CASM Comparisons for Individual Airlines	43
3.3 Domestic Operations Aggregate CASM Comparisons	57
3.4 Stage Length Adjusted CASM Comparisons for Individual Airlines	62
Chapter 4: Aircraft Productivity Analysis	69
4.1 System Aggregate Aircraft Productivity	69

4.1.1	Aggregate Industry Aircraft Productivity Comparisons for NLCs, LCCs, and ULCCs	69
4.1.2	System Aggregate Aircraft Productivity Comparisons for Individual Airlines	75
4.2	Domestic Operations Aggregate Aircraft Productivity Comparisons	86
4.3	Stage Length Adjusted Aircraft Productivity Comparisons for Individual Airlines	91
Chapter 5: Employee Productivity Analysis.....		96
5.1	System Aggregate Employee Productivity.....	96
5.1.1	Aggregate Industry Employee Productivity Comparisons for NLCs, LCCs, and ULCCs..	96
5.1.2	System Aggregate Employee Productivity Comparisons for Individual Airlines.....	101
5.2	Domestic Operations Aggregate Employee Productivity Comparisons.....	112
5.3	Stage Length Adjusted Employee Productivity Comparisons for Individual Airlines.....	116
Chapter 6: Summary of Results and Conclusions.....		121
6.1	Summary of Results	121
6.2	Further Research	124
Works Cited.....		126

List of Figures

Figure 1 System Aggregate Comparison: CASM ex Transport Rel.	37
Figure 2 System Aggregate Comparison: CASM ex Transport Rel. & Fuel	38
Figure 3 System Aggregate Comparison: Non-Labor CASM	39
Figure 4 System Aggregate Comparison: Labor CASM.....	40
Figure 5 NLCs CASM Breakdown	41
Figure 6 LCCs CASM Breakdown	41
Figure 7 ULCCs CASM Breakdown.....	42
Figure 8 Non-Labor System CASM for Individual Airlines 2004, 2008, and 2012	43
Figure 9 Labor System CASM for Individual Airlines 2004, 2008, and 2012	44
Figure 10 Delta Airlines CASMs	45
Figure 11 Northwest Airlines CASMs	46
Figure 12 United Airlines CASMs.....	47
Figure 13 Continental Airlines CASMs	48
Figure 14 American Airlines CASMs.....	50
Figure 15 US Airways CASMs.....	50
Figure 16 Southwest Airlines CASMs	51
Figure 17 AirTran Airways CASMs	51
Figure 18 JetBlue Airways CASMs	52
Figure 19 Virgin America CASMs	53
Figure 20 Spirit Airlines CASMs.....	54
Figure 21 Frontier Airlines CASMs.....	55
Figure 22 Allegiant Air CASMs	55
Figure 23 Domestic Operations Comparison: CASM ex Transport Rel.....	58
Figure 24 Domestic Operations Comparison: CASM ex Transport Rel. & Fuel.....	58
Figure 25 Domestic Operations Comparison: Non-Labor CASM	59
Figure 26 Domestic Operations Comparison: Labor CASM	59
Figure 27 Non-Labor CASM vs Stage Length: Change from 2004 to 2008.....	62
Figure 28 Labor CASM vs Stage Length: Change from 2004 to 2008.....	63
Figure 29 Non-Labor CASM vs Stage Length: Change from 2008 to 2012.....	64
Figure 30 Labor CASM vs Stage Length: Change from 2008 to 2012.....	64
Figure 31 Stage Length Adjusted Non-Labor CASM for Individual Airlines 2004, 2008, and 2012	66
Figure 32 Stage Length Adjusted Labor CASM for Individual Airlines 2004, 2008, and 2012.....	66
Figure 33 System Aggregate Comparison: Aircraft Utilization.....	70
Figure 34 System Aggregate: Block Hours.....	71
Figure 35 System Aggregate: Aircraft Days	71
Figure 36 System Aggregate: ASMs.....	71
Figure 37 System Aggregate: Average Stage Length	72
Figure 38 System Aggregate: Aircraft Productivity.....	73
Figure 39 System Aggregate: Average Number of Seats per Aircraft	74
Figure 40 System Aggregate: Number of Departures per Aircraft per Day.....	75

Figure 41 Aircraft Utilization for Individual Airlines 2004, 2009, and 2012	76
Figure 42 Aircraft Productivity for Individual Airlines 2004, 2009, and 2012.....	76
Figure 43 % Change of Aircraft Utilization and Productivity from 2004 to 2012.....	77
Figure 44 Individual Network Legacy Carriers: Aircraft Utilization and Productivity	80
Figure 45 Individual Low Cost Carriers: Aircraft Utilization and Productivity	83
Figure 46 Individual Ultra Low Cost Carriers: Aircraft Utilization and Productivity	84
Figure 47 Domestic Operations Comparison: Aircraft Utilization*	86
Figure 48 Domestic Operations: Average Stage Length.....	87
Figure 49 Domestic Operations: Average Number of Seats per Aircraft.....	87
Figure 50 Domestic Operations: Number of Departures per Aircraft per Day	88
Figure 51 Domestic Operations Comparison: Aircraft Productivity.....	89
Figure 52 Aircraft Utilization vs Stage Length: Change from 2009 to 2012	91
Figure 53 Aircraft Productivity vs Stage Length: Change from 2009 to 2012	92
Figure 54 Aircraft Utilization and Productivity Linear Regressions for 2009	93
Figure 55 Aircraft Utilization and Productivity Linear Regressions for 2012	93
Figure 56 System Aggregate Comparison: Employment.....	97
Figure 57 System Aggregate: Average Salary & Benefits per Employee.....	97
Figure 58 System Aggregate Comparison: Employee Productivity.....	98
Figure 59 System Aggregate Comparison: Wage Productivity	99
Figure 60 System Aggregate: Passengers per Employee	100
Figure 61 Employee Productivity for Individual Airlines, 2004, 2008, and 2012	101
Figure 62 Wage Productivity for Individual Airlines 2004, 2008, and 2012.....	101
Figure 63 % Change in Employee and Wage Productivity from 2004 to 2012	102
Figure 64 % Change in # of Employees and Wage from 2004 to 2012.....	102
Figure 65 Individual Network Legacy Carriers: Employee and Wage Productivity.....	106
Figure 66 Individual Low Cost Carriers: Employee and Wage Productivity.....	109
Figure 67 Individual Ultra Low Cost Carriers: Employee and Wage Productivity	110
Figure 68 Domestic Operations Comparison: Employment	112
Figure 69 Domestic Operations: Average Salary & Benefits per Employee	113
Figure 70 Domestic Operations: Employee Productivity.....	113
Figure 71 Domestic Operations: Wage Productivity.....	114
Figure 72 Employee Productivity vs Stage Length: Change from 2009 to 2012.....	116
Figure 73 Wage Productivity vs Stage Length: Change from 2009 to 2012.....	117
Figure 74 Employee and Wage Productivity Linear Regressions by Airlines for 2012	118
Figure 75 Employee and Wage Productivity Linear Regressions by Groups for 2012.....	118

List of Figures

Table 1 Individual Airline's Contribution to Aggregate Group 2004-2012	43
Table 2 2012 System: CASM Rankings for All Airlines	56
Table 3 2012 Domestic Operations: CASM Rankings for All Airlines	61
Table 4 Aggregate: System versus Stage Length Adjusted Unit Costs.....	66
Table 5 Individual Airlines: System versus Stage Length Adjusted Unit Costs	67
Table 6 2012 Stage Length Adjusted: CASM Rankings for All Airlines	68
Table 7 2012 System: Aircraft Utilization and Productivity Rankings for All Airlines	76
Table 8 2012 Domestic Operations: Aircraft Utilization and Productivity Rankings for All Airlines	90
Table 9 Aggregate: System vs. Stage Length Adjusted Aircraft Utilization & Productivity.....	94
Table 10 Individual Airlines: System vs. Stage Length Adjusted Aircraft Utilization & Productivity	94
Table 11 2012 Stage Length Adjusted Aircraft Utilization and Productivity Rankings for All Airlines ...	95
Table 12 System: Employee and Wage Productivity Rankings for All Airlines	102
Table 13 2012 Domestic Operations: Employee and Wage Productivity Rankings for All Airlines	115
Table 14 Aggregate: System vs. Stage Length Adjusted Employee & Wage Productivity	119
Table 15 Individual Airlines: System vs. Stage Length Adjusted Employee & Wage Productivity	119
Table 16 2012 Stage Length Adjusted: Employee and Wage Productivity Rankings for All Airlines.....	120

PAGE INTENTIONALLY LEFT BLANK

Chapter 1: Introduction

Since the deregulation in 1978, the U.S. airline industry has grown immensely. Major U.S. network legacy carriers rapidly expanded their network and increased services to meet the growth in air travel demand, and they enjoyed high profitability in the late 1990s. However, in the 2000s, major events such as severe economic recessions, competition from new entrant and low cost carriers, rising fuel prices, and unforeseen natural disasters and incidents such as the terrorist attack on September 11, 2001 drove several network legacy carriers filing for bankruptcy to restructure and to implement drastic measures to reduce cost.

Network legacy carriers pursued merger and consolidation opportunities, slashed excess capacity, cut cost, and improved operational efficiency in order stay in competitive in the presence of their low cost rivals. On the contrary, the low cost carriers, which are known for their smaller point-to-point network, simpler service, and lower cost structure, have been profitable and captured a large portion of market share from the legacy carriers. However, low cost carriers are now challenged with maintaining their operating margin while facing cost increase from network expansion and aging labor and fleets. Recently, ultra-low cost carriers, a new breed of low cost carriers, begin to offer strictly no frills service at extremely competitive low base fares, targeting mainly leisure travel markets. The ultra-low lost carriers are slowly expanding into larger domestic markets, and their presence brings new challenges to the network legacy and low cost carriers in those markets.

The goal of this thesis is to provide an in-depth analysis to examine the evolution of unit cost and productivity of network legacy, low cost, and ultra-low cost carriers from 2004 to 2012. We evaluate the trends and extent of the changes in unit cost and productivity, and we also explore the underlying forces driving these changes.

1.1 The U.S. Airline Industry Recent Trends 2000 to present

We begin by summarizing the major events that have affected the U.S. airline industry in the past decade.

1.1.1 Bankruptcies

The crash of the dot-com bubble in 2000, the 9/11 terrorist attack in 2001, and the SARS epidemic outbreak led to a significant reduction in passenger traffic, and U.S. network legacy carriers responded with immediate cut backs in capacity and flight schedules. The increase in fare transparency through online search engines and bookings kept fares low and competitive. In addition, the increase in labor costs due to union contract negotiations and the rise of oil prices drove the legacy carriers further into unprofitability. Between 2001 and 2005, U.S. airlines reported a cumulative net loss of over \$40 billion¹.

In the aftermath of these events, several large network legacy carriers filed for bankruptcy protection. U.S. Airways filed twice over a two year period, 2002 and 2004, and Northwest Airlines and Delta Airlines filed for bankruptcy in 2005. In 2011, American Airlines filed voluntary petitions for Chapter 11. Although filing bankruptcy can have negative impacts on the airlines' image and their shareholders, it effectively allowed airlines to alter their business models, and legacy carriers placed their main efforts on cutting cost and improving productivity. Under bankruptcy protection and additional financing, many legacy airlines cut capacity, reduced excess resources, obtained labor union contract concessions, and adjusted unprofitable routes.

1.1.2 Mergers & Consolidations

Some of the network legacy carriers also pursued mergers as a way to exit bankruptcy. In 2005, U.S. Airways merged with America West and exited bankruptcy. Other network legacy carriers sought after merger for network expansion and savings through operational synergies. Northwest Airlines and Delta Airlines merged in 2008, and United Airlines and Continental Airlines merged in 2010. In 2011, Southwest Airlines acquired AirTran Airways in 2011 to grow

¹ Heimlich, John. Air Transport Association, *2007 Outlook: "Reaching for the Skies?"*. < www.airlines.org>. January 2007.

its network and strengthen its presence in the southeast United States. Most recently, U.S. Airways and American Airlines were in the process of completing their merger. Initially, the U.S. Department of Justice filed a lawsuit blocking the merger because it feared the merger would limit competition, which might lead to higher fare prices. However, the airlines reached an antitrust settlement with DOJ, and the merger was allowed to proceed if the airlines give up takeoff and landing slots at their major hub airports, Reagan National Airport and La Guardia Airport, and gates at Dallas Fort Worth Airport.

Therefore, mergers not only allowed several airlines to exit bankruptcy, but also helped airlines to integrate and further trim excess resources and capacity, consolidate networks and hub operations to achieve greater economies of scale. Between June 2007 and June 2012, 13.9 percent of domestic scheduled passenger flights were eliminated, and most of the cuts were made in 2008 and 2009. Post Delta and Northwest Airlines' merger, hub operations at Cincinnati Airport and Memphis Airport decreased by 63 and 36 percent, respectively, between 2007 and 2012².

Although mergers benefited the airlines greatly, travelers struggled as inevitable post-merger operation challenges occurred. Passenger complaints about United Airlines' service increased by 60 percent after it merged with Continental Airlines³. On-time arrivals fell significantly after Delta Airlines merged with Northwest Airlines. After Southwest Airlines merged with AirTran Airways, the joining of flight schedules between the two airlines was not smooth. Agents from both airlines struggled to maintain consistent ticketing practices. Both airlines were known to have exceptional service, but post-merger inconsistencies and disruptions frustrated the travelers⁴. The merging of operations between two airlines is immensely complex, and over time the merged airlines will resolve these issues.

² Department of Air Transportation, *Aviation Industry Performance: A Review of the Aviation Industry, 2008-2011*. Number: CC-2012-029. 24 September 2012.

³ Mutzabaugh, Ben. "United Airlines Still Hearing Complaints after Merger Switchover." USA Today, 28 Mar. 2012. <<http://travel.usatoday.com/flights/post/2012/03/united-airlines-still-leaving-passengers-on-hold-/658647/1>>.

⁴ Notte, Jason. "Airline Mergers Mean More Pain for Passengers." MSNMoney, 13 Feb. 2013. <<http://money.msn.com/now/post.aspx?post=c9573475-1893-4cac-953f-9183bc62a01f>>.

1.1.3 The Successes and Evolution of the Low Cost Carriers

Since the early 1970s, several U.S. airlines adopted the low cost strategy (further discussed in Chapter 2, section 2.2.2), but only a few survived the 2000s. Southwest Airline has been notably profitable during unstable economic times, and its business model has been adopted by several low cost carriers around the world. The original low cost business model came from Southwest Airlines and focused on delivering low fare and no-frill service to customers and maintaining low costs by attaining high operational efficiency through operating a smaller point-to-point network, using cheaper secondary airports to avoid congestion, keeping flight operating and maintenance costs low by using a single aircraft type, and having high aircraft utilization and employee productivity. The growth of low cost airlines in the 2000s posed formidable challenges to network legacy carriers. During the economic downturns, business travelers sought cheaper alternatives to paying premium airfares on network legacy carriers, and what the low cost carriers offered during those times were especially appealing. Low cost carriers' domestic passenger share increased from 8% in 1995 to about 26% in 2010, and has since leveled off to about 33% of the total U.S. domestic passenger share⁵. Low cost carriers' financial success is due to their ability to operate at consistently low costs.

Recently, traditional low cost carriers have introduced services similar to network legacy carriers. Southwest Airlines is now servicing AirTran's international markets, and it has added a second fleet type and has been using congested airports like Newark and Philadelphia and cutting back flights in smaller and secondary airports like Albuquerque and Birmingham. Southwest has bolstered its presence in large cities such as New York and Boston in the past few years, and adding nonstop services into Los Angeles, Las Vegas, and Chicago in 2014⁶. JetBlue will be introducing its premium service Mint from N.Y.C. to L.A. in 2014. However, low cost carriers such as Spirit Airlines and Allegiant Air still maintain characteristics of the original low cost business model, and they begin to call themselves the ultra-low cost carriers⁷. These ultra-low

⁵ Swelbar, Bill. MIT Airline Industry Lecture Notes, *LCC Airlines: Cost and Productivity Convergence*, 2 October 2013. Slide 9.

⁶ Koenig, David. "Southwest Airlines to Add 20 Nonstop Flights to Major Cities including Las Vegas." *Las Vegas Review-Journal*. Las Vegas Review-Journal, 3 Feb. 2014. <<http://www.reviewjournal.com/business/southwest-airlines-add-20-nonstop-flights-major-cities-including-las-vegas>>.

⁷ "US Ultra Low-cost Airlines Capitalise on Opportunities Created by Consolidation: Part 1." Centre for Aviation, 25 June 2013. <<http://centreforaviation.com/analysis/us-ultra-low-cost-airlines-capitalise-on-opportunities-created-by-consolidation-part-1-115834>>.

cost carriers are carving out a new niche in the market by offering strictly no-frills service at rock bottom low fares.

1.1.4 2008 Financial Crisis

The financial crisis in 2008 was considered the worst financial crisis since the Great Depression, and the economic slowdown caused the airline industry to suffer immensely. In response, U.S. carriers slashed routes and grounded more than 500 airplanes, and domestic routes in the U.S. have been the hardest hit. In addition, the financial crisis pushed the airlines to cut jobs more aggressively. U.S airlines lost 54,000 jobs within two years post-recession⁸.

By the end of 2008, the International Air Transport Association (IATA) reported a 4.6% year-over-year decrease in international air passenger traffic⁹. With the decrease in demand, airlines reduced the number of domestic scheduled passenger flights. Oil prices surged since 2006, and fuel became the largest expense for all airlines. Even though the price of oil dropped in the late 2008, the significant decrease in demand due to unstable financial conditions drove major U.S. carriers unprofitable. U.S. carriers posted combined losses of about \$4.5 billion³. Southwest Airlines was the only major U.S. carrier that reported a profit in 2008 due to its success in fuel hedging.

1.1.5 A Profitable Future

Airlines accumulated massive losses during the economic recession when the demand for air travel decreased. However, as airlines continue to consolidate, reduce overcapacity, and increase operational efficiency, they have slowly regained profitability post 2008. Airlines have also been raising fares and charging additional fees for services that previously were covered in the base ticket price. The unbundling of base fares not only creates transparency for air travelers, but also allows “upselling” to passengers who are willing to pay for an improved service experience. Major U.S. airlines collected a total of \$12.4 billion from ancillary revenue alone in

⁸ BomKamp, Samantha. "US Airlines Have Lost 54K Jobs in Last Two Years." Global Travel Industry News, 11 Aug. 2010. <<http://www.eturbonews.com/17818/us-airlines-have-lost-54k-jobs-last-two-years>>.

⁹ Adams, Marilyn. "USA TODAY Today in the Sky." USA TODAY, 30 Jan. 2009. <http://usatoday30.usatoday.com/travel/flights/2009-01-29-profit-loss-airlines_N.htm>.

2012, and airlines have slowly regained their edge in profitability by recognizing and tailoring to the needs of passengers with differences in willingness to pay for goods and services¹⁰.

Major U.S. airlines reported an estimated net profit of \$1.6 billion during the first half of 2013, up from the \$1.2 billion reported in 2012 over the same period. The improvement of 2.1% profit margin prompts airlines to start adding services after years of deep cuts¹¹. U.S. carriers plan to offer 1.4% more seats by fourth quarter of 2013¹². In summary, although U.S. airlines are still vulnerable to unpredictable and uncontrollable external factors, they have evolved in the past few years to be more agile and adaptable to these external forces in order to sustain profitability.

1.2 Thesis Objective

The focus of this thesis is to examine the evolution of cost and productivity of major U.S. airlines from 2004 to 2012. Ten major passenger airlines are classified into three categories: network legacy carriers (NLCs), low cost carriers (LCCs), and ultra-low cost carriers (ULCCs). We are interested in the evolution of unit cost and productivity trends among these three categories, and these trends are compared at both the overall industry aggregate level and domestic operations level. We also explore the effect of stage length on unit cost and productivity measures for individual airlines.

¹⁰ Lewis, Alan, and Dan McKone. "HBR Blog Network." Harvard Business Review, 26 Sept. 2013. <<http://blogs.hbr.org/2013/09/how-the-u-s-airline-industry-found-its-edge/>>.

¹¹ Airlines for America. 22 Aug. 2013. <<http://www.airlines.org/Pages/U.S.-Airlines-Achieve-2-Percent-Net-Profit-Margin-in-First-Half-of-2013-and-Deliver-Solid-Operational-Performance.aspx>>.

¹² Nicas, Jack. "U.S. Airlines Add Service as Profits Grow." *The Wall Street Journal*, 22 Aug 2013. <<http://online.wsj.com/news/articles/SB10001424127887323980604579028922722699670>>.

1.3 Thesis Structure

This thesis is composed of six chapters:

In Chapter 1, we summarize the recent trends in the U.S. airline industry, present the objective and motivation of the thesis, and outline the thesis by chapter.

Chapter 2 begins with a literature review that first presents some background on the low cost business model and the recent changes in their business model and competitive strategies. We then cite previous work done on the cost and productivity comparisons for the U.S. network legacy carriers and low cost carriers. Then, we describe the data source and outline the methodology used to calculate cost and productivity measures compared in this thesis.

Chapter 3 provides detailed unit cost analysis for the three airline categories. First, we compare the three airline groups as well as individual airlines at the system level. Then, the aggregate comparisons are repeated at domestic operations level, and stage length adjusted results are compared for individual airlines.

Chapter 4 and 5 provide detailed aircraft and employee productivity analysis for the three airline categories and is structured in the same way as Chapter 3.

Finally, Chapter 6 summarizes the findings within this thesis and suggests directions for future research.

Chapter 2: Definitions and Literature Review

We begin this chapter by defining the terms used throughout the thesis in the first section. The second section is a literature review of the evolution of the low cost model and previous work done on unit cost and productivity comparisons of NLCs and LCCs. The third section presents the data source and the data set extracted and used in the unit cost and productivity analysis in the subsequent chapters. Lastly, we present the measures computed and the methodology used for aggregate and stage length adjusted analysis.

2.1 Definitions

The following terms are used throughout the thesis.

Aircraft Days (ACDays): The number of days the aircraft in service owned by an airline through either rental or lease. The total Aircraft Days of an airline is computed as the total number of aircraft multiplied by the number of days they are being used or in service.

Aircraft Operating Cost: In-flight operating expenses of an aircraft.

Aircraft Productivity per day: Aircraft output produced in total Available Seat Miles (ASMs) per Aircraft Day (ACDay).

Aircraft Utilization: Total number of block hours per Aircraft Day (ACDay).

Available Seat Mile (ASM): A measure of airlines' output capacity that is a function of seats and distance flown. The Available Seat Mile (ASM) produced per flight is computed as the total number of seats per aircraft multiplied by the distance flown for the flight.

Average Stage Length (SL): The average flight distance per aircraft from takeoff to landing. It can be derived by dividing the total aircraft miles flown in revenue service by the number of aircraft departures performed.

Block Hours (BH): The total time between aircraft door close to door open, which includes taxi times and the total flight time when the aircraft is in use. It can also be defined as the time between the aircraft's departure from the origin gate to arrival to the destination gate, or gate-to-gate time.

Domestic Operation: "All air carrier operations having destinations within the 50 United States, the District of Columbia, the Commonwealth of Puerto Rico, and the U.S. Virgin Islands¹³." The definition of this term is taken directly from the Bureau of Transportation Statistics (BTS) glossary, where the domestic operations only data for our analysis are extracted and are reported by airlines as a distinct region.

Employee Productivity: Average output produced per employee. It can be computed by dividing the total number of employees by the total Available Seat Mile (ASM) produced.

Revenue Passenger Miles (RPM): One revenue passenger transported one mile in revenue service. Revenue passenger miles are computed by multiplying the revenue aircraft miles on each flight segment by the number of revenue passengers carried on that flight segment.

Unit Cost (CASM): Total operating expenses divided by total Available Seat Mile (ASM). Total operating expense varies among airlines due to differences in capacity, size, and average distance flown, and dividing it by ASM removes these differences. Unit costs can be compared across airlines.

Labor Unit Cost: Total employee salaries and benefits divided by total Available Seat Mile (ASM).

Transport Related Expenses: expenses accrued from air transportation services, which cover a wide range of services such as expenses paid for air cargo pickup and delivery, ground restaurants, gift shop, maintenance work, and regional code-share partners carrying code-share passengers.

¹³ Bureau of Transportation Statistics (BTS) Glossary. < <http://www.transtats.bts.gov/glossary.asp>>

Wages Productivity: Total available seat mile per dollar paid in salaries and benefits to employees.

2.2 Literature Review

2.2.1 The Evolution of the Low Cost Business Model

While network legacy carriers (NLCs) have struggled to restructure and reduce operating costs to breakeven, low cost carriers (LCCs) like Southwest Airlines have been profitable by consistently operating at costs below their revenue. Southwest Airlines pioneered the low cost business model, and the model has demonstrated success and profitability. Numerous other low cost airlines around the world have mimicked and implemented some, if not all, of Southwest Airlines' low cost strategy.

The product features of Southwest Airlines' original business model include¹⁴:

- Low fares
- Ticketless, avoided traditional distribution channels
- No frequent flier program
- Single cabin service, no in-flight entertainment, reduced "frills", and no seat assignment

The operating features of Southwest Airlines' original business model include:

- Point-to-point service
- Single aircraft type, high aircraft utilization
- Competitive labor wages, high labor productivity
- Utilization of secondary airports

¹⁴ Alamdari, Fariba, and Simon Fagan. "Impact of the Adherence to the Original Low-cost Model on the Profitability of Low-cost Airlines." *Transport Reviews* 25.3 (2005): 377-92.

As LCCs continue to grow in size and increase their market share, Some LCCs, when faced with strong incentives to differentiate among themselves, have since evolved and deviated from the original business model, and even Southwest's business model has changed. Ryanair is the only low cost carrier that completely adheres to Southwest Airlines' original business model¹⁵. JetBlue Airways is known for its in-flight entertainment and leather seats. JetBlue, Frontier and Southwest Airlines offer drinks and snacks in-flight and have their own frequent flyer programs. Frontier Airlines has a full hub-and-spoke system. Southwest exhibited high utilization and productivity by using uncongested secondary airports and point-to-point passenger service, but it has been expanding their network into mainstream cities. As their network continues to grow, their entire network is centered in their major focus cities and begins to resemble a hub-and-spoke network. Even though Southwest's CEO assures the public that Southwest still has a point-to-point network, the percent of its direct flights decreased from 80% in 2004 to 70% in 2012¹⁶. Also a low cost carrier, Frontier Airlines has a full hub-and-spoke system. While Southwest and Virgin offer online facility to travel agents at a reduced commission, JetBlue, Frontier, and Spirit sell their seats through travel agents via the Global Distribution System (GDS). Many LCCs now have mixed aircraft types.

Alamdari and Fagan⁴ performed a detailed study of ten major LCCs with specific regard to the product and operational features of Southwest Airlines' original business model, and found evidence that suggests a strong correlation between a carrier's adherence to the original low cost business model and profitability. The original low cost model was based on cost leadership, and deviations from it would not enhance LCCs' ability to capture the additional revenue for the added service offerings. They found that product differentiation does not lead to an increase in yield and higher profit margins, and the revenue benefit from additional service is marginal. The study shows that European LCCs, such as Ryanair, tend to adhere more closely to the original model to secure competitive cost advantage and lucrative profit margins. In addition, Francis, Humphreys, Ison, and Aickien¹⁷ in their assessment of LCCs' patterns of growth and expansion

¹⁵ Swelbar, Bill. MIT Airline Industry Lecture Notes, *LCC Airlines: Cost and Productivity Convergence*, 2 October 2013. Slide 6.

¹⁶ Nicas, Jack. "As Southwest Goes Mainstream, Will Direct Flights Go Extinct?" Corporate Intelligence RSS. Wall Street Journal, 2 Apr. 2014. <<http://blogs.wsj.com/corporate-intelligence/2014/04/02/as-southwest-goes-mainstream-will-direct-flights-go-extinct/>>.

¹⁷ Francis, G., I. Humphreys, S. Ison, and M. Aicken. "Where next for Low Cost Airlines? A Spatial and Temporal Comparative Study." *Journal of Transport Geography* 14.2 (2006): 83-94.

globally concluded that those LCCs, who have only adopted some, but not all, of the low cost features of the Southwest's model and started from scratch, have a higher chance to fail.

Most recently, Spirit Airline has become the forerunner of a new breed of LCCs, the ultra-low cost carriers (ULCCs). In Spirit's CEO Ben Baldanza's own words¹⁸, "Spirit was a low cost airline but not low cost enough and was competing in a space that was very saturated with other competitors. We looked at everyone in the industry. Where are the characteristics of airline that make money all the time? The answer was low fare, low cost companies such as Ryanair, AirAsia and Southwest Airlines." Baldanza stressed that smaller U.S. airports are favorable areas of growth. Spirit will be replacing 28 aircraft, 26 A319s and 2 A321s, with dense and single class configured 178 seat A320s, and will end up with a single fleet type to increase cost efficiency and utilization¹⁹. In addition, Spirit offers no inflight entertainment, uses unbundled pricing, and offers additional service upon passengers' request to acquire ancillary revenue. Similarly, Allegiant Air has followed Spirit's ultra-low cost business model, and it keeps cost low by operating older MD80 aircraft with low ownership costs and services small to mid-sized U.S. cities to leisure markets. Allegiant Air also maximizes its ancillary revenue by partnering with third parties and offers vacation, car rental, and hotel deals. Recently, Frontier Airlines has positioned itself as an ULCC and has begun making changes to its business model to be more like Spirit, and these changes include imposing new fees and cutting back on its frequent flyer benefits²⁰.

Southwest and JetBlue have adopted more traditional NLCs' traits, while Spirit, Allegiant, and Frontier have more traits of Southwest's original low cost business. These ULCCs target the niche budget traveler market, untouched by NLCs and other LCCs, by pricing at lowest possible rate, and increase profit by unbundling their product and maximizing their ancillary revenue.

¹⁸ Arnoult, Sandra. "How Low Can You Go?" Air Transport World Dec. 2007: 63-65.

¹⁹ Yeo, Ghim-Lay. "INTERVIEW: Spirit Airlines Chief Executive Ben Baldanza." INTERVIEW: Spirit Airlines Chief Executive Ben Baldanza. N.p., 26 Apr. 2012. <<http://www.flightglobal.com/news/articles/interview-spirit-airlines-chief-executive-ben-baldanza-371158/>>.

²⁰ Winship, Tim. "Frontier Eyes Future as 'Ultra-Low-Cost Carrier'" Frontier Eyes Future as 'Ultra-Low-Cost Carrier' - SmarterTravel.com. N.p., 3 Oct. 2013. <<http://www.smartertravel.com/blogs/today-in-travel/frontier-eyes-future-as-ultra-low-cost-carrier.html?id=16309111>>.

2.2.2 Cost Comparisons of NLCs vs. LCCs

As their business models further evolve, LCCs rapidly increased their market share on short-haul routes, and they have faced cost challenges associated with network expansion, increase labor seniority, and aging fleets, while NLCs have made significant changes in their operational strategies to address their cost and productivity issues to stay competitive. The unit cost and productivity gap between NLCs and LCCs has narrowed.

A large number of studies have been performed comparing NLCs and LCCs, and these studies involve extensive comparisons of the differences between NLCs' and LCCs' network structure, operations, and product features, as well as analysis of the evolution of the two carrier groups. These studies focused on figuring out why LCCs have been so successful in the past decade. All of these studies attribute LCCs' financial success to their efforts keeping their operating costs low and productivities high.

Rigas Doganis²¹ found that although LCCs' unit revenues were similar to other NLCs competing in the same regions or markets, LCCs operated at a cost level 28-50 percent lower than NLCs. It was the difference in unit cost that made LCCs significantly more profitable. Doganis summarized the main drivers of LCCs' cost advantages over NLCs' and the impact of these advantages:

Operating advantages – 27% cost reduction

- Higher seating density
- Higher aircraft utilization
- Lower flight and cabin crew costs
- Use of cheaper secondary airports
- Outsourcing maintenance
- Usage of single aircraft type

²¹ Doganis, Rigas. *The Airline Business, Second Edition*, Routledge, 2006. p152.

Product/ service features – 12% cost reduction

- Minimal station costs and outsourced handling
- Fewer passenger services

Differences in distribution – 9% cost reduction

- No agents or GDS commissions
- Reduced sales/reservation costs

Other advantages – 3% cost reduction

- Smaller administration and fewer staff/offices

Markus Franke²² summarized several challenges NLCs faced when competing with LCCs. NLCs have to respond to the challenge without weakening the competitive position compared to other network carriers serving the same markets. NLCs have little success capturing the demand stimulated by LCCs upon market entry, and they face declining yield levels from losing their premium passengers. Franke emphasized NLCs' need to restructure and consolidate their operational platforms, to reduce overcapacity and resources to increase efficiency, and to shift their focus to international markets to expand and secure a robust international destination portfolio to compensate the loss of revenue in the domestic markets. Hansen et al.²³ agreed with Franke but added the need to retain NLCs' advantage over LCCs, which include the large network coverage, superior customer loyalty programs, and onboard services. Hansen et al. predicted that the network carriers could potentially close about 60-80% of the cost gap from restructuring without abandoning their hub and spoke system but to increase efficiency without deterioration in service levels and decrease in network coverage.

Gerassimos Tsoukalas' Master's thesis examined the extent of such convergence in unit cost between the two groups from 1995 to 2006²⁴. Tsoukalas found that fuel and transport related

²² Franke, Marcus. "Competition between Network Carriers and Low-Cost Carriers: retreat Battle or Breakthrough to a New Level of Efficiency?" *Journal of Air Transport Management* 10.1 (2004): 15-21. Print.

²³ Hansson, T., Ringbeck, J., Franke, M., 2003. "Flight for survival: a new business model for the airline industry." *Strategy + Business*, Issue 31: 78-85. < <http://www.strategy-business.com/article/21966?pg=all>>

²⁴ Tsoukalas, Gerassimos, *Convergence in the US Airline Industry: A Unit Cost and Productivity Analysis*, Department of Aeronautics and Astronautics Thesis, MIT. 27 Aug, 2007.

expenses were the dominant factors that were driving up the unit cost of NLCs, and fuel expense was the main cause for the increase in unit cost for LCCs. While seeing no significant change in non-labor unit cost gap between NLCs and LCCs, the greatest convergence between NLCs and LCCs was labor unit cost, which decreased by 83.3% from 2002 to 2006. This convergence was mainly due to NLCs' massive employee layoffs and pay cuts post 2001 and LCCs' increased employee seniority and age of their fleets. The labor unit cost convergence showed NLCs' effective cost cutting strategies, and NLCs reached a significant competitive level in labor cost with LCCs by 2006.

Before Tsoukalas' analysis, Taneja foresaw the convergence of legacy carriers and low cost carriers' models, as legacy carriers achieve competitive costs from structuring of their operations and gain help from bankruptcy protection and labor concessions and low cost carriers continue to expand and slowly adopt more and more of legacy carriers' traits²⁵. Similar to Tsoukalas' findings, a study done by IATA in 2006 also concluded a closing in overall stage length adjusted unit cost gap between U.S. NLCs and LCCs, and most significantly for labor unit cost²⁶. More recent cost gap studies performed by Oliver Wyman, which involved five consecutive years of analysis on unit cost gap between NLCs and LCCs, found that domestic unit cost gap has been converging. In Oliver Wyman's 2013 study, they compared unit cost gaps between NLCs and LCCs, and LCCs and ULCCs. They found that the domestic unit cost gap between NLCs and LCCs has closed to all time low, and the unit cost gap between LCCs and ULCCs has been increasing²⁷. In addition, they found that legacy carriers' unit costs have been increasing at a much slower rate than low cost carriers', and noted that fuel cost and hedging have not been substantial factors in costs because the volatility of fuel prices in the recent year has been low. Another unit cost study done by KPMG showed the dramatically narrowing of unit cost gap between NLCs and LCCs²⁸. From their analysis, KPMG concluded that the remaining unit cost difference between NLCs and LCCs is structural in nature. In 2013, KPMG predicted that legacy carriers will continue to explore new business strategies in their short haul networks,

²⁵ Taneja, N.K., 2004. *Simpli-Flying: Optimizing the Airline Business Model*, Ashgate, p70.

²⁶ Pearce, B., Smyth, M., *Airline Cost Performance, IATA Economics Briefing No. 5*, International Air Transport Association, Jul, 2006. < http://www.iata.org/whatwedo/Documents/economics/airline_cost_performance.pdf>.

²⁷ Oliver Wyman, *Airline Economic Analysis*, Nov, 2013. < http://www.oliverwyman.com/content/dam/oliverwyman/global/en/files/archive/2013/2013_Airline_Economic_Analysis.pdf>.

²⁸ KPMG, *2013 Airline Disclosures Handbook*, 2013.

<<https://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/airline-disclosures-handbook-2013-v2.pdf>>.

and low cost carriers will split into two distinct groups: those that remain strictly low cost and offer low fares, and those that compete with legacy carriers for their higher value customers.

Although the above mentioned studies arrived at the same conclusion, different methodologies were used for each analysis. It is the goal of this thesis to continue Tsoukalas' detailed and comprehensive study on unit cost and productivity. Our analysis uses Tsoukalas' methodology but covers the time period from 2004 to 2012. In this thesis, we separate traditional low cost carriers into two groups: those that adopted network legacy carrier traits, LCCs; and those that remain strictly low cost, ULCCs.

2.3 Sources and Dataset

For this thesis, airlines' Form 41 filings to the U.S. Department of Transportation and the Securities and Exchange Commission are used to extract all of the financial and operating data needed for this thesis. Annual aggregate data for each airline is extracted directly from Bureau of Transportation Statistics' website.

Below is the complete list of measures along with the schedule from which they were extracted:

Schedule P-1.2: Statement of Operations for Carriers with Annual Operating Revenues of \$20 Million or More

- Transport Related Expenses
- Total Operating Expenses

Schedule P-5.2: Aircraft Operating Expenses

- Flight Operations – Aircraft Fuel Expenses

Schedule P-6: Employee Salaries and Benefits for Carriers with Annual Operating Revenues of \$20 Million or More

- Total Salaries and Fringe Benefits

Schedule P-10: Annual Employee Statistics

- Total Employees (Full Time and Part Time)

Schedule T-2: U.S. Carrier Traffic and Capacity Statistics for Scheduled and Non-Scheduled Services

- Total Available Seat Miles (ASMs)
- Total Revenue Passenger Miles (RPMs)
- Revenue Air Miles – total miles flown
- Departure Performed – total number of aircraft departures performed
- Block Hours – total time between aircraft door close to door open
- Aircraft Days – carrier equipment aircraft days

Schedule T-3: U.S. Air Carrier Airport Activity Statistics

- Total Number of Passengers

Reporting changed due to airline mergers, and joint reporting began after Federal Aviation Administration's approval of a single operating certificate.

- Jan. 2006: US Airways (US) and America West (HP) start to report combined on-time data in January 2006 as US Airways (US).
- Oct. 2007: US Airways (US) and America West (HP) start to report combined traffic and financial data as US Airways (US).
- Jan. 2010: Delta (DL) and Northwest (NW) start to report jointly as Delta (DL).
- Jan. 2012: United (UA) and Continental (CO) start to report jointly as United (UA).

2.4 Methodology

2.4.1 Airline Group Selection

We classify major U.S. carriers into three categories:

Network Legacy Carriers (NLCs) – Airlines with large multi-hub-and-spoke networks, known for the breadth of both global and domestic network, offer premium and coach service classes.

- Delta Airlines (DL)
- United Airlines (UA)
- American Airlines (AA)
- US Airways (US)

Low Cost Carriers (LCCs) – Airlines offer lower fares than NLCs and have a lower cost structure. These airlines have a hybrid business model with both traits of the low cost carrier and full service network legacy carrier. Their network structure is still smaller and less extensive than NLCs’.

- Southwest Airlines (WN) + AirTran Airways (FL)
- JetBlue Airways (B6)
- Virgin America (VX)

Ultra-Low Cost Carriers (ULCCs) – Airlines that achieve unit costs among the lowest in the airline industry, strictly “no frills” service, and unbundled fare structure.

- Spirit Airlines (NK)
- Frontier Airlines (F9)
- Allegiant Air (G4)

Although these airlines are classified using the above definitions for the three categories, not all of the airlines under each category satisfy all characteristics defined. The airlines under each group are selected because they are most representative of these characteristics.

2.4.2 Measures Computed

Using the measured extracted from Form 41 above, the CASM, employee and aircraft productivity are computed as follows:

Unit Cost (CASM) Related

- CASM ex. Transport Rel. Expenses =
$$\frac{\text{Total Operating Expenses} - \text{Transport Related Expenses}}{\text{Total ASMs}}$$
- CASM ex. Transport Rel. & Fuel Expenses =
$$\frac{\text{Total Operating Expenses} - \text{Transport Related Expenses} - \text{AC Fuel Expenses}}{\text{Total ASMs}}$$
- CASM Labor =
$$\frac{\text{Total Salaries and Fringe Benefits}}{\text{Total ASMs}}$$
- CASM Non-Labor =
$$\frac{\text{Total Operating Expenses} - \text{Transport Related Expenses} - \text{AC Fuel Expenses} - \text{Total Salaries}}{\text{Total ASMs}}$$

Aircraft Productivity Related

- Utilization =
$$\frac{\text{Block Hours}}{\text{Aircraft Day}}$$
- Aircraft Productivity =
$$\frac{\text{Total ASMs}}{\text{Aircraft Day}}$$

Employee Productivity Related

- Employment = Total Number of Employees
- Average Salary per Employee =
$$\frac{\text{Total Salaries \& Fringe Benefits}}{\text{Total Number of Employees}}$$

- Employee Productivity = $\frac{\text{Total ASMs}}{\text{Total Number of Employees}}$
- Wage Productivity = $\frac{\text{Total ASMs}}{\text{Total Salaries \& Fringe Benefits}}$
- Passenger to Employee Ratio = $\frac{\text{Total Number of Passengers}}{\text{Total Number of Employees}}$

2.4.3 Aggregation Methods

The system aggregate numbers for each airline group is calculated by summing up the totals for each measure for all the airlines in that group. The cost and productivity measures are then computed from these system aggregates. These aggregates are done per year since all of the data extracted from Bureau of Transportation Statistics are annual numbers.

Take the calculation for NLCs' group yearly Labor CASM for example:

$$NLC \text{ Labor CASM} = \frac{\sum_{i=1}^4 \text{Total Salaries \& Benefits}}{\sum_{i=1}^4 \text{Total ASM s}}$$

The sum of total salaries and benefits of United Airlines, Delta Airlines, American Airlines, and US Airways is divided by the sum of total ASM of these four carriers for that specific year to obtain a group "average". The same computations are repeated for all the cost and productivity measures for the LCC and ULCC groups and are used for airline aggregate group comparisons.

2.4.4 Regression Analysis for Stage Length Adjustment

For the stage length adjusted aircraft and employee productivity analysis, the linear regression model is used to fit the curve between average stage length and various cost and productivity variables analyzed in this thesis, which are extracted at the system level. The intent is to normalize these variables in order to compare results assuming all carriers fly the same mission.

Linear Regression Model:

The general additive multiple regression model equation is used:

$$Y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \dots + \beta_kx_k + \epsilon = \beta_0 + \sum_{i=1}^k \beta_ix_i + \epsilon$$

Where β_i s are the regression coefficients and estimated using the least squares method, x_i s are the explanatory variables, and ϵ is the error.

Example: Stage Length Adjusted Aircraft Productivity (2012)

Minitab is used to fit aircraft productivity versus stage length for all 10 airlines, and for this example, the linear regression analysis of our sample data yields a slope of 389.9 and an intercept of 206,952 ASM/ACDay.

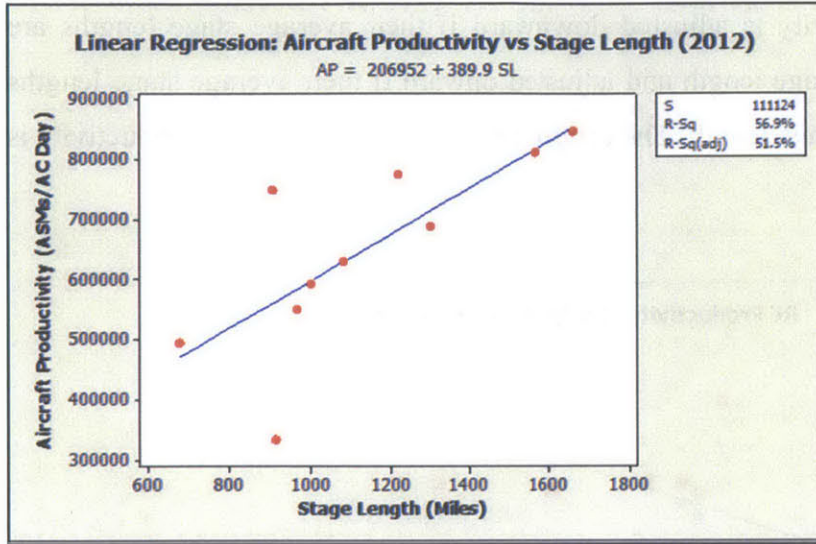
Regression Analysis: 2012 AP versus 2012 SL

The regression equation is
2012 AP = 206952 + 389.9 2012 SL

S = 111124 R-Sq = 56.9% R-Sq(adj) = 51.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	1.30178E+11	1.30178E+11	10.54	0.012
Error	8	9.87878E+10	1.23485E+10		
Total	9	2.28965E+11			



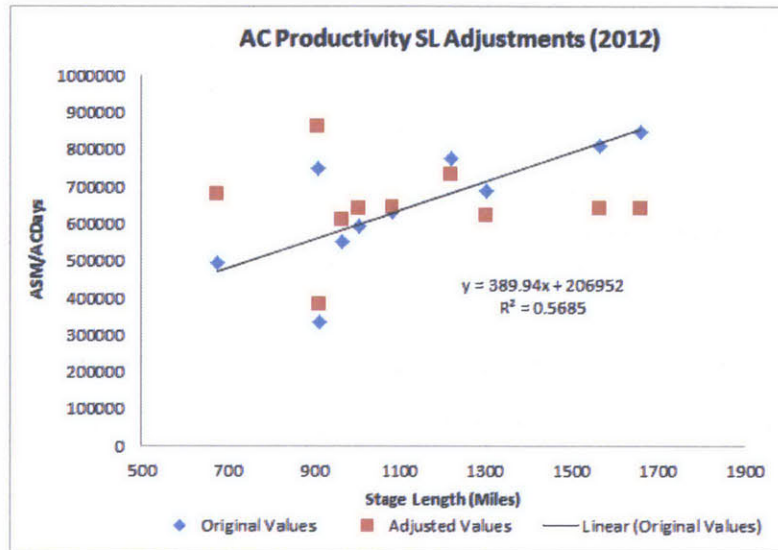
Applying the linear approximation for our sample data set, absolute and percent errors are calculated and are applied to the computation of adjusted aircraft productivity as follows for individual airlines:

$$ACP_{SLadj} = E \left[\frac{ASMs}{Day} \right] \times (1 + \%error)$$

Where the $E \left[\frac{ASMs}{Day} \right]$ is the expected industry aircraft productivity calculated using the average stage length of the sample, 1130 miles, in the linear regression.

Airline	ASM/ACDays AC Productivity 2012	SL 2012	E[ASMs/Day]	Abs(error)	%(error)	SLadj_ASMs/Day
American Airlines	687939	1302	714606	-26667	-3.7%	623509
Continental Airlines						
Delta Airlines	776086	1221	682940	93146	13.6%	736015
Northwest Airlines						
US Airways	592894	1004	598358	-5463	-0.9%	641765
United Airlines	847558	1661	854452	-6893	-0.8%	642453
AirTran Airways						
JetBlue Airways	629959	1083	629199	760	0.1%	648461
Southwest Airlines	495568	678	471194	24374	5.2%	681182
Virgin America	811420	1567	818056	-6636	-0.8%	642425
Allegiant Air	334642	913	563084	-228442	-40.6%	384917
Frontier Airlines	551528	966	583564	-32036	-5.5%	612123
Spirit Airlines	749675	909	561334	188341	33.6%	864990
		0	647679			
	Average SL	1130	647679			

Airlines' aircraft productivity is adjusted downward if their average stage lengths are greater than the sample average stage length and adjusted upward if their average stage lengths are less than the sample average stage length. The original versus adjusted aircraft productivity is shown in the figure below.



Chapter 3: Unit Cost Analysis

Results from our unit cost analysis are presented in this chapter. The first section of this chapter explains the adjustments made to the total operating expenses in order to have an unbiased comparison of unit costs across airlines. The second section examines the overall industry trends at the system aggregate level comparing unit costs of network legacy carriers (NLCs), low cost carriers (LCCs), and ultra-low cost carriers (ULCCs) and at the individual airline level. The third section presents results from comparisons of unit costs from domestic operations only, and the fourth section shows results from comparisons of unit costs for individual airlines after stage length adjustments.

3.1 Unit Cost Adjustments and Break Down

Before we begin the unit cost analysis, total operating expenses reported in Form 41 for all airlines were adjusted to exclude transport related expenses. Transport related expenses, by definition, are “all expense items applicable to the generation of transport-related revenues of all classes of traffic in scheduled and nonscheduled service”²⁹. These transport-related expenses are accrued from air transportation services performed by air carriers and cover a wide range of services including expenses paid for air cargo pickup and delivery, ground restaurant, gift shop, maintenance work, and regional code-share partners carrying code-share passengers³⁰. NLCs incur these expenses more than LCCs and ULCCs do, because most NLCs have cargo operations and are more reliant on regional carriers for providing connecting service to regional locations. Since transport related expenses do not contribute to the airlines’ production of ASMs and do not reflect airlines’ operational cost efficiency. Therefore, the transport related expenses are excluded in our analysis.

Another factor that can lead to biased unit cost comparisons across all airlines is fuel expenses. Fuel expenses, by definition, are “cost of aviation fuel used in flight operations, excluding taxes, transportation, storage, and into-plane expenses”²⁹. The emergence of financial

²⁹ Bureau of Transportation Statistics (BTS) Glossary. < <http://www.transtats.bts.gov/glossary.asp>>

³⁰ US DOT Form 41 Airline Operational Cost Analysis Report Definitions

hedging tools has allowed airlines to gain control of their fuel expenses. Successful fuel hedging protects airlines from volatility and potential surges in fuel prices during the contractual period and places these airlines at a cost advantage over others. Airlines can employ different hedging strategies and pay different fuel prices. Removing fuel expenses levels the playing field for comparing remaining unit costs among airlines.

After transport related and fuel expenses are removed from the total operating cost, the remaining cost can be divided into non-labor and labor costs. Labor Costs are the total salaries and fringe benefits paid to full time and part time employees. Non-labor costs consist of all other direct and indirect operating costs that are not transport, fuel, and labor related, and these costs include hub operations, aircraft maintenance and overhaul, airport charges, sales and promotion, passenger servicing, and general administrative costs. We focus our comparisons on the labor and non-labor unit costs for aggregate groups and individual airlines. Both the labor and non-labor costs are directly linked to the production of capacity output, ASMs, and they indicate cost efficiency and productivity of labor and non-labor inputs.

3.2 System Aggregate Industry CASM

3.2.1 Aggregate Industry CASM comparisons for NLCs, LCCs, and ULCCs

In this section, we present the general trends of the system aggregate unit costs for NLCs, LCCs, and ULCCs from 2004 to 2012. Our analysis starts from total unit costs excluding transport related expenses and breaks down further into labor and non-labor unit cost components. We focus on examining the differences in unit costs among the three aggregate groups and how these differences have evolved over time.

Figure 1 presents the trends of unit cost excluding transport related expenses ($CASM_{exT}$) of the three groups. The $CASM_{exT}$ of all three groups increased in two periods, from 2004 to 2008 and from 2009 to 2012, but decreased sharply between 2008 and 2009. Overall from 2004 to 2012, $CASM_{exT}$ increased by 42% for NLCs, 74% for LCCs, and 39% for ULCCs. LCCs had the largest percent growth in $CASM_{exT}$.

In 2004, the $CASM_{exT}$ gap between NLCs and LCCs was 2.66 cents/ASM and narrowed to 1.93 cents/ASM in 2006. This cost gap converged further in 2009, down to 0.93 cents/ASM, and diverged to 1.36 cents/ASM from 2009 to 2012. LCCs were trending almost parallel to NLCs from 2009 to 2012. The unit cost convergence in 2009 was due to NLCs' significant cost cuts in response to the 2008 financial crisis. NLCs' unit cost had the most significant drop of 10% from 2008 to 2009.

ULCCs' $CASM_{exT}$ dropped below LCCs' in 2006 and trended consistently lower than LCCs' since then. The $CASM_{exT}$ gap between LCCs and ULCCs grew from 0.04 cents/ASM in 2006 to 1.21 cents/ASM in 2012. The $CASM_{exT}$ gap between NLCs and ULCCs grew from 1.58 cents/ASM in 2009 to 2.57 cents/ASM in 2012.

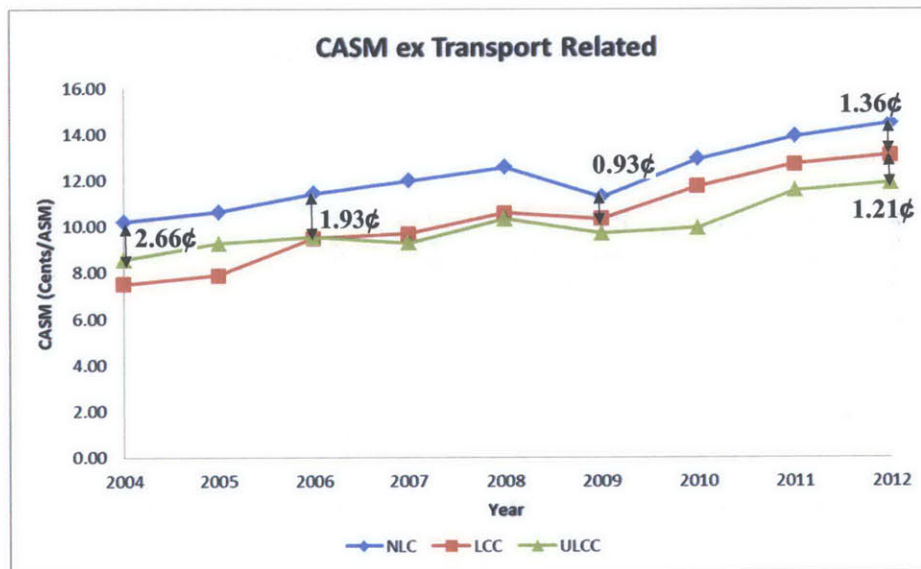


Figure 1 System Aggregate Comparison: CASM ex Transport Rel.

Figure 2 shows unit cost excluding both fuel and transport related expenses, $CASM_{exTF}$, of the three groups. From 2004 to 2012, $CASM_{exTF}$ increased by 16% for NLCs, 41% for LCCs, and 11% for ULCCs. Both NLCs' and ULCCs' trends are flatter than LCCs' when fuel costs are excluded, which suggest that the rise in fuel prices affected NLCs and ULCCs more than it did on LCCs. In Figure 1, the dip in $CASM_{exT}$ occurred in 2009, but in Figure 2 the dip in $CASM_{exTF}$ occurred in 2008. In 2008, the aggregate groups' $CASM_{exTF}$'s drop from $CASM_{exT}$ is 5.12

cents/ASM for NLCs, 3.76 cents/ASM for LCCs, and 4.41 cents/ASM for ULCCs. Clearly, NLCs were hit the hardest by the surge in fuel prices in 2008.

The $CASM_{exTF}$ gap between NLCs and LCCs converged from 2.17 cents/ASM in 2004 to 0.60 cents/ASM in 2008 and diverged to an average of 1 cent/ASM from 2009 to 2012. LCCs have been trending almost parallel to NLCs since 2009, and do not seem to have the unit cost advantage over NLCs as they had before 2008. The $CASM_{exTF}$ gap between LCCs and ULCCs converged to 0.35 cents/ASM in 2009 but diverged to 1.12 cents/ASM in 2012. The $CASM_{exTF}$ gap between ULCCs and NLCs grew from 1.09 cents/ASM in 2009 to 2.13 cents/ASM in 2012. The divergence in cost gaps between ULCCs and the other two groups suggests the significant unit cost advantage ULCCs have over the other two groups.

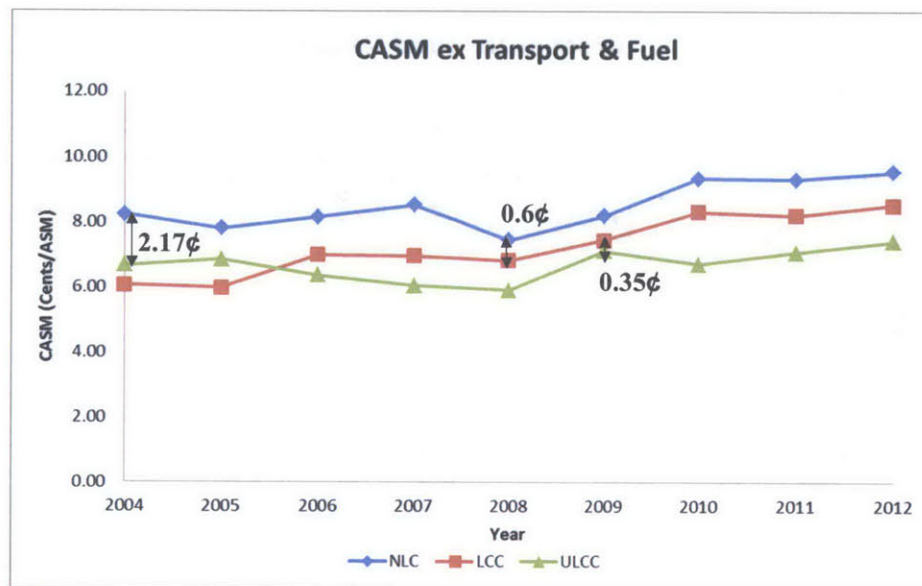


Figure 2 System Aggregate Comparison: CASM ex Transport Rel. & Fuel

To breakdown the unit cost further, Figure 3 shows the non-labor unit cost of the three groups. From 2004 to 2012, the overall $CASM_{Non-Labor}$ increased by 29% for NLCs, 60% for LCCs, and 21% for ULCCs. The significant growth in LCCs' $CASM_{Non-Labor}$ was due to LCCs' aggressive network expansion and aircraft purchases, adding new aircraft to existing fleets and introducing flights to new markets, and LCCs' increase in non-labor related costs outpaced their production in additional ASMs. NLCs' $CASM_{Non-Labor}$ grew at a comparable rate as LCCs' from 2004 to 2007, but it dropped by 21.3% from 5.24 cents/ASM in 2007 to 4.12 cents/ASM in 2008.

In response to the economic crisis in 2008, NLCs cut unprofitable routes and reduced flight frequency and capacity mainly in US domestic markets, which resulted in the shrinkage of their network and the decrease in their hub operations. NLCs' non-labor CASM dropped at a much steeper rate than the decrease of their total ASMs. In addition, the surge in fuel prices in 2008 caused many legacy carriers to retire older aircraft and place orders for more fuel efficient aircraft. From 2008 to 2010, NLCs' $CASM_{Non-Labor}$ increased by 37.8% and leveled at 5.6 cents/ASM ever since. The $CASM_{Non-Labor}$ gap between NLCs and LCCs narrowed from 1.27 cents/ASM in 2004 to 0.3 cents/ASM in 2008, a 76% reduction, but grew to about 0.8 cents/ASM in 2010. ULCCs' $CASM_{Non-Labor}$ decreased by 11% from 2004 to 2008 and fluctuated about 5 cents/ASM between 2008 and 2012. In general, NLCs' non-labor unit cost is higher than LCCs' and ULCCs', because of structural differences such as NLCs' expansive route network and complex hub-and-spoke network structure.

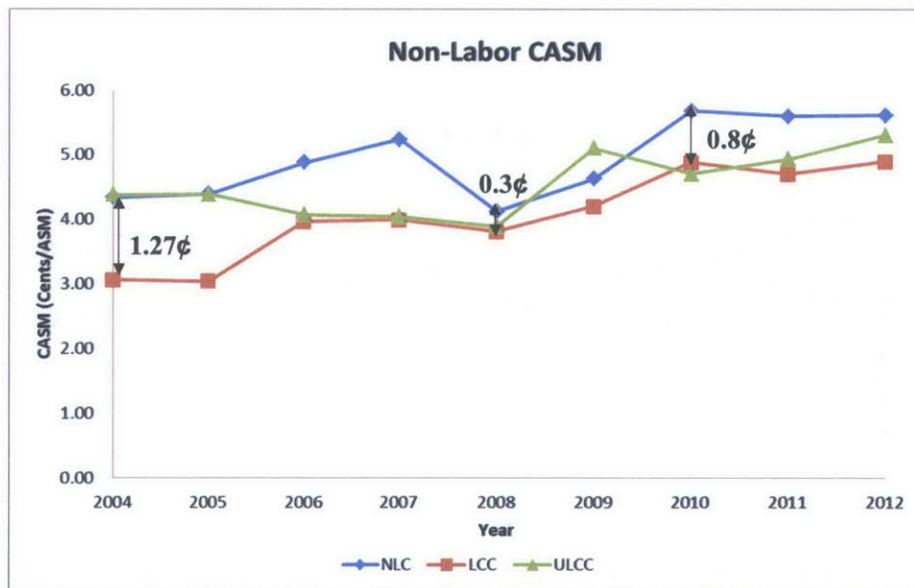


Figure 3 System Aggregate Comparison: Non-Labor CASM

Figure 4 shows the $CASM_{Labor}$ of the three groups. Many legacy carriers went through deep labor cuts in the early 2000s, which brought down the labor unit cost significantly by 16.3% from 3.9 cents/ASM in 2004 down to 3.26 cents/ASM in 2008. However, NLCs' $CASM_{Labor}$ slowly increased to 3.94 cents/ASM in 2012, a 1% increase from 2004. LCCs' $CASM_{Labor}$ stayed

around 3 cents/ASM from 2004 to 2008, but increased by 21% from 3 cents/ASM in 2008 to 3.63 cents/ASM in 2012. As LCCs' workforce age, the increase in LCCs' $CASM_{Labor}$ is expected. On the contrary, ULCCs' $CASM_{Labor}$ decreased by 7% from 2.27 cents/ASM in 2004 to 2.11 cents/ASM in 2012.

Overall, the changes in $CASM_{Labor}$ of each of the groups aren't dramatic, but there is a converging trend in cost gap between NLCs and LCCs and a diverging trend in cost gap between ULCCs and the other two groups. The $CASM_{Labor}$ gap between NLCs and LCCs decreased from 0.9 cents/ASM in 2004 to 0.25 cents/ASM in 2006 and stayed constant at about 0.3 cents/ASM since. The $CASM_{Labor}$ gap between ULCCs and LCCs increased from 0.49 cents/ASM in 2005 to 1.52 cents/ASM in 2012, and the $CASM_{Labor}$ gap between ULCCs and NLCs increased from 0.95 cents/ASM in 2005 to 1.83 cents/ASM in 2012. In 2012, ULCCs' $CASM_{Labor}$ was about half of that of NLCs. ULCCs have significant labor unit cost advantage over the other two groups, and this is mainly because ULCCs have younger fleets and relatively less senior labor force.

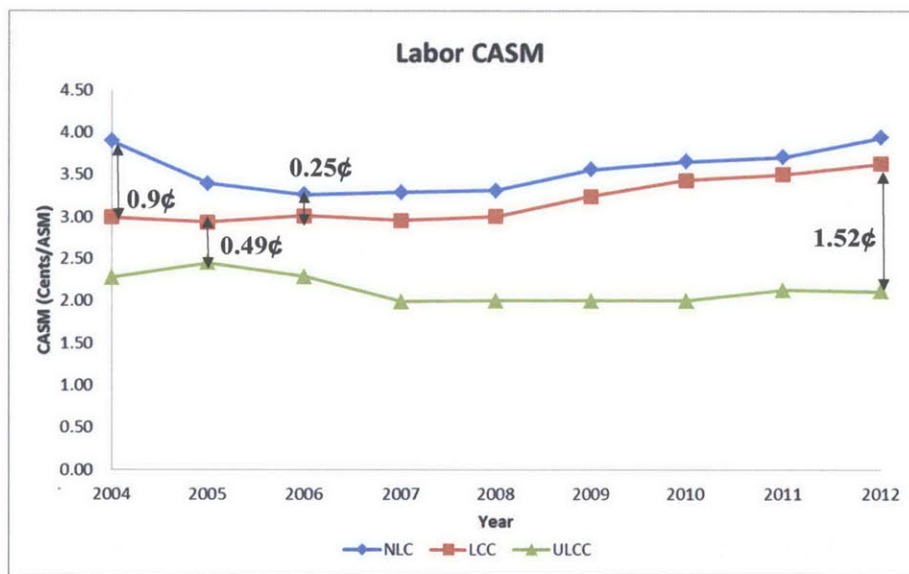


Figure 4 System Aggregate Comparison: Labor CASM

Figure 5, Figure 6, and Figure 7 show the breakdown of $CASM_{exT}$ into percent contributions from fuel, labor, and non-labor costs. Similar to what was found previously in the trend charts, NLCs and ULCCs were most affected by the surge in fuel prices from 2004 to 2008,

and they had more significant changes in cost structure. NLCs' fuel expenses grew from 19% of their total $CASM_{exT}$ in 2004 to 41% of the total in 2008, and ULCCs' fuel expenses grew from 22% of their total $CASM_{exT}$ in 2004 to 43% of their total in 2008. When the fuel prices decreased in 2009 and 2010, fuel expenses decreased for all three groups during those two years, but ULCCs were still about 4-5% higher in fuel cost contribution than the other two groups in 2011 and 2012.

The percent non-labor unit cost contribution to total $CASM_{exT}$ for all three groups was lowest in 2008, and this was mainly because of the higher proportion of fuel expenses that year. NLCs' and LCCs' non-labor unit cost contribution fluctuated about 40% in other years, while ULCCs' fluctuated about 46%.

Although ULCCs had the highest percent contributions for both the fuel and non-labor costs to the total $CASM_{exT}$, they had the lowest percent contribution for labor costs to the total $CASM_{exT}$. The average percent labor cost contribution was about 22% of the total $CASM_{exT}$, while both NLCs and LCCs averaged about 10% to 12% higher. As noted previously, NLCs' efforts in labor cuts in the early 2000s reduced labor unit cost from 38% of the total $CASM_{exT}$ in 2004 to 26% of the total in 2006. LCCs' percent contribution for labor cost averaged about 30%.

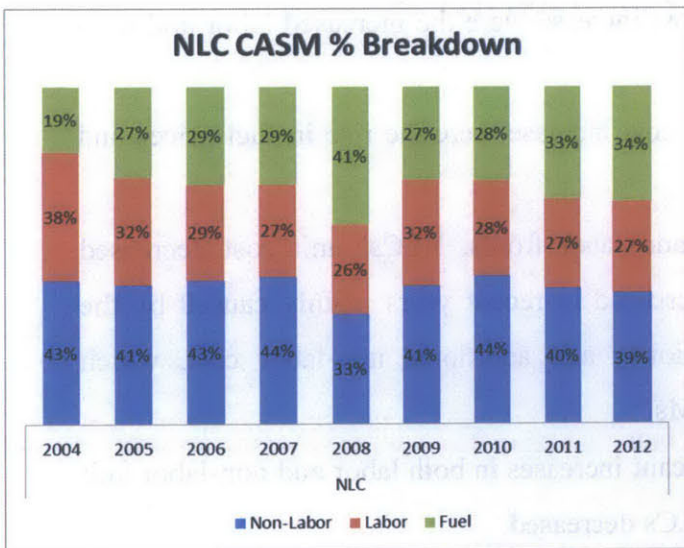


Figure 5 NLCs CASM Breakdown

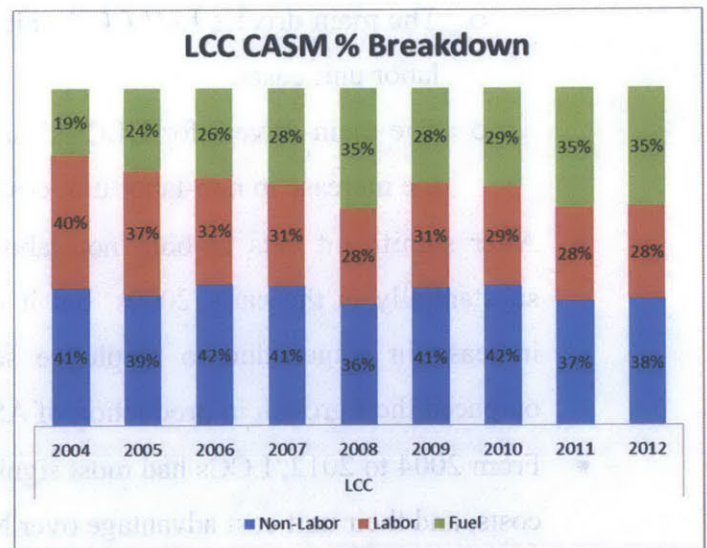


Figure 6 LCCs CASM Breakdown

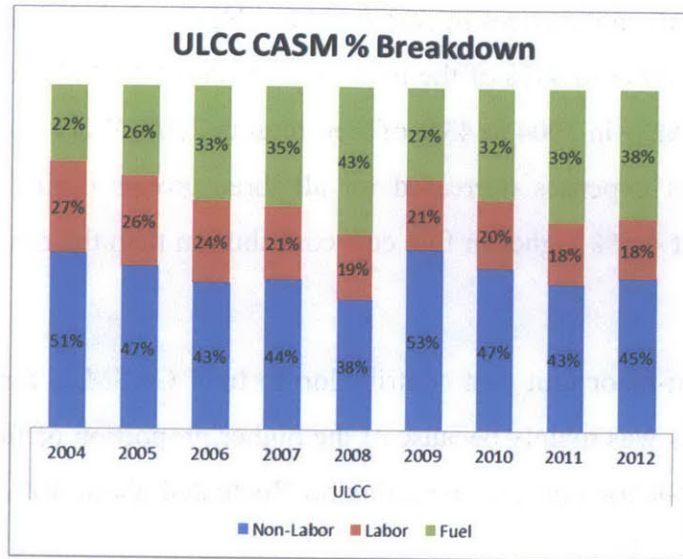


Figure 7 ULCCs CASM Breakdown

Summary:

- At the system aggregate level with transport related expenses excluded from the total operating cost, all three groups' unit costs increased from 2004 to 2012: NLCs by 42%, LCCs by 74%, and ULCCs by 39%.
 - The main drivers for NLCs' unit cost increase were the rise in fuel prices and the increase in non-labor unit cost.
 - The main drivers for LCCs' unit cost increase were the increased labor and non-labor unit costs.
 - The main drivers for ULCCs' unit cost increase were the rise in fuel prices and the increase in non-labor unit cost.
- After significant cuts in both non-labor and labor fronts, NLCs' unit cost decreased substantially in the early 2000s, but it increased in recent years mainly caused by the increase in wages due to employee seniority and additional non-labor cost, which outpaced their growth in production of ASMs.
- From 2004 to 2012, LCCs had most significant increases in both labor and non-labor unit costs, and their unit cost advantage over NLCs decreased.
- ULCCs' greatest cost advantage over both NLCs and LCC was their low labor cost.

3.2.2 System Aggregate CASM Comparisons for Individual Airlines

In this section, we look at individual airlines' contribution to aggregate NLCs, LCCs, and ULCCs labor and non-labor unit costs. For each aggregate group, individual airlines' proportion of contribution is equal to the proportion of each airline's ASM to the aggregate total ASM of the group it belongs, since the unit cost measures for each group are been divided by the total ASM. The proportion of each airline's contribution to its corresponding aggregate groups from 2004 to 2012 is summarized in Table 1.

Airline	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
American Airlines	26%	26%	26%	25%	24%	24%	24%	24%	24%	25%
Delta Airlines	19%	20%	19%	19%	19%	19%	31%	31%	31%	23%
United Airlines	21%	21%	21%	21%	20%	19%	19%	18%	34%	22%
Continental Airlines	12%	13%	14%	15%	14%	15%	15%	15%	-	14%
Northwest Airlines	14%	13%	13%	13%	12%	12%	-	-	-	13%
US Airways	8%	8%	7%	8%	11%	11%	11%	11%	12%	10%
Southwest Airlines	71%	69%	66%	65%	65%	64%	63%	63%	63%	65%
JetBlue Airways	18%	19%	20%	21%	20%	21%	22%	22%	24%	21%
AirTran Airways	11%	12%	14%	15%	15%	15%	15%	15%	13%	14%
Virgin America	-	-	-	1%	3%	4%	5%	6%	7%	4%
Frontier Airlines	54%	56%	56%	51%	49%	45%	44%	43%	39%	49%
Spirit Airlines	39%	34%	30%	34%	33%	32%	32%	34%	37%	34%
Allegiant Air	7%	10%	15%	15%	17%	23%	24%	22%	24%	17%

Table 1 Individual Airline's Contribution to Aggregate Group 2004-2012

Figure 8 and Figure 9 show the non-labor and labor unit costs for all airlines in 2004, 2008, and 2012. We discuss the key drivers for each airline's non-labor and labor unit cost changes in this section.

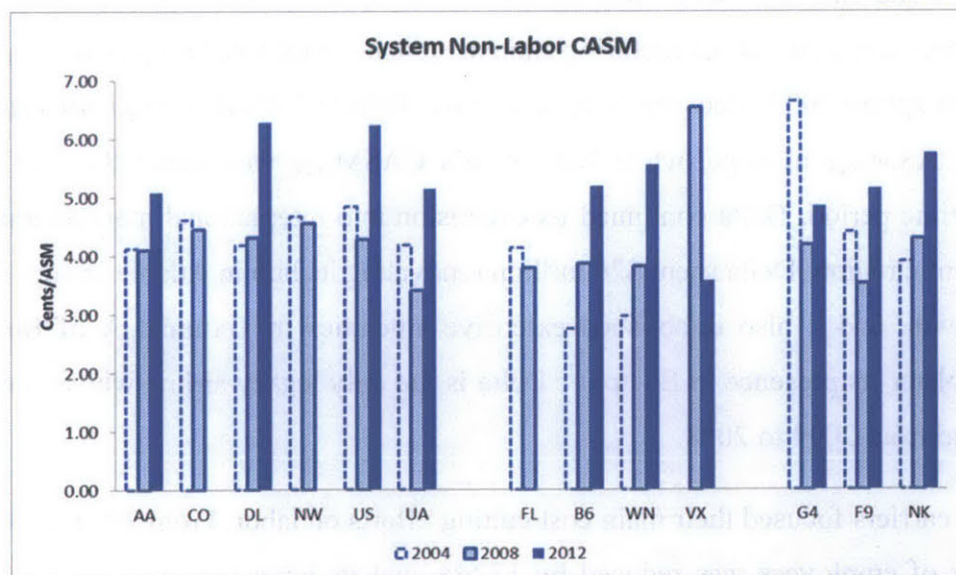


Figure 8 Non-Labor System CASM for Individual Airlines 2004, 2008, and 2012

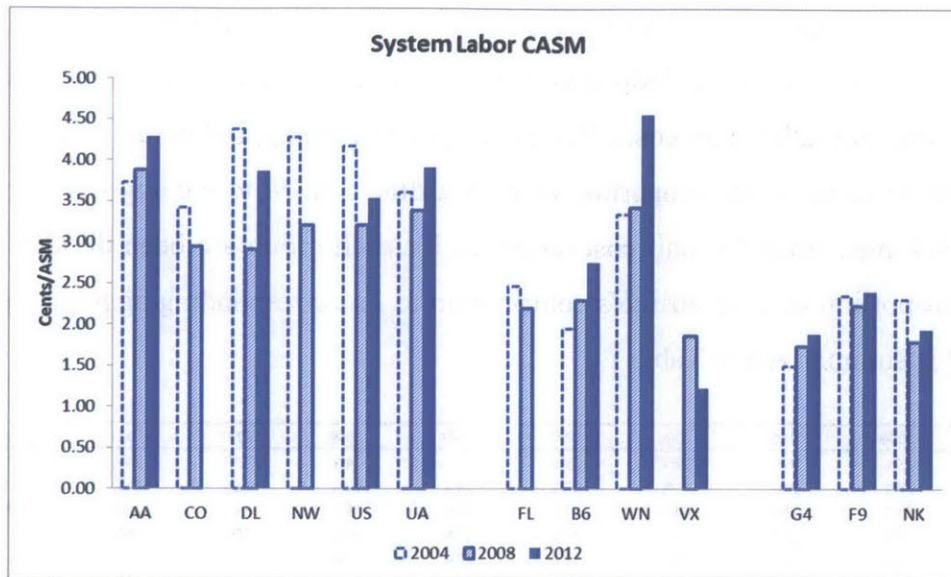


Figure 9 Labor System CASM for Individual Airlines 2004, 2008, and 2012

3.2.2.1 Individual Network Legacy Carriers CASMs

NLCs: American, Delta, and United Airlines’ total weights sum up to be about 70% of the total group, and the unit cost trends for NLCs are mostly affected by these three airlines.

Delta and Northwest Airlines

Both Delta and Northwest Airlines filed for Chapter 11 bankruptcy protection in 2005, and after almost two years of restructuring and cost reduction efforts, both carriers emerged from Chapter 11 in spring 2007. Between 2005 and 2007, Delta’s $CASM_{exTF}$ was consistently below the NLCs’ $CASM_{exTF}$ average, while Northwest’s $CASM_{exTF}$ was above the NLCs’ average. During this time period, Delta continued its expansion into international markets and growth in the mid-Atlantic region. Delta spent \$26 million renovating its hub in Atlanta in support of future network growth, and it also established extensive amenities in Terminal A of Boston Logan Airport to bolster its presence in Boston³¹. Delta is the only legacy airline whose non-labor unit cost increased from 2004 to 2008.

Both carriers focused their main cost cutting efforts on labor. From 2004 to 2008, Delta’s total number of employees was reduced by 17.6%, and its labor unit cost decreased by 34%;

³¹ "Delta to Connect Northeast Business Centers with Significant Boston Expansion." Delta News Archive, 21 Dec. 2006. Web. 30 Mar. 2014.

similarly, Northwest's total number of employees was reduced by 24.3%, and its labor unit cost decreased by 25%. When Northwest declared bankruptcy in 2005, it needed a 1.4 billion cut in labor cost. Northwest received \$250 million cost savings from the concession of its pilots, and later on another \$195 million cost savings from the concession of its flight attendants³². Delta obtained \$280 million annual cost savings from its pilot concession in 2006³³. Since 2008, Delta trimmed its capacity in response to rising fuel prices and retired more than 350 less fuel efficient aircraft³⁴, DC-9s, CRJs, and Saab turboprops. It also placed orders for fuel efficient aircraft such as Boeing 717-200 and 737-900ER, which will begin service in third quarter of 2014. Delta projected a cost saving of approximately \$300 million a year with new airplanes entering into service in the next few years³⁵.

Delta and Northwest completed their merger in January 2010. After absorbing Northwest, the new Delta saw significant increase in both non-labor and labor unit cost. In 2012, Delta's non-labor unit cost increased by 46% and labor unit cost by 33% from 2008. The additional labor and non-labor cost accrued post-merger grew faster than the increase in the production of ASMs.

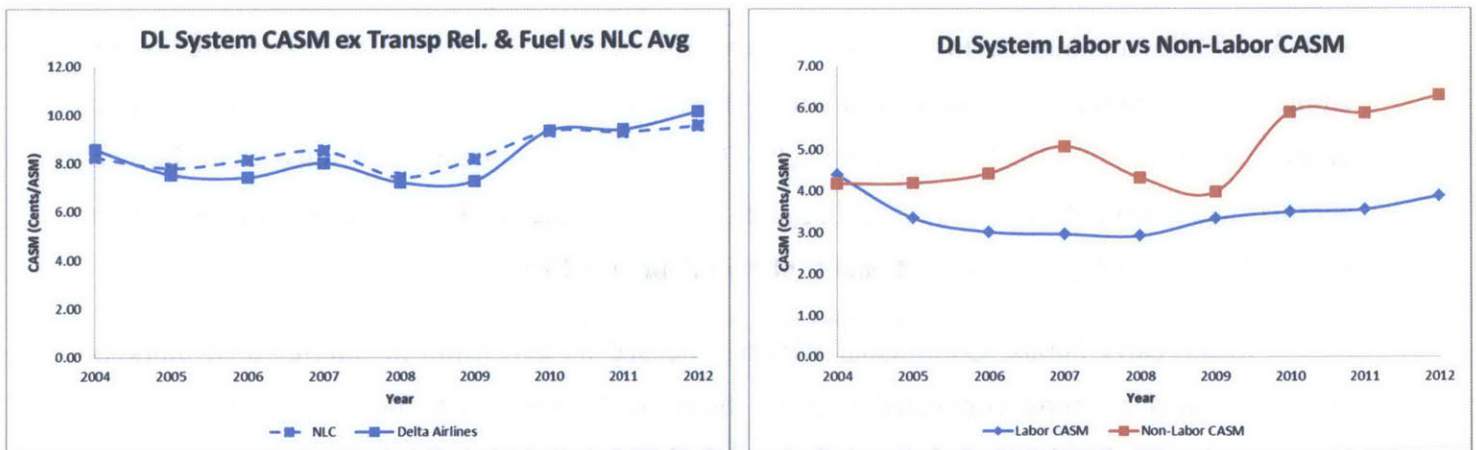


Figure 10 Delta Airlines CASMs

³² Isaacs, Jerry. "Unions for Flight Attendants, Pilots Agree to Huge Concessions at Northwest Airlines." 4 Mar. 2006. <<http://www.wswn.org/en/articles/2006/03/norw-m04.html>>.

³³ Tang, Stanton. "Bankruptcy Court Approves Delta Union Concessions." 31 May 2006. <<http://www.wzzm13.com/news/story.aspx?storyid=55397>>.

³⁴ Blachly, Linda. "Delta Air Lines Retires Last Commercial DC-9 Aircraft." *ATWOnline*. 7 Jan. 2014. <<http://atwonline.com/airframes/delta-air-lines-retires-last-commercial-dc-9-aircraft>>.

³⁵ Holder, Mark. "Cost Savings in Motion at Delta Air Lines." *The Motley Fool*. 3 Oct. 2013. <<http://www.fool.com/investing/general/2013/10/03/cost-saving-in-motion-at-delta-air-lines.aspx>>.

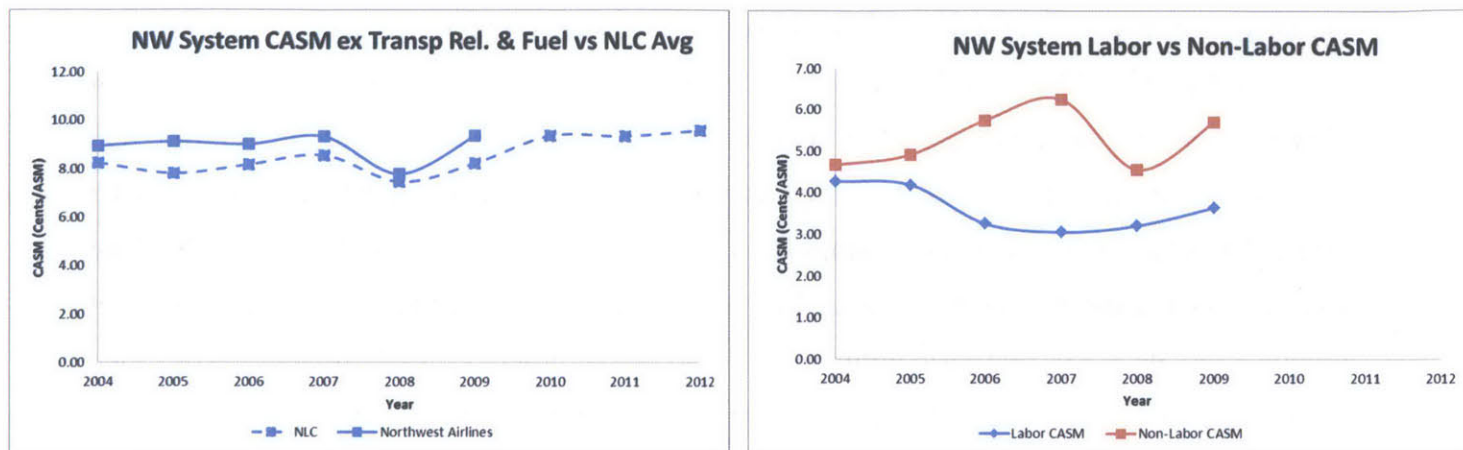


Figure 11 Northwest Airlines CASMs

Continental and United Airlines

United Airlines filed for Chapter 11 bankruptcy protection in 2002 and took drastic measures to cut cost. It had a 19% drop in non-labor unit cost from 2004 to 2008, the greatest among all of the legacy carriers. On the non-labor side, United reduced their mainline fleet from 497 aircraft in 2004 to 360 aircraft by 2009³⁶, cancelled several contracts with their feeder regional service airlines, and stopped its low-cost carrier division, Ted. On the labor side, while United was under bankruptcy protection, new labor contracts signed in 2003 provided United with \$2.56 billion annual savings on cost of labor for six years. In 2005, United defaulted on its employees’ pension plans, which freed United from its \$3.2 billion pension obligation over five years, and the default affected approximately 134,000 United employees³⁷. United went through another negotiation of labor cuts in 2005, and obtained another \$700 million annual savings on labor³⁸. United finally exited out of bankruptcy in February 2006.

In the early 2000s, Continental Airlines focused its expansion in international markets and established a strong connected network from North America to both Asia and Europe. However, international travel demand decreased significantly due to 9/11 terrorist attack, the SARS outbreak, and the Iraq war, and Continental took actions to reduce cost. In 2005, Continental received \$500 million labor cost savings from pilot and mechanics concessions, and

³⁶ Mainline Operations: United Airlines, Airline Financials.

<http://www.airlinefinancials.com/uploads/United_2002-2010__mainline_ops_.pdf>.

³⁷ Maynard, Cicheline. "United Air Wins Right to Default on Its Employee Pension Plans." *The New York Times*. 11 May 2005. <<http://www.nytimes.com/2005/05/11/business/11air.html?pagewanted=all>>.

³⁸ "Timeline of United Airlines’ Bankruptcy." *USA Today*. 1 Feb 2006.

<http://usatoday30.usatoday.com/travel/flights/2006-02-01-united-timeline_x.htm>.

an additional \$68 million savings from flight attendants concession in 2006³⁹. Continental's labor unit cost decreased by 14% from 2004 to 2008. Continental reduced its mainline fleet size from 366 aircraft in 2002 to 337 aircraft by 2009⁴⁰, and it also retired all of its Boeing 737-300s from service. Overall, Continental's non-labor unit cost decreased by 4% from 2004 to 2008, and its $CASM_{exTF}$ consistently trended below the NLCs' $CASM_{exTF}$ average from 2004 to 2011.

United and Continental started their earliest stages of merger talks in 2008, and they began to codeshare in 2009 after Continental joined United's Star Alliance. It was not until 2010 did the two airlines officially agreed to merge. The merger was forecast to deliver more than \$1 billion savings a year to the new United⁴¹. United's non-labor unit cost post-merger increased by 51%, and its labor unit cost increased by 15%. In 2012, United's workforce almost doubled after its merger with Continental, but the new United was not been able to increase its ASM. United announced its plan to cut \$2 billion cost annually by improving operations and increasing employee productivity, and it expected tremendous fuel cost savings from the 100 or so new aircraft that will be entering service in 2014⁴². United's total $CASM_{exTF}$ was above the NLCs' $CASM_{exTF}$ average in 2011, while it was consistently below the NLCs' $CASM_{exTF}$ average in other years.

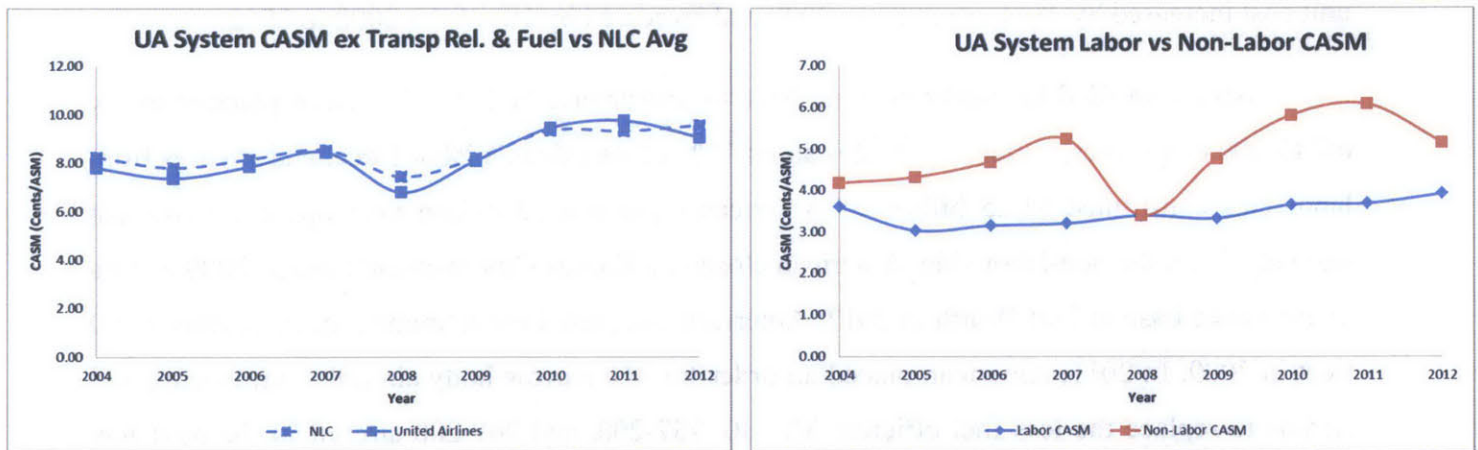


Figure 12 United Airlines CASMs

³⁹ "Continental Flight Attendants Approve Labor Deal." *mnsbc.com*. 30 Jan. 2006. <http://www.nbcnews.com/id/11102868/ns/business-us_business/t/continental-flight-attendants-approve-labor-deal/>.

⁴⁰ Mainline Operations: Continental Airlines, Airline Financials. <http://www.airlinefinancials.com/uploads/2002-2009_Continental_mainline.pdf>.

⁴¹ "United and Continental Airlines to Merge." *BBC News*. 03 May 2010. <<http://www.bbc.co.uk/news/10095080>>.

⁴² Nicas, Jack. "United Airlines Aims for 42 Billion in Annual Cost Cuts." *The Wall Street Journal*, 19 Nov. 2013. <<http://online.wsj.com/news/articles/SB10001424052702304439804579207693313317838>>.

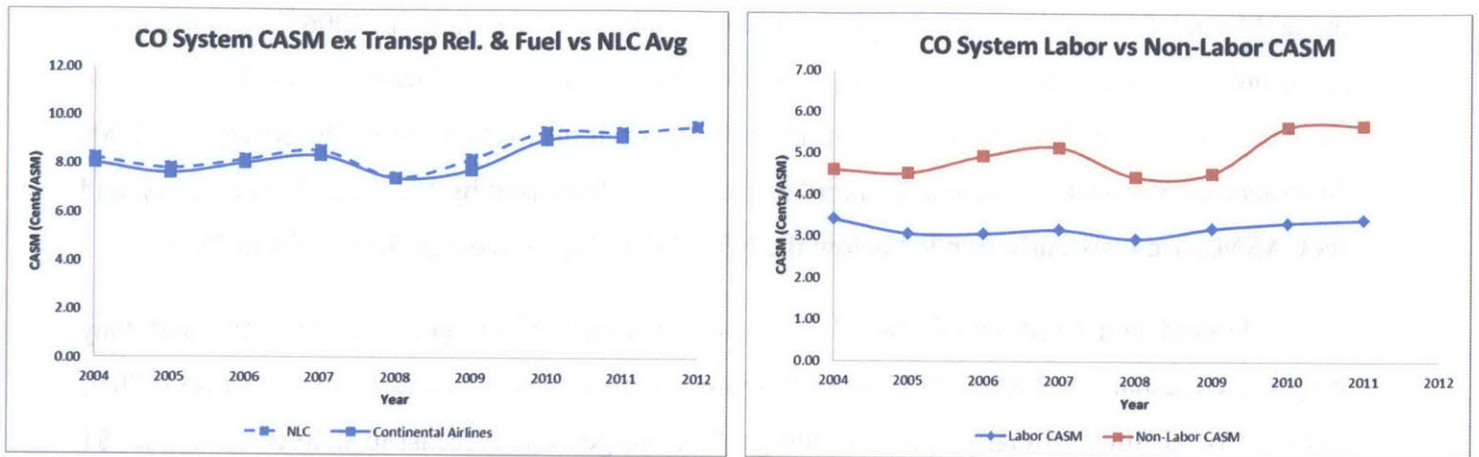


Figure 13 Continental Airlines CASMs

American Airlines and US Airways

American Airlines kept its unit cost relatively lower than other legacy carriers in the early 2000s. American completed the retirement of its entire Boeing 727 fleet in 2002 and implemented massive labor cuts in 2003. American was able to obtain \$1.8 billion cost savings in employee wages through several union concessions⁴³. American reduced its contributions to employee' pension plan since 2006 and saved about \$2.1 billion by 2012⁴⁴. American's labor unit cost increased by 4% from 2004 to 2008 and increased by 10% from 2008 to 2012.

American filed for bankruptcy in 2011 to restructure. In 2012, American planned to lay off 13,000 employees, which constitutes about 18% of American's labor force, and savings from labor cuts constituted \$1.25 billion of American's planned \$2 billion total operating cost cut annually⁴⁵. On the non-labor side, American closed its Kansas City overhaul base in 2008 and its maintenance base in Fort Worth in 2012. American completed the retirement of its Airbus A300 fleet in 2009. In 2011, American placed an order for 460 narrow body aircraft from Boeing and Airbus to replace the less fuel efficient MD-80, 757-200, and 767-200 aircraft in the next few

⁴³ Sherman, Paul. "Massive Wage Cuts Imposed on American Airlines Workers." 18 Apr. 2003. <<http://www.wsws.org/en/articles/2003/04/aa-a18.html>>.

⁴⁴ Mufson, Steven. "American Airlines' Plan for Pension Bailout Draws Criticism." The Washington Post, 07 Feb. 2012. <http://www.washingtonpost.com/business/economy/american-airlines-request-for-pension-bailout-draws-criticism/2012/02/03/gIQAu1m1nQ_story.html>.

⁴⁵ Schlangenstein, Mary. "AMR Will Fire 13,000 as Part of Plan to Lower Costs by \$2 Billion a Year." Bloomberg, 1 Feb. 2012. <<http://www.bloomberg.com/news/2012-02-01/amr-poised-to-start-labor-talks-with-10-000-job-cuts-possible.html>>.

years. American's non-labor unit cost increased by 24% from 2008 to 2012. Overall, American's $CASM_{exTF}$ was trending very closely to the NLCs' $CASM_{exTF}$ average from 2004 to 2012.

In 2004, US Airways filed for bankruptcy protection for the second time in two years. Since it had declared bankruptcy for the first time in 2002, it slashed \$2.5 billion in employee wage and benefits. In 2005, it further gained more than \$800 million annual labor savings from labor concessions⁴⁶. US Airways' labor unit cost decreased by 23% from 2004 to 2008. On the non-labor side, after its merger with America West, the new US cut down 14% of its capacity by returning leased aircraft and cutting back flights⁴⁷. US Airways decreased its presence in Pittsburgh International Airport and reduced the number of flights in and out of Pittsburgh from 500 flights daily in 2001 to 111 flights daily in 2007⁴⁸. In response to the rising fuel prices and the economic crisis in 2008, US Airways ceased onboard beverage service and cancelled its plans to upgrade its in-flight entertainment services. In 2010, US Airways further cut routes in Boston, Las Vegas, and New York LaGuardia, which were once its focus cities. Despite these cuts, the US Airways' non-labor cost increased by 10% from 2008 to 2012, and overall US Airways' $CASM_{exTF}$ was trending above the NLCs' $CASM_{exTF}$ average from 2004 to 2012.

US Airways and American Airlines agreed to merge in February 2013 and the decision was approved by the Department of Justice in November 2013. The biggest challenge for the new American is the high non-labor cost, and it has already taken action toward trimming down capacity. In early 2014, American announced the halt in nonstop services from Reagan National Airport to 17 cities a part of new American's restructuring plan⁴⁹.

⁴⁶ "Feds to Extend Financing to US Airways." *Msnbc.com*. 13 Jan. 2005.

<http://www.nbcnews.com/id/6821347/ns/business-us_business/t/feds-extend-financing-us-airways/>.

⁴⁷ Reed, Dan, and Barbara De Lollis. "USATODAY.com - America West, US Airways Merger Goes for a Tight Fit." *USATODAY.com* 21 May 2005. <http://usatoday30.usatoday.com/money/biztravel/2005-05-19-merger_x.htm>.

⁴⁸ Vellucci, Justin. "US Airways' Pittsburgh Market Share under 40 Percent." *TribLIVE.com*. 15 Sept. 2007. <http://triblive.com/x/pittsburghtrib/business/s_527588.html>.

⁴⁹ "American Airlines Cuts Flights from Reagan, LaGuardia Airports." *Chicago Tribune*. 15 Jan. 2014. <<http://www.chicagotribune.com/news/sns-rt-us-americanairlines-usairways-flights-20140115,0,77124.story>>.

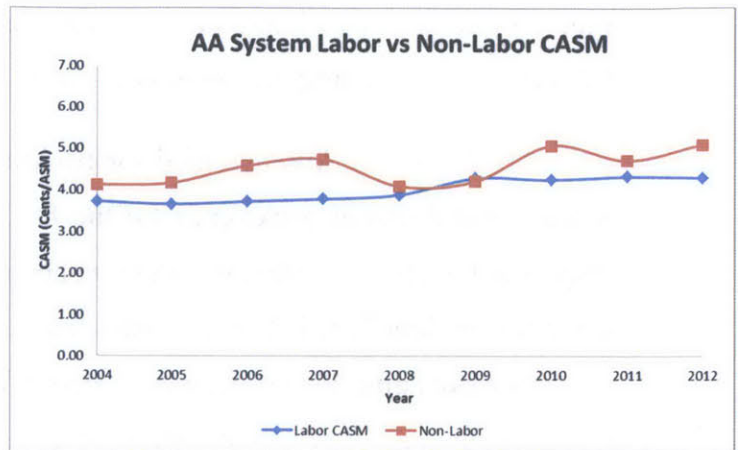
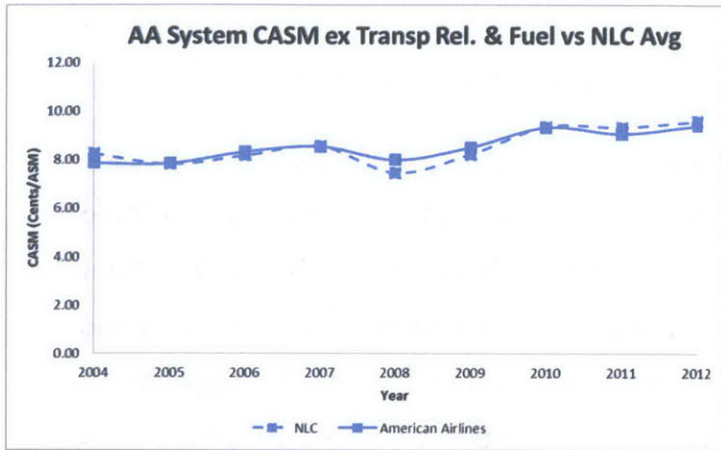


Figure 14 American Airlines CASMs

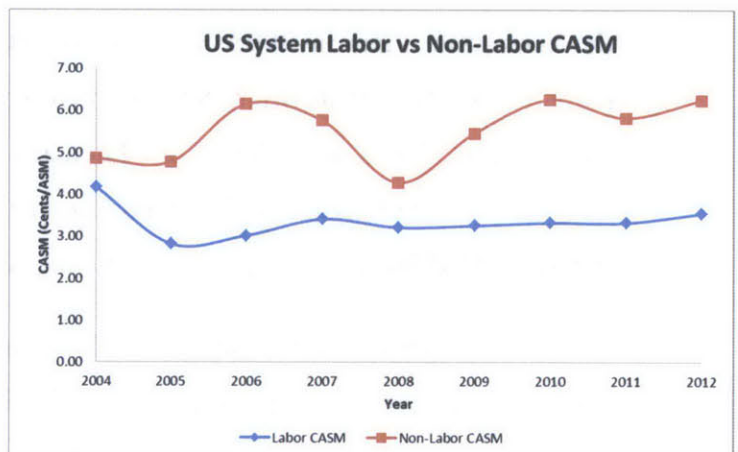
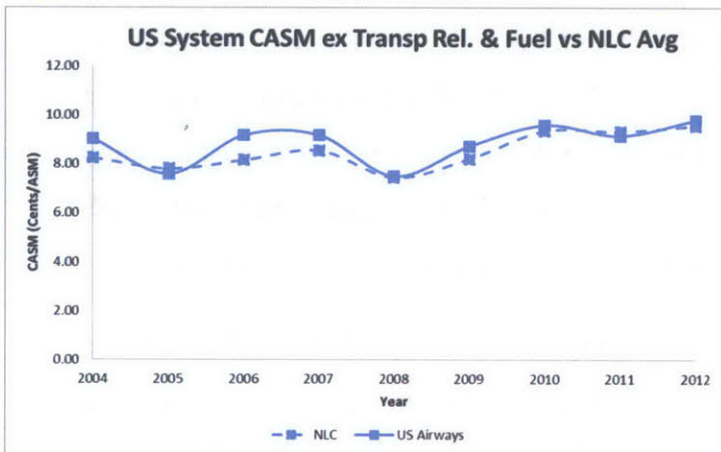


Figure 15 US Airways CASMs

3.2.2.2 Individual Low Cost Carriers CASMs

LLCs: Southwest Airlines and JetBlue Airways' total weights sum up to be more than 80% of the total group, and the unit cost trends for the LLC are mostly affected by these two airlines.

Southwest Airlines and AirTran Airways

With the immense savings from its success in fuel hedging, Southwest Airlines expanded its network aggressively in the past decade, while keeping both of its labor and non-labor unit costs low. From 2004 to 2008, Southwest's non-labor unit cost grew by 28%, but its labor unit cost only increased by 2%. While the rest of the airline industry struggled with the high fuel prices in 2008, Southwest purchased the bankrupt ATA Airlines, and began its expansion into New York LaGuardia. Three years later, Southwest acquired AirTran Airways. Prior to

Southwest's acquisition, AirTran was adding routes from its main hub in Atlanta and expanded into Milwaukee, its second hub. After its merger with AirTran, Southwest not only strengthened its presence in the southeast region of the United States but also gained several international destinations including cities in Mexico and the Caribbean. Southwest began code sharing with AirTran in 2013 and planned to complete the full integration of the two airlines in 2014. In 2011, Southwest ordered 208 Boeing 737 jets, which included fuel efficient MAX model. Southwest's total number of employees increased by 26% from 2008 to 2012. Overall from 2008 to 2012, Southwest's non-labor unit cost increased by 46%, and its labor unit cost increased by 33%. Compared to the legacy carriers, Southwest's non-labor unit cost was lower than those of Delta and US Airways but greater than those of American and United Airlines. In 2012, Southwest's labor unit cost was the highest among all the airlines compared in this thesis. Overall, Southwest's $CASM_{exTF}$ was trending above the LCC $CASM_{exTF}$ average from 2004 to 2012.

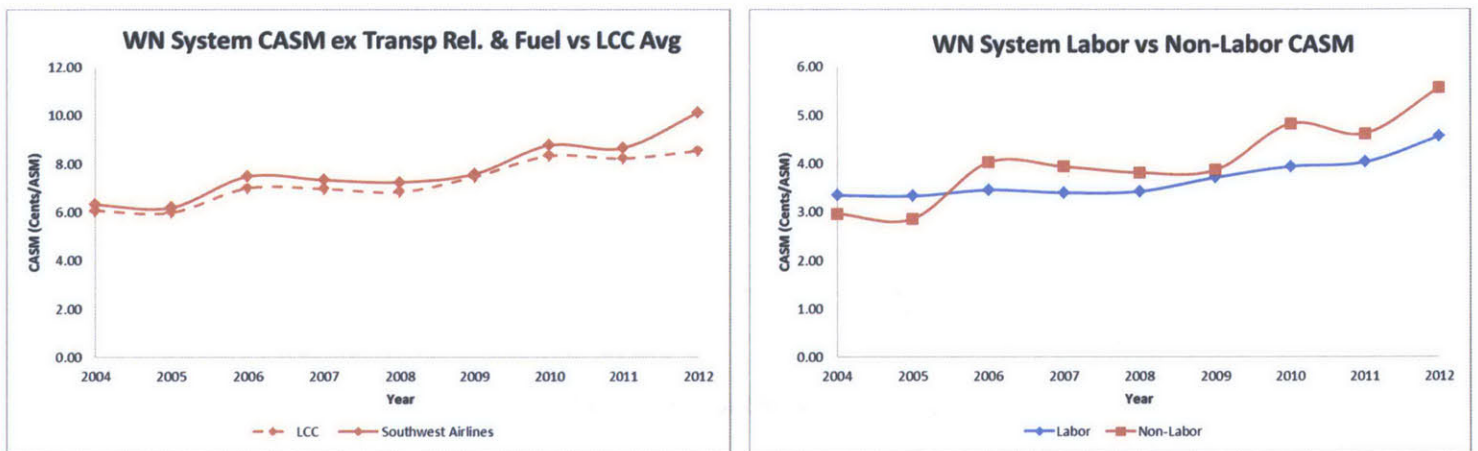


Figure 16 Southwest Airlines CASMs

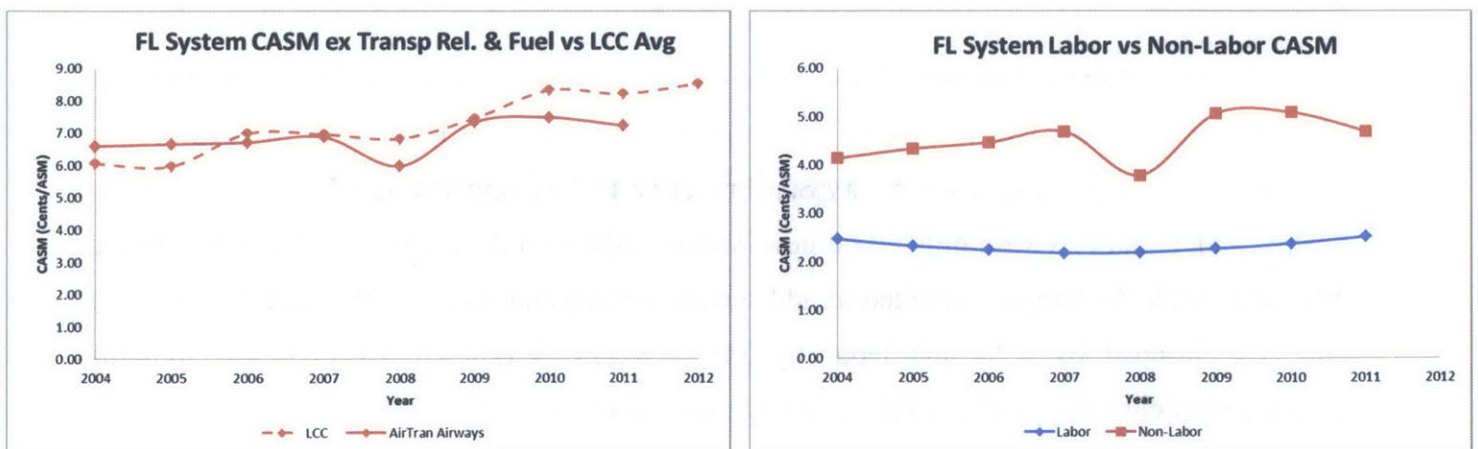


Figure 17 AirTran Airways CASMs

JetBlue Airways

JetBlue Airways was founded in 1999 and was one of the few airline that was profitable in the aftermaths of the industry downturn post 9/11. Similar to Southwest, JetBlue has expanded tremendously in size since it commenced operations. JetBlue’s total number of employees almost doubled from 2004 to 2008 and increased by another 21% from 2008 to 2012. JetBlue expanded into the Caribbean in 2007 and Mexico and South America in 2008. New aircraft have been added to JetBlue’s fleet every year, and JetBlue’s fleet size grew from 69 to 194 aircraft from 2004 to 2013. Overall, JetBlue has had consistent increase in both labor and non-labor unit costs, and its $CASM_{exTF}$ was consistently trending below the LCC $CASM_{exTF}$ average from 2004 to 2012.

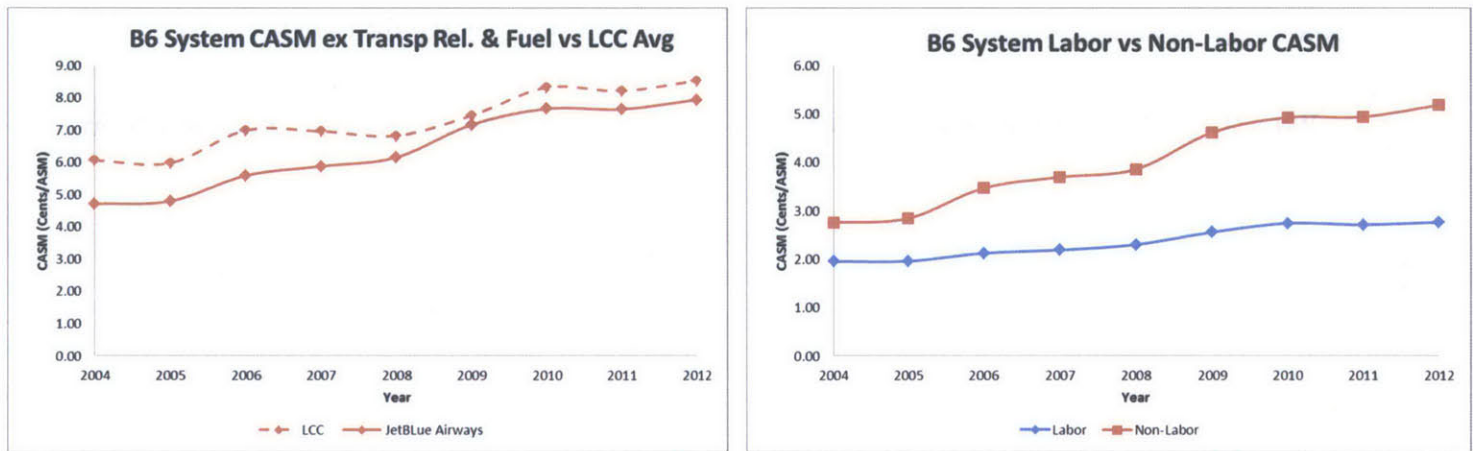


Figure 18 JetBlue Airways CASMs

Virgin America

Virgin America commenced its operations in August 2007, and its high non-labor and labor unit cost in 2008 was mainly due to the airline’s startup cost. From 2007 to 2012, Virgin expanded its services from its hub city San Francisco to Los Angeles, Las Vegas, New York, Seattle, and Toronto. Virgin ordered 60 new Airbus A320 aircraft in 2011 for delivery between 2013 and 2016. As Virgin continued to add service and expand its network, Virgin’s non-labor unit cost dropped by 45% and labor by 34%. Overall, Virgin’s $CASM_{exTF}$ was trending significantly below the LCC $CASM_{exTF}$ average from 2009 to 2012.

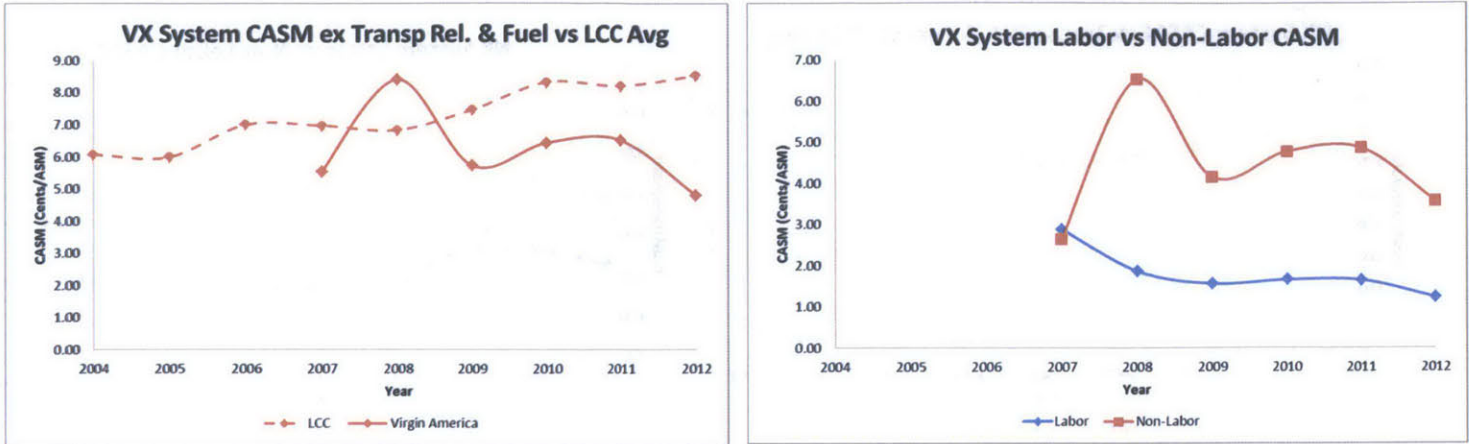


Figure 19 Virgin America CASMs

3.2.2.3 Individual Ultra-Low Cost Carriers CASMs

ULLCs: Frontier and Spirit Airlines total weights sum up to be more than 80% of the total group, and the unit cost trends for the ULLC are mostly affected by these two airlines.

Spirit Airlines

Spirit Airlines transitioned into a Ultra Low Cost Carrier in 2006 when acquired by Indigo Partners, a private equity and venture capital firm that invests in the air transportation industry. Spirit quickly expanded into the Caribbean, Central and South America. In 2004, Spirit began its transition into an all-Airbus fleet, and the transition was completed in 2006. From 2004 to 2008, Spirit's non-labor unit cost increased by 10% but its labor unit cost decreased by 23%. In response to high fuel prices, Spirit laid off 460 employees in June 2008⁵⁰ but quickly hired more employees from 2009 to 2012 to service a spur of new routes added during that period. From 2008 to 2012, Spirit's non-labor unit cost increased by 34%, and its labor unit cost increased by 10%. Overall, Spirit's CASM_{exTF} was trending slightly above the ULCC CASM_{exTF} average from 2004 to 2012.

⁵⁰ Gillie, John. "The News Tribune." *Tacoma News Tribune*. 4 June 2008. <<http://blog.thenewstribune.com/business/2008/06/04/spirit-airlines-warns-of-layoffs/>>.

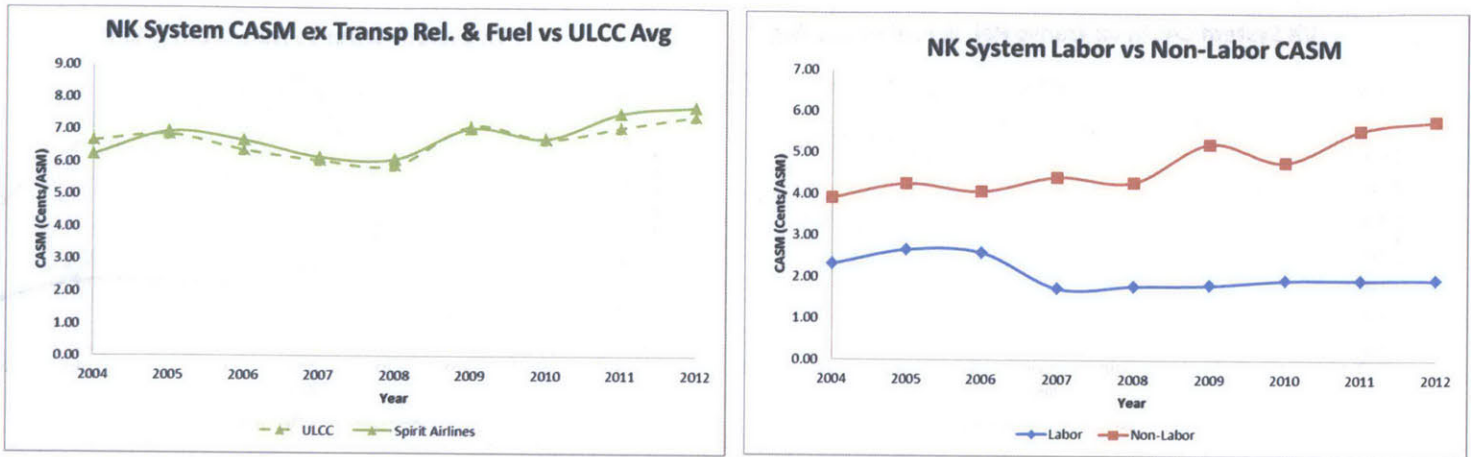


Figure 20 Spirit Airlines CASMs

Frontier Airlines

Frontier Airlines struggled to stay competitive when Southwest Airlines entered Frontier's main hub, Denver, in 2006. In 2008, Frontier went bankrupt when its credit card processor wanted to withhold a majority of Frontier's ticket sales. From 2004 to 2008, Frontier's non-labor unit cost decreased by 20%, and its labor unit cost decreased by 5%. In 2009, Republic Airways holdings acquired Frontier, which allowed Frontier to exit bankruptcy. In 2010, Frontier merged with Midwest Airlines and began a series of downsizing and layoffs. Frontier downsized Midwest's Milwaukee hub, laid off about 450 Milwaukee based employees, and reduced flights out of Milwaukee from 32 to 18 per day⁵¹. Since 2012, Frontier expanded services into Trenton, NJ and Wilmington, DE. From 2008 to 2012, Frontier's non-labor unit cost increased by 46%, and its labor unit cost increased by 8%. In December 2013, Indigo Partners purchased Frontier, and Frontier's transition into an ultra-low cost carrier has since begun. Overall, Frontier's $CASM_{exTF}$ trended closely to the ULCC $CASM_{exTF}$ average from 2004 to 2012.

⁵¹ "Frontier Airlines to Cut about 450 Milwaukee-area Employees." 13 Feb. 2012. <<http://www.jsonline.com/business/frontier-airlines-to-cut-500-milwaukeearea-employees-cv46bem-139239153.html>>.

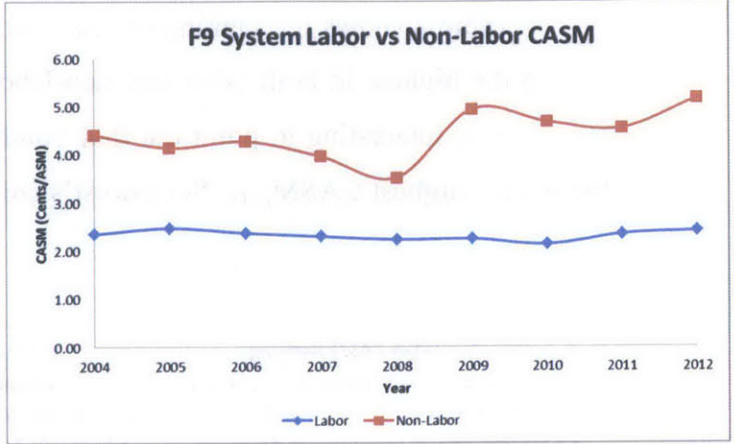
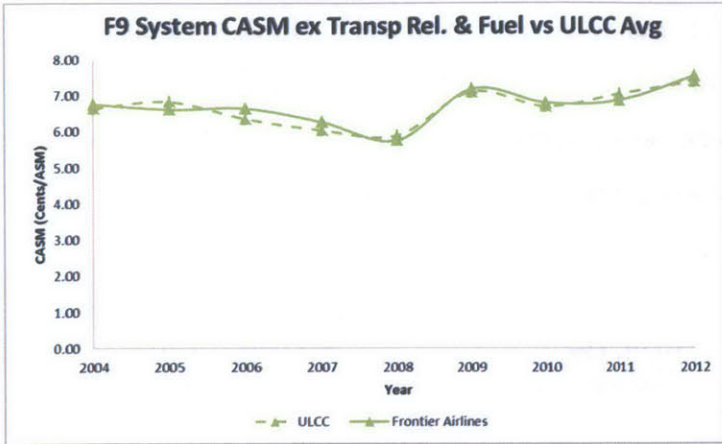


Figure 21 Frontier Airlines CASMs

Allegiant Air

Allegiant Air was restructured into a low cost carrier in 2002. Since then, Allegiant expanded aggressively into leisure travel markets with its main goal of connecting passengers from small cities, and the airline was servicing 13 cities to and from its Las Vegas hub by 2004. Frontier’s non-labor unit cost was high in 2004 due to its high startup cost but decreased by 37% in 2008. Frontier consistently expanded its labor force, and its labor unit cost increased by 16% from 2004 to 2008 and by 8% from 2008 to 2012. Overall, Allegiant’s $CASM_{exTF}$ was trending below the ULCC $CASM_{exTF}$ average from 2006 to 2012.

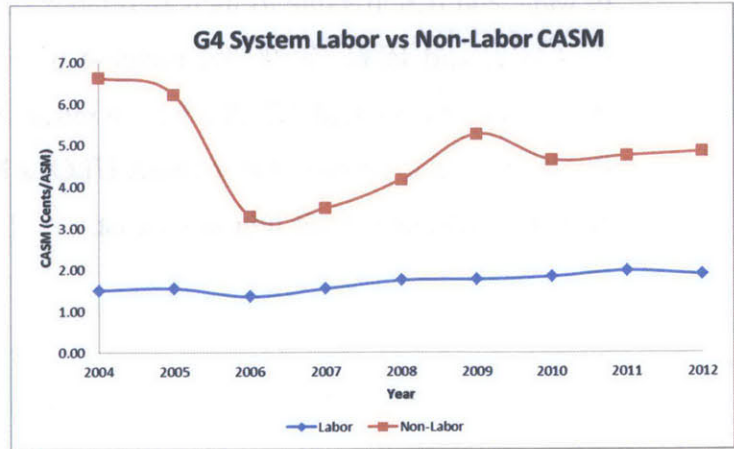
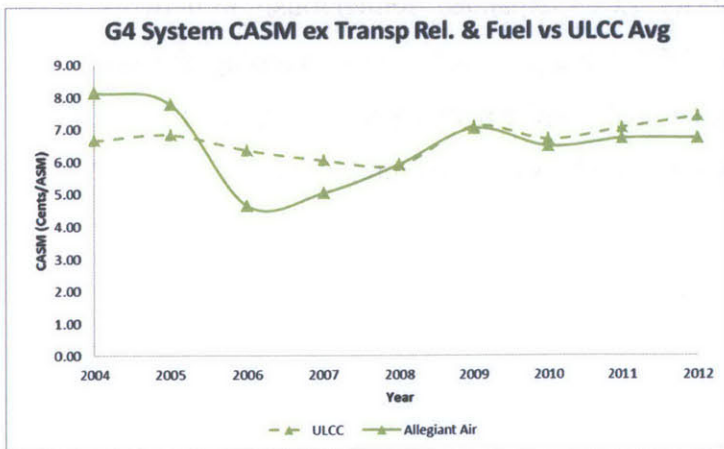


Figure 22 Allegiant Air CASMs

Table 2 shows the ranking of unit costs for individual airlines in 2012. NLCs are ranked among the highest in both labor and non-labor unit costs, while ULCCs are ranked among the lowest. It is interesting to point out that Southwest now has the highest labor unit cost and has the second highest $CASM_{exTF}$. Southwest's unit costs are comparable to NLCs'.

2012 Non-Labor CASM Ranking		2012 Labor CASM Ranking		2012 $CASM_{exTF}$ Ranking	
Airline	CASM (Cents/ASM)	Airline	CASM (Cents/ASM)	Airline	CASM (Cents/ASM)
1 Virgin America	3.57	1 Virgin America	1.23	1 Virgin America	4.81
2 Allegiant Air	4.85	2 Allegiant Air	1.88	2 Allegiant Air	6.74
3 American Airlines	5.09	3 Spirit Airlines	1.94	3 Frontier Airlines	7.57
4 United Airlines	5.15	4 Frontier Airlines	2.41	4 Spirit Airlines	7.70
5 Frontier Airlines	5.16	5 JetBlue Airways	2.76	5 JetBlue Airways	7.94
6 JetBlue Airways	5.19	6 US Airways	3.54	6 United Airlines	9.05
7 Southwest Airlines	5.57	7 Delta Airlines	3.86	7 American Airlines	9.37
8 Spirit Airlines	5.76	8 United Airlines	3.90	8 US Airways	9.78
9 US Airways	6.24	9 American Airlines	4.28	9 Southwest Airlines	10.12
10 Delta Airlines	6.29	10 Southwest Airlines	4.55	10 Delta Airlines	10.15

Table 2 2012 System: CASM Rankings for All Airlines

Summary:

From 2004 to 2008, NLCs' overall decreasing trends for both non-labor and labor unit costs were due to cost savings from capacity cuts and labor concessions with a slower decrease in their production of ASMs. From 2008 to 2012, NLCs had an overall increasing trends for both non-labor and labor unit costs. Their increase in labor unit cost can be explained by the increase in wage and benefits due to increased labor seniority. LCCs expanded tremendously in network, fleet size, and labor. With the increase in size, LCCs' biggest challenge is keeping the cost efficiencies it once had. ULCCs have a much smaller and simpler network than NLCs and LCCs. Because of their younger labor force, ULCCs have tremendous cost advantage in labor. ULCCs' biggest challenge is their non-labor cost.

3.3 Domestic Operations Aggregate CASM Comparisons

In this section, we present the general trends of the domestic operations aggregate unit costs for NLCs, LCCs, and ULCCs from 2004 to 2012. Similar to the system aggregate analysis in the previous section, our analysis begins from total unit costs excluding transport related expenses, which is then broken down further into labor and non-labor unit cost components. We compare the unit cost trends of domestic operations to those of system aggregate, and examine the impact of domestic and international operations on unit costs.

Airlines providing scheduled and non-scheduled services are required to make separate financial and traffic report by the world regions they service in Form 41. For reporting scheduled services, there are four regional options: Domestic, Atlantic, Pacific, and Latin America; and for reporting non-scheduled service, there are two regional options: Domestic and International. For our analysis in this section, we have used reported data for both scheduled and non-scheduled cost and operations data for the domestic region in Form 41. Domestic operations, by definition, are “all air carrier operations having destinations within the 50 United States, the District of Columbia, the Commonwealth of Puerto Rico, and the U.S. Virgin Islands”²⁹.

Figure 23 shows the domestic operation comparisons for $CASM_{exT}$ of the three groups. Domestic operations $CASM_{exT}$ increased by 35% for NLCs, 68% for LCCs, and 29% for ULCCs. In 2008, NLCs’ $CASM_{exT}$ peaked to 14 cents/ASM, resulting in a 3.7 cents/ASM unit cost gap between NLCs and the other two groups. Similar to the trends we found at the system aggregate level, LCCs’ domestic $CASM_{exT}$ trended almost parallel to NLCs from 2009 to 2012, with an average cost gap of 2 cents/ASM. ULCCs’ $CASM_{exT}$ began to drop below that of LCCs in 2009, and the $CASM_{exT}$ gap between LCCs and ULCCs averaged about 1.3 cents/ASM from 2009 to 2012.

Figure 24 shows the domestic operations comparisons for $CASM_{exTF}$ of the three groups. From 2004 to 2012, $CASM_{exTF}$ increased by 11% for NLCs and 33% for LCCs. ULCCs’ $CASM_{exTF}$ decreased by 3%. The $CASM_{exTF}$ gap between NLCs and LCCs decreased from 2.65 cents/ASM in 2004 to 1.62 cents/ASM in 2012 by 39%. ULCCs’ $CASM_{exTF}$ trended below that of LCCs since 2007, and the unit cost gap between these two groups diverged from 0.5 cents/ASM in 2007 to 1.43 cents/ASM in 2012.

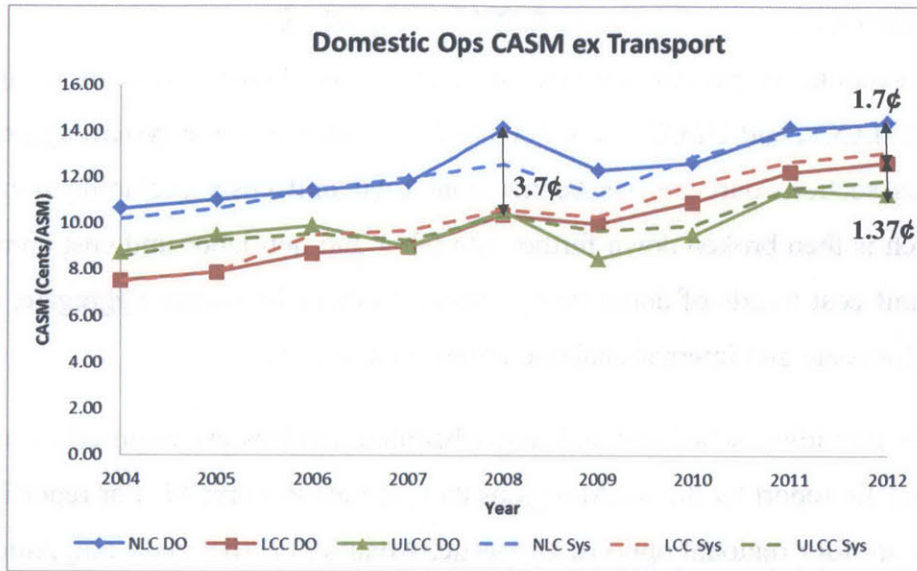


Figure 23 Domestic Operations Comparison: CASM ex Transport Rel.

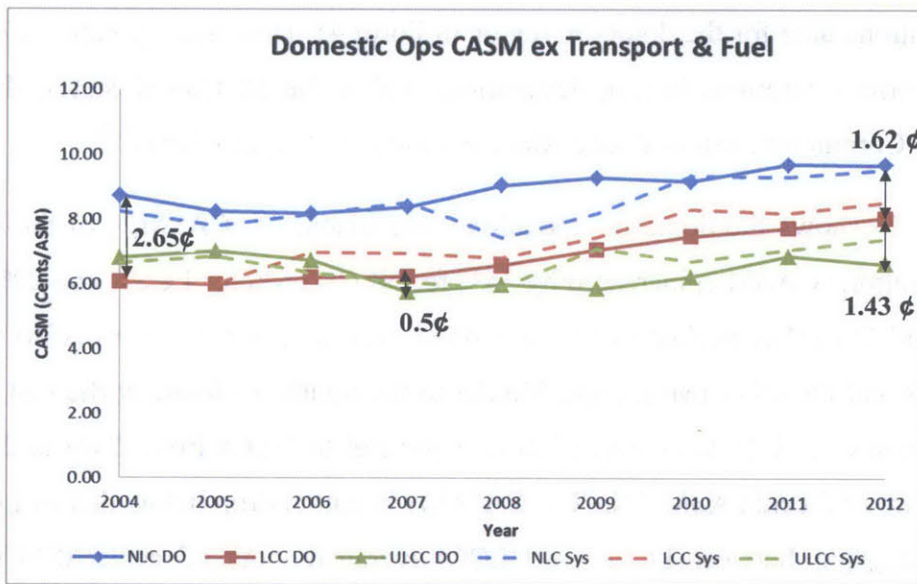


Figure 24 Domestic Operations Comparison: CASM ex Transport Rel. & Fuel

Figure 25 and Figure 26 show the domestic operations comparisons of $CASM_{Non-Labor}$ and $CASM_{Labor}$ of the three groups. From 2004 to 2008, NLCs' $CASM_{Non-Labor}$ increased by 22%, and their $CASM_{Labor}$ decreased by 0.3%. NLCs' $CASM_{Non-Labor}$ decreased by 16% from 2004 to 2007, but by 2012 it slowly increased back to what it was in 2004. From 2004 to 2012, LCCs' $CASM_{Non-Labor}$ increased by 1.3 cents/ASM or 42%, and their $CASM_{Labor}$ increased by 23%.

ULCCs' $CASM_{Non-Labor}$ and $CASM_{Labor}$ decreased from 2004 to 2012 by 1% and 5.6% respectively.

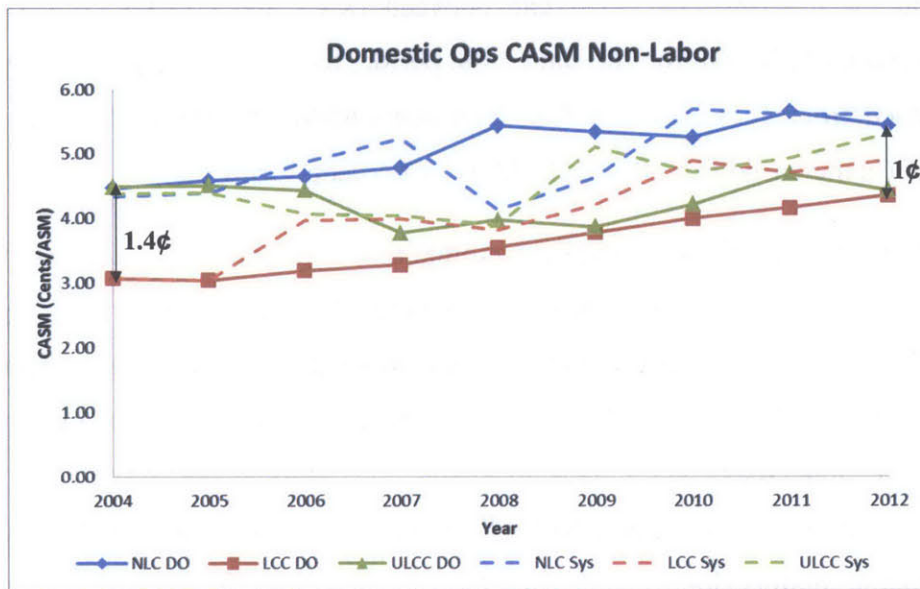


Figure 25 Domestic Operations Comparison: Non-Labor CASM

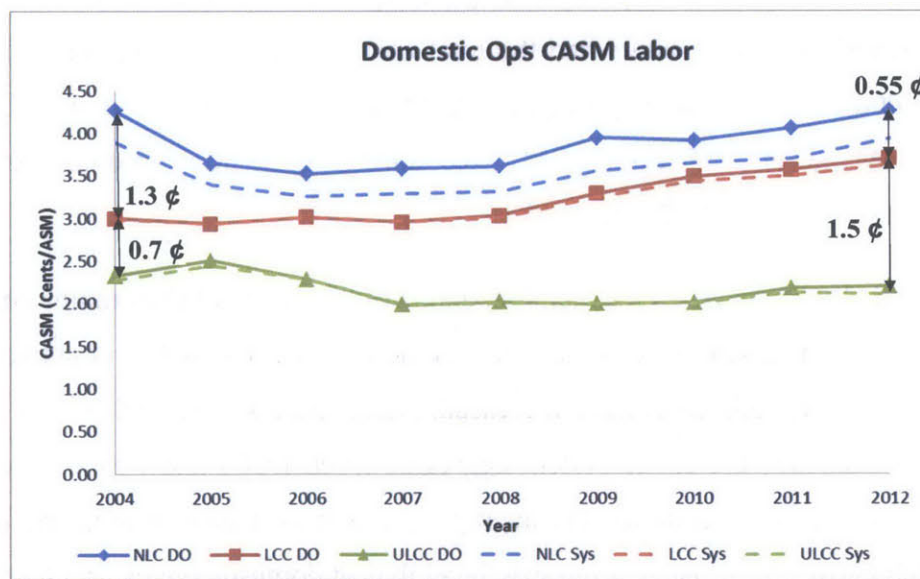


Figure 26 Domestic Operations Comparison: Labor CASM

The $CASM_{Non-Labor}$ gap between NLCs and LCCs decreased from 1.4 cents/ASM to 1 cents/ASM, and the $CASM_{Labor}$ gap between the two groups decreased from 1.3 cents/ASM to 0.55 cent/ASM. An overall convergence in NLCs' and LCCs' non-labor and labor unit cost can

be seen. On the contrary, ULCCs' non-labor and labor unit cost were diverging from NLCs' and LCCs'. From 2004 to 2012, the $CASM_{\text{Non-Labor}}$ gap between NLCs and ULCCs increased to 1 cent/ASM, and the $CASM_{\text{Non-Labor}}$ cost gap between LCCs and ULCCs converged from 1.4 cents/ASM to 0 cent/ASM. During the same time period, the $CASM_{\text{Labor}}$ gap between NLCs and ULCCs increased from 1.94 cents/ASM to 2.06 cents/ASM, and the $CASM_{\text{Labor}}$ gap between LCCs and ULCCs increased from 0.7 cents/ASM to 1.5 cents/ASM.

System aggregate unit cost trends are plotted as dotted lines in the figures in this section. Comparing these domestic operations unit cost trends to the industry system aggregate unit cost trends, we see that on average, NLCs' domestic operations unit costs are higher than their system aggregate unit costs, and LCCs' and ULCCs' domestic operations unit costs are lower than their system aggregate unit costs. NLCs have extensive international operations, and international operations output more ASMs because NLCs fly larger airplanes and longer stage lengths. LCCs and ULCCs operate mainly domestically, and their average stage lengths are lower than NLCs'. All NLCs have hub network structures and operate mixed fleets in both domestic and international regions, and these complexities require higher cost to operate. ASMs increase as the average stage length increases, and when the total cost is spread over greater ASMs, unit cost decreases. In 2008, NLCs' system aggregate $CASM_{\text{exTF}}$ is 7.43 cents/ASM, and their domestic operations $CASM_{\text{exTF}}$ is 9.05 cents/ASM. Accounting for NLCs' international operations decreases their $CASM_{\text{exTF}}$ by 1.62 cents/ASM.

LCCs and ULCCs have been expanding and evolving many of their major cities into hubs, and many are adding international destinations. As their business models and network structures become more complex, their costs have increased. NLCs are less cost efficient at the domestic operations level than they are at the system aggregate level. LCCs and ULCCs are much more cost efficient in domestic operations. On average, the unit cost gaps among the three airlines groups are much narrower at system aggregate level than at domestic operations level.

Table 3 shows the rankings of the unit costs by individual airlines, and the rankings have changed from the rankings in Table 2. Airlines with large international networks are ranked higher here than they were ranked at the system aggregate level. ULCCs are consistently ranked among the lowest $CASM_{\text{exTF}}$ because of their smaller network and lower labor unit cost.

2012 Non-Labor CASM Ranking		2012 Labor CASM Ranking		2012 CASM _{EXTF} Ranking	
Airline	CASM (Cents/ASM)	Airline	CASM (Cents/ASM)	Airline	CASM (Cents/ASM)
1 Allegiant Air	3.39	1 Virgin America	1.67	1 Allegiant Air	5.28
2 Spirit Airlines	4.24	2 Allegiant Air	1.88	2 Spirit Airlines	6.19
3 JetBlue Airways	4.39	3 Spirit Airlines	1.95	3 Virgin America	6.90
4 Southwest Airlines	4.94	4 Frontier Airlines	2.65	4 JetBlue Airways	7.25
5 American Airlines	5.11	5 JetBlue Airways	2.86	5 Frontier Airlines	7.99
6 United Airlines	5.20	6 US Airways	3.67	6 US Airways	9.01
7 Virgin America	5.23	7 United Airlines	4.07	7 United Airlines	9.28
8 US Airways	5.34	8 American Airlines	4.35	8 American Airlines	9.46
9 Frontier Airlines	5.34	9 Southwest Airlines	4.52	9 Southwest Airlines	9.46
10 Delta Airlines	5.99	10 Delta Airlines	4.65	10 Delta Airlines	10.63

Table 3 2012 Domestic Operations: CASM Rankings for All Airlines

Summary:

- At the domestic operations level with transport related expenses excluded from the total operating cost, all three groups' unit costs increased from 2004 to 2012: NLCs by 35%, LCCs by 68%, and ULCCs by 29%.
 - The main drivers for NLCs' domestic operations unit cost increase were the rise in fuel prices and the increase in non-labor unit cost.
 - The main drivers for LCCs' domestic operations unit cost increase were the increased labor and non-labor unit costs.
 - The main drivers for ULCCs' unit cost increase were the rise in fuel prices.
- NLCs' unit costs are much higher when international operations are excluded. On average, NLCs' unit costs are lower at the system aggregate level, and legacy carriers have achieved greater cost efficiencies with international operations.
- Overall, LCCs and ULCCs have greater cost advantage over NLCs at the domestic operations level.

3.4 Stage Length Adjusted CASM Comparisons for Individual Airlines

In theory, when airlines fly longer stage lengths, their unit costs would decrease because they can achieve economies of scale in unit costs by producing higher ASMs. As we have seen in the previous section, because NLCs have higher fixed costs than LCCs and ULCCs, they depend on international operations to keep their unit costs low. In this section, we adjust individual airlines' unit cost to account for their differences in average stage length, and we compare the stage length adjusted unit costs at the system level.

Figure 27 and Figure 28 depict individual airlines' non-labor and labor CASM changes with respect to their average stage lengths from 2004 to 2008.

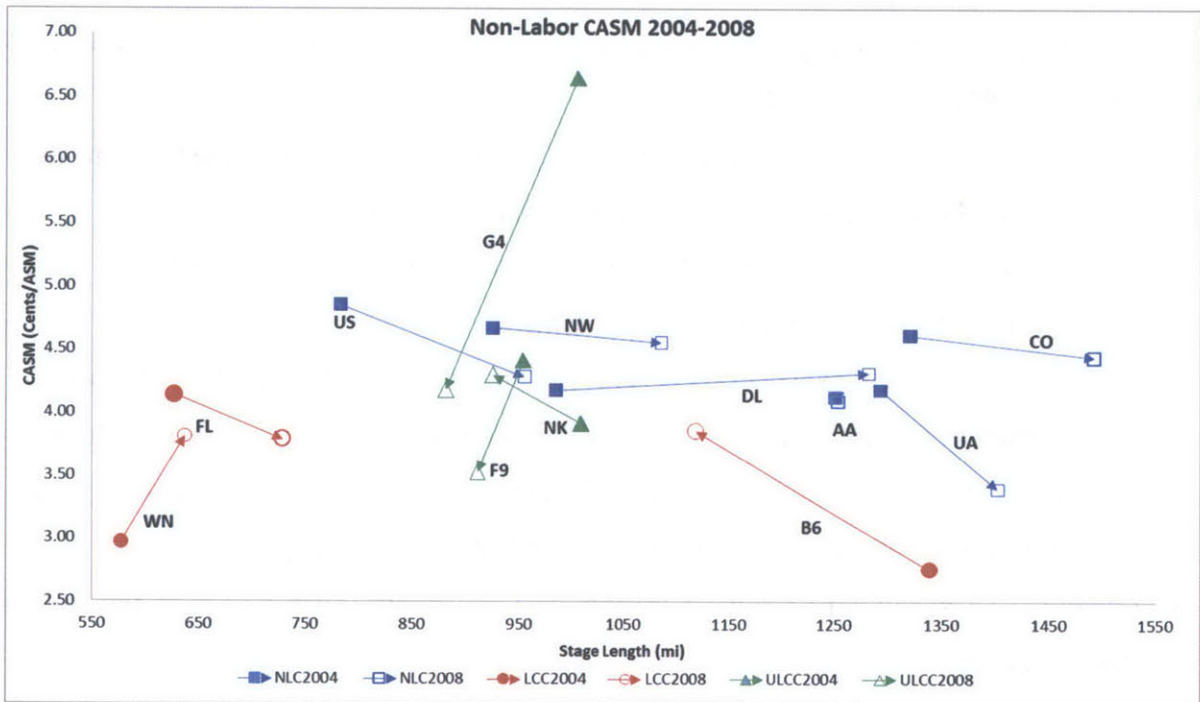


Figure 27 Non-Labor CASM vs Stage Length: Change from 2004 to 2008

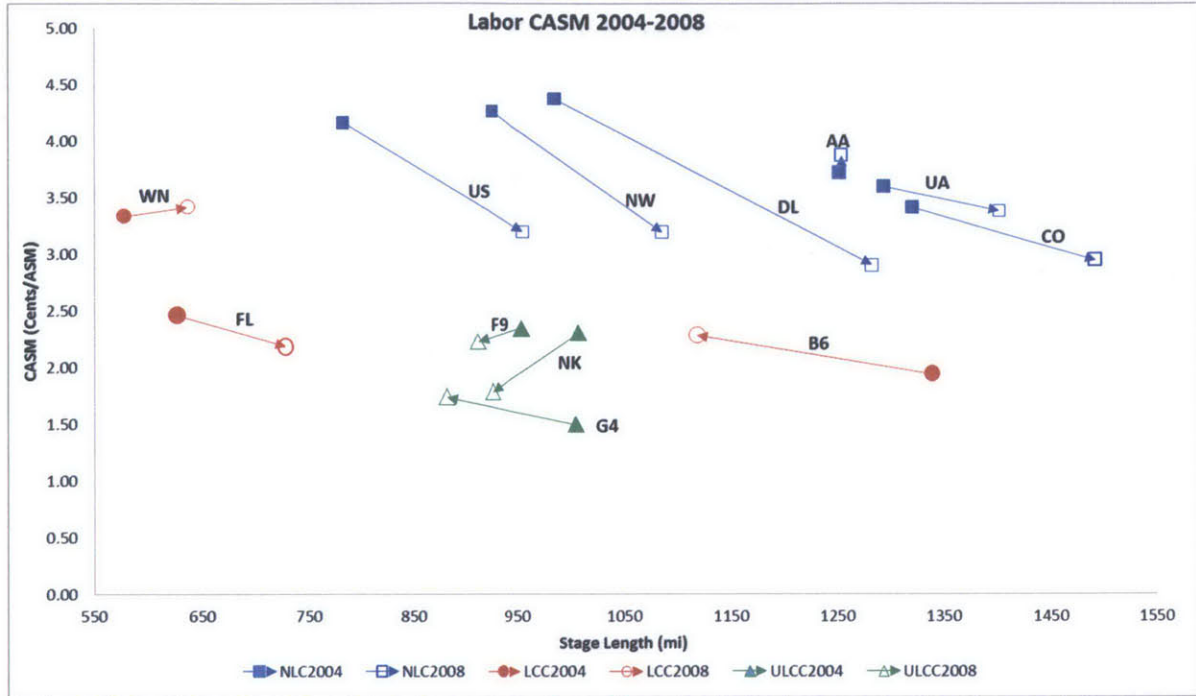


Figure 28 Labor CASM vs Stage Length: Change from 2004 to 2008

In general, legacy carriers fly longer stage lengths and have higher unit costs. Legacy carriers that took cost reduction efforts on both their non-labor and labor costs and stretched to fly longer stage lengths have downward sloped arrows, and those carriers are US, Northwest, American, United, and Continental. AirTran is the only LCC that had lower non-labor and labor unit costs with an increase in stage length in 2008. The rest of LCCs and ULCCs have mixed trends. Southwest's non-labor and labor unit costs both increased with an increase in stage length. Both JetBlue and Allegiant saw increase in labor unit costs with a decrease in stage length. Frontier managed to have a lower unit cost flying shorter stage lengths.

Figure 29 and Figure 30 show individual airlines' non-labor and labor CASM changes with respect to their stage lengths from 2008 to 2012. Both non-labor and labor unit costs for all airlines except Virgin America increased from 2008 to 2012 despite the direction of change in stage length. Southwest, Allegiant, Frontier, US, American, and United increased their stage lengths, while Spirit, JetBlue, and Delta decreased their stage lengths. Southwest consistently has operated shortest stage lengths of all. ULCCs operate shorter stage lengths than the other two LCCs and all of NLCs. In 2012, Virgin America's stage length was comparable to that of NLCs, but it has a much lower unit cost.

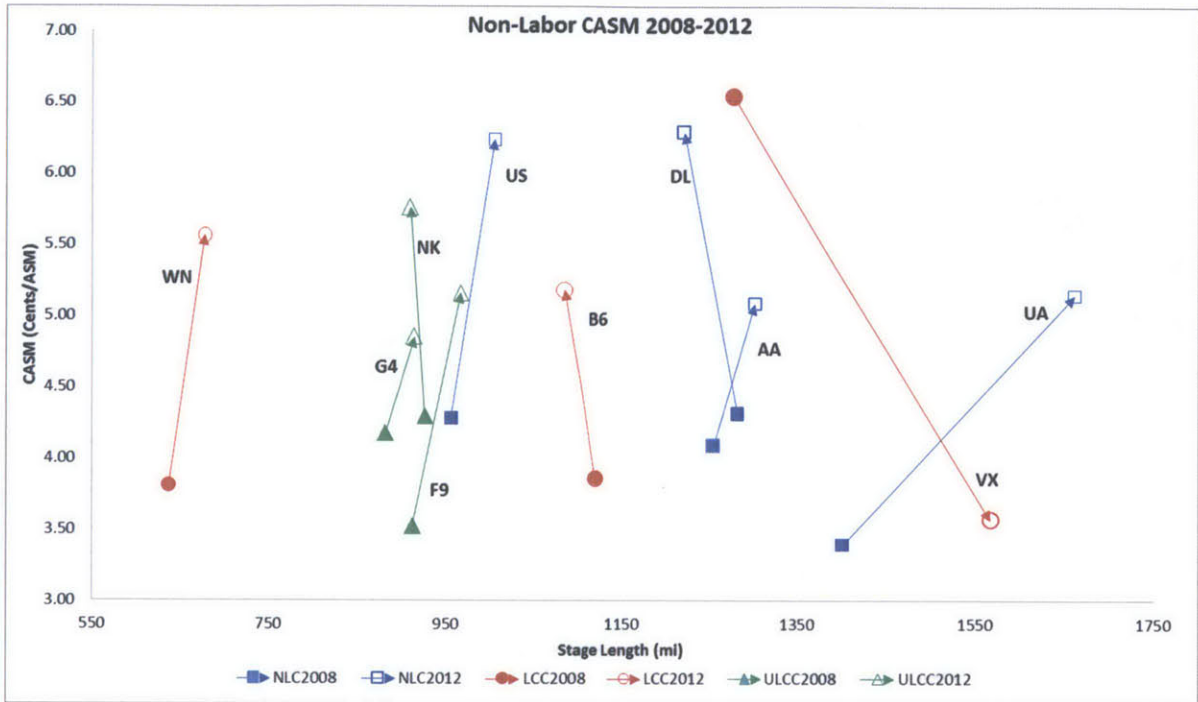


Figure 29 Non-Labor CASM vs Stage Length: Change from 2008 to 2012

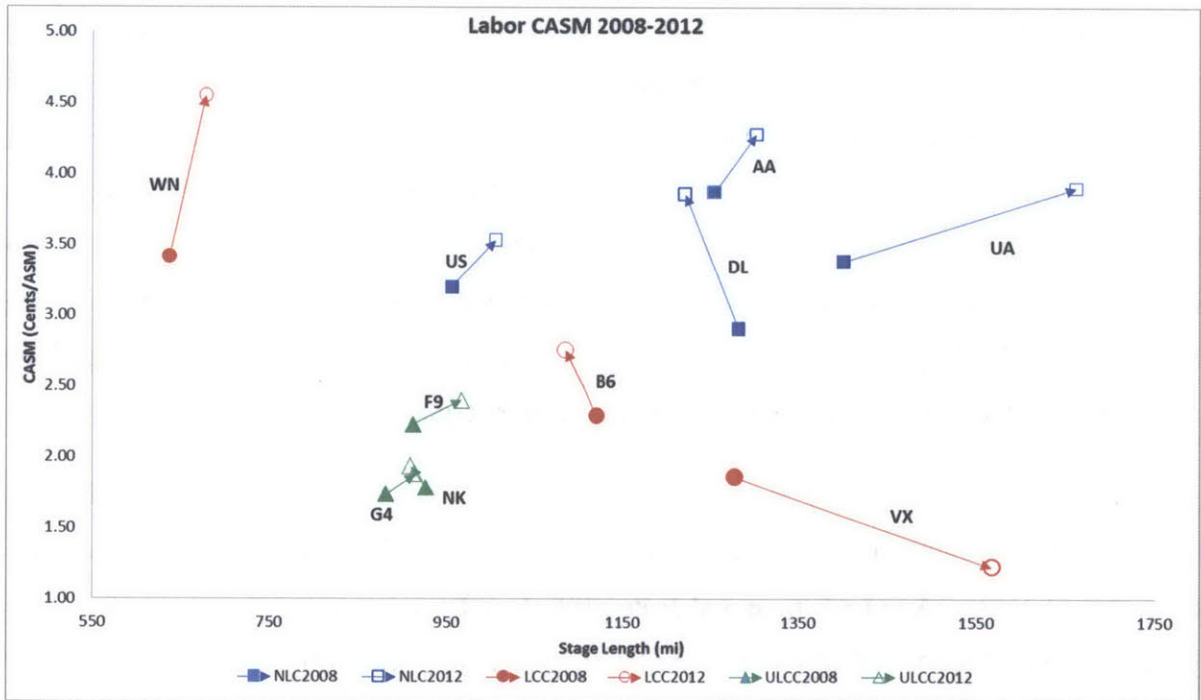


Figure 30 Labor CASM vs Stage Length: Change from 2008 to 2012

Stage length unit cost adjustments are made for this sample of airlines using the industry unit cost curve. The industry unit cost curve slopes downward with respect to airline's average stage length, and unit cost decreases with square root of stage length. The relationship can be expressed as:

$$CASM = K \times (SL)^{0.5}$$

Where K is a constant. This relationship is used for our sample of airlines, and the adjusted unit cost for an airline can be calculated using the formula below:

$$CASM_{adjusted} = CASM \times \left(\frac{SL}{SL_{average}}\right)^{0.5}$$

Where $SL_{average}$ is the average stage length of a sample of airlines⁵².

When all of the airlines are adjusted with respect to the average stage length of the entire sample, unit costs of airlines with stage lengths greater than the average stage length of the sample are adjusted upwards, discounting the theoretical unit cost advantage from flying longer stage lengths. Unit costs of airlines with stage lengths less than the average stage length of the sample are adjusted downwards.

Figure 31 and Figure 32 show the stage length adjusted non-labor and labor unit costs for all airlines in 2004, 2008, and 2012. Compare these charts to Figure 8 and Figure 9, NLCs' unit costs are adjusted up, and LCC and ULCCs' unit costs are adjusted down. The difference between system level and stage length adjusted non-labor and labor unit costs for each aggregate group for 2012 is summarized in Table 4.

⁵² Swelbar, Bill. MIT Airline Management Lecture Notes, *Operating Cost, Productivity and Performance Analysis*, 20 February 2013. Slide 13.

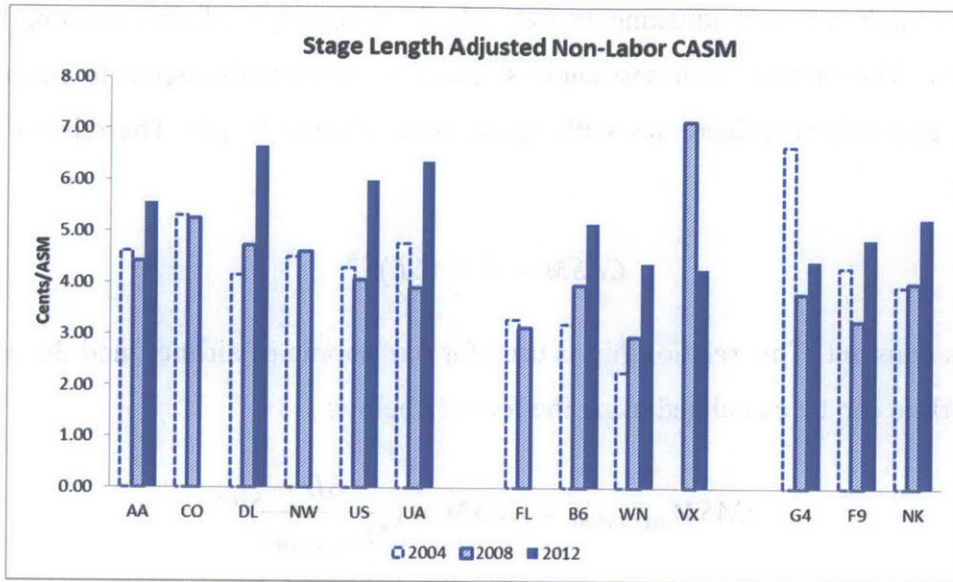


Figure 31 Stage Length Adjusted Non-Labor CASM for Individual Airlines 2004, 2008, and 2012

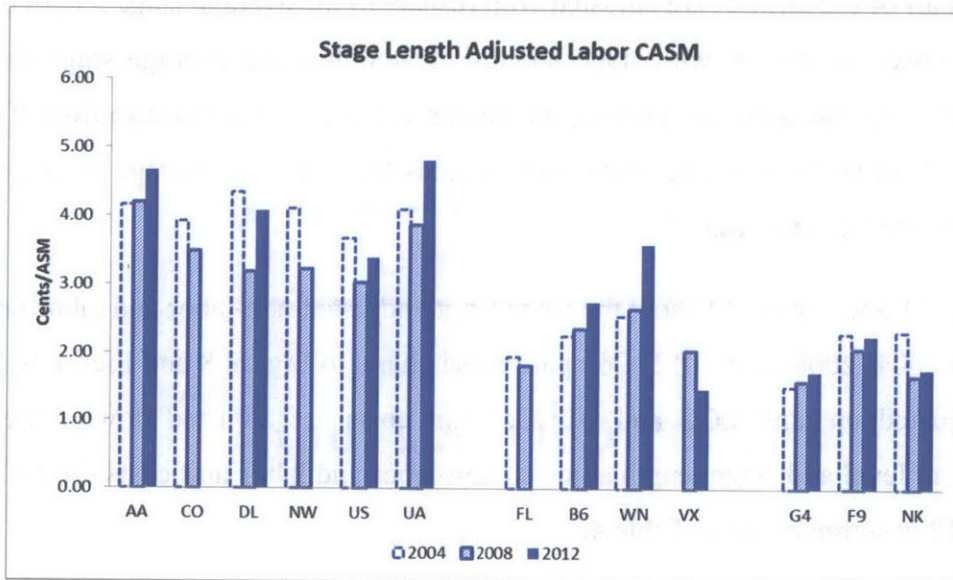


Figure 32 Stage Length Adjusted Labor CASM for Individual Airlines 2004, 2008, and 2012

2012	Non-Labor CASM (Cents/ASM)			Labor (Cents/ASM)		
	System	SL-Adj	Δ	System	SL-Adj	Δ
NLC average	5.69	6.12	0.43	3.90	4.23	0.33
LCC average	4.78	4.60	-0.18	2.85	2.60	-0.25
ULCC average	5.26	4.84	-0.42	2.08	1.91	-0.17

Table 4 Aggregate: System versus Stage Length Adjusted Unit Costs

The difference between system level and stage length adjusted unit costs for individual airlines in 2012 is summarized in Table 5. US Airways has the lowest average stage length among NLCs, and its unit costs are adjusted down. United has the highest average stage length among NLCs, and it has the highest unit cost adjustment upward. Virgin America has the longest average stage length among LCCs, and its unit cost is adjusted up while the other LCCs' unit costs are adjusted down. Southwest has the shortest average stage length among LCCs, and its unit cost has the highest adjustment downward. All ULCCs' unit costs are adjusted down.

2012	Non-Labor CASM (Cents/ASM)			Labor (Cents/ASM)		
	System	SL-Adj	Δ	System	SL-Adj	Δ
American Airlines	5.09	5.54	0.46	4.28	4.66	0.38
Delta Airlines	6.29	6.63	0.35	3.86	4.07	0.21
US Airways	6.24	5.97	-0.27	3.54	3.38	-0.15
United Airlines	5.15	6.33	1.19	3.90	4.80	0.90
JetBlue Airways	5.19	5.15	-0.03	2.76	2.74	-0.02
Southwest Airlines	5.57	4.38	-1.19	4.55	3.58	-0.97
Virgin America	3.57	4.27	0.70	1.23	1.47	0.24
Allegiant Air	4.85	4.43	-0.42	1.88	1.72	-0.16
Frontier Airlines	5.16	4.84	-0.32	2.41	2.26	-0.15
Spirit Airlines	5.76	5.24	-0.52	1.94	1.76	-0.17

Table 5 Individual Airlines: System versus Stage Length Adjusted Unit Costs

Table 6 shows the rankings of the stage length adjusted unit costs by individual airlines. Comparing the rankings here with those in Table 2, several airlines' ranking positions have changed. Southwest and United have the most notable changes. Southwest's non-labor unit cost dropped from #7 in Table 2 to #2 in Table 6, which shows Southwest's significant non-labor unit cost efficiency operating short stage lengths. Southwest's labor unit cost is the highest at the system level but dropped to #7 after adjusting for stage length. Overall, Southwest's $CASM_{exTF}$ dropped below all legacy carriers'. United Airlines moved up from #4 in Table 2 to #9 Table 6 after its non-labor unit cost is adjusted for its long average stage length. Overall, United's stage length adjusted $CASM_{exTF}$ is the highest among all the airlines.

2012 Non-Labor CASM Ranking		2012 Labor CASM Ranking		2012 CASM _{EXTF} Ranking	
Airline	CASM (Cents/ASM)	Airline	CASM (Cents/ASM)	Airline	CASM (Cents/ASM)
1 Virgin America	4.27	1 Virgin America	1.47	1 Virgin America	5.74
2 Southwest Airlines	4.38	2 Allegiant Air	1.72	2 Allegiant Air	6.15
3 Allegiant Air	4.43	3 Spirit Airlines	1.76	3 Spirit Airlines	7.01
4 Frontier Airlines	4.84	4 Frontier Airlines	2.26	4 Frontier Airlines	7.10
5 JetBlue Airways	5.15	5 JetBlue Airways	2.74	5 JetBlue Airways	7.89
6 Spirit Airlines	5.24	6 US Airways	3.38	6 Southwest Airlines	7.96
7 American Airlines	5.54	7 Southwest Airlines	3.58	7 US Airways	9.35
8 US Airways	5.97	8 Delta Airlines	4.07	8 American Airlines	10.21
9 United Airlines	6.33	9 American Airlines	4.66	9 Delta Airlines	10.70
10 Delta Airlines	6.63	10 United Airlines	4.80	10 United Airlines	11.14

Table 6 2012 Stage Length Adjusted: CASM Rankings for All Airlines

Summary:

Both stage length adjusted and non-adjusted unit cost results consistently show that on average, ULCCs operate at lower costs than LCCs and NLCs, and ULCCs have cost advantage over the other two groups for both non-labor and labor unit cost components. The stage length adjusted results show the cost efficiency of Southwest and indicate that the new United has difficulties with its cost. The stage length adjusted results are better representations of cost and operational efficiency of the airlines.

Chapter 4: Aircraft Productivity Analysis

Results from our aircraft productivity analysis are presented in this chapter. The first section of this chapter presents the overall industry trends at the system aggregate level comparing aircraft productivity of NLCs, LCCs, and ULCCs, and it also examines the changes in aircraft productivity at the individual airlines level. The second section presents results from comparisons of aircraft productivity from domestic operations only at the aggregate level. Lastly, the third section shows the effect of stage lengths on aircraft utilization and productivity and compares individual airlines' aircraft utilization and productivity after stage length adjustments.

4.1 System Aggregate Aircraft Productivity

4.1.1 Aggregate Industry Aircraft Productivity Comparisons for NLCs, LCCs, and ULCCs

In this section, we present the general trends of the system aggregate aircraft utilization and productivity measures for NLCs, LCCs, and ULCCs from 2004 to 2012. Aircraft utilization is expressed in block hours per aircraft day, and aircraft productivity is measured by ASMs produced per aircraft day. Aircraft days are the number of days the aircraft are under the airlines' ownership through either rental or lease and are directly related to airlines' available capacity. When the increase in aircraft days is outpacing the growth of block hours and ASMs, airlines' aircraft utilization and productivity would decrease. In this section, our main focus is to compare these productivity measures at the system aggregate level, to examine how these measures changed over time for the three airlines groups, and to identify the drivers behind these changes in trends.

Figure 33 shows the trends of aircraft utilization of the three groups. From 2004 to 2012, NLCs' aircraft utilization decreased by 1.64% and had been stable at about 10.3 hours/day. Figure 34 and Figure 35 show that NLCs, especially those that filed bankruptcies in the early 2000s aggressively downsized and reduced capacity from 2004 to 2006, and the sharp decrease in their block hours and aircraft days post 2008 was from the further reductions in capacity and flights in response to the high fuel prices and the significant decrease in air traffic demand as a

result of the economic crisis. The decrease in total block hours is slower than the decrease in aircraft days since 2008, and NLCs' aircraft utilization increased slightly from 2009 to 2012.

LCCs' aircraft utilization decreased by 12.1% from 11.19 hours/day 2004 to 9.84 hours/day in 2009 due to the rapid increase in aircraft days. LCCs were losing their operational efficiency and having difficulties keeping up with their rapid growth in capacity, outputting ASMs at a much slower rate. From 2009 to 2012, LCCs' aircraft days decreased, while their total block hours continued to grow, and LCCs regained their operational efficiency, which can be seen from the increase in total block hours in Figure 34. LCCs' aircraft utilization improved by 18.5% from 9.84 hours/day in 2009 to 11.66 hours/day in 2012.

ULCCs' aircraft utilization trended downward from 2006 to 2012 and decreased by 16.6% from 2004 to 2012. ULCCs have been aggressively expanding their network and increasing capacity, and overall their increase in aircraft days outpaced their increase in block hours.

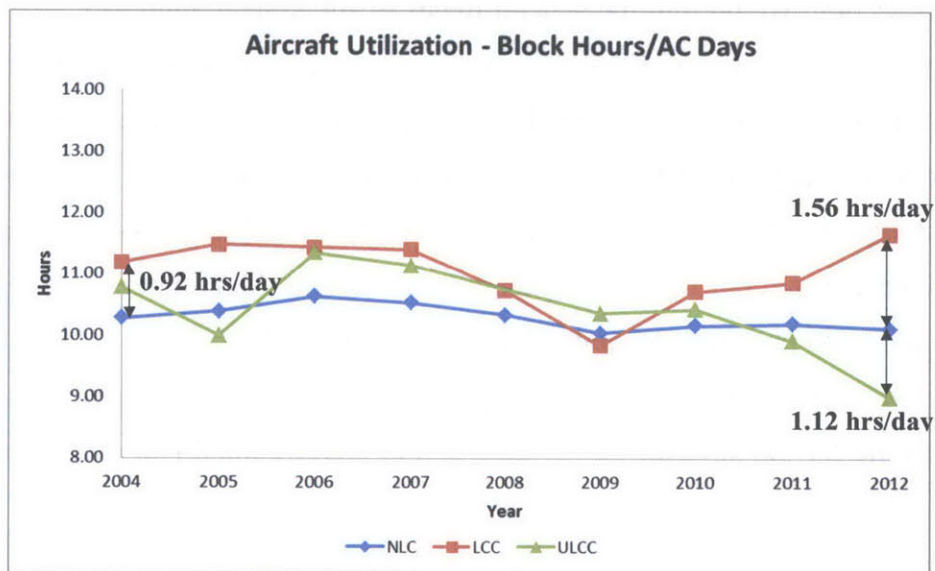


Figure 33 System Aggregate Comparison: Aircraft Utilization

*ULCC's aircraft utilization data point is removed for 2008 due to an incorrect reporting of Frontier's total block hours for 2008.

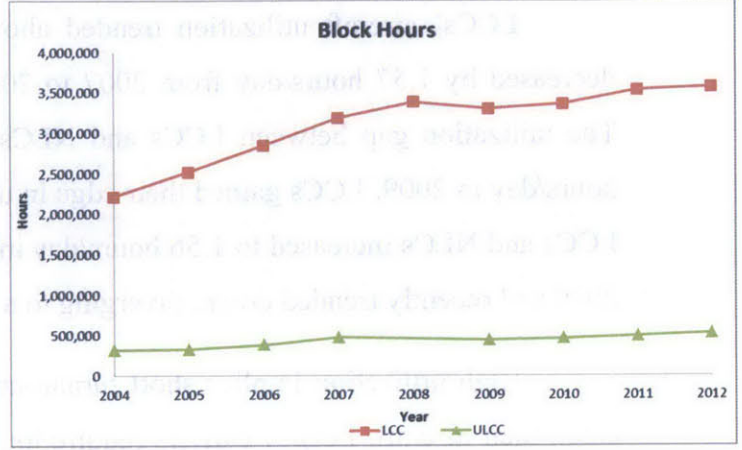
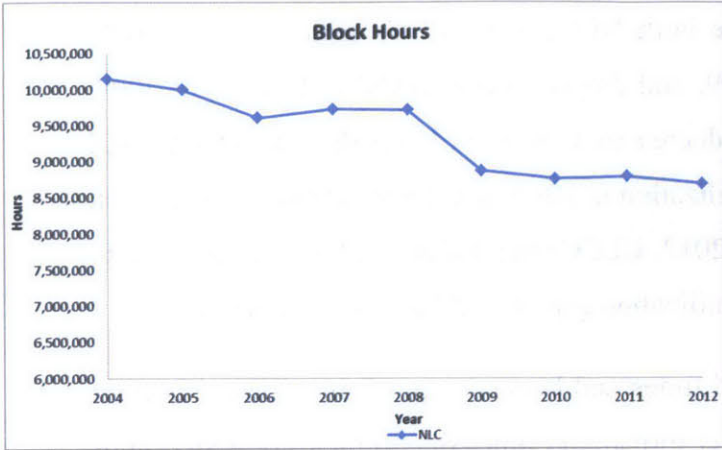


Figure 34 System Aggregate: Block Hours

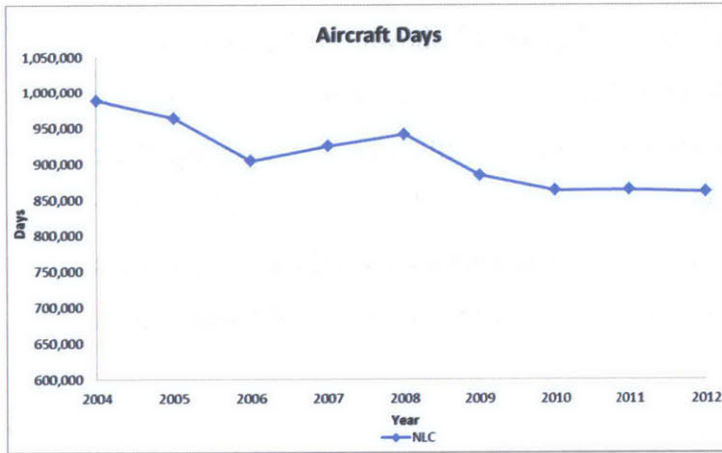


Figure 35 System Aggregate: Aircraft Days

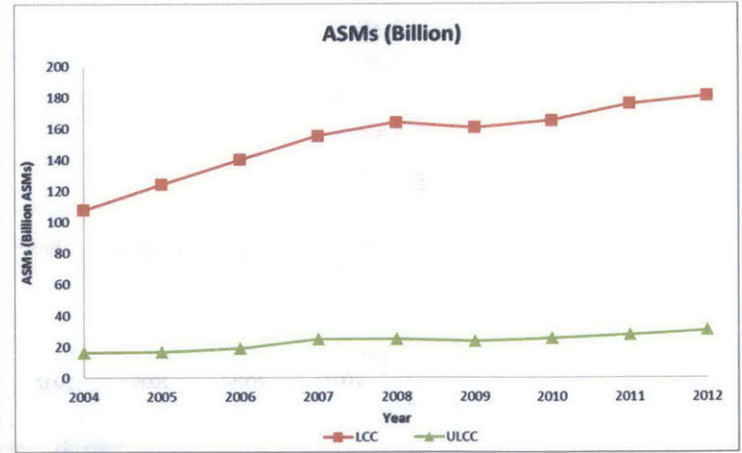
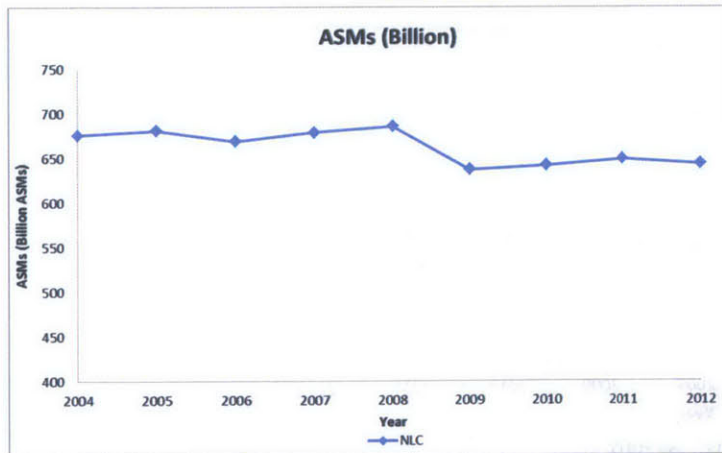


Figure 36 System Aggregate: ASMs

LCCs' aircraft utilization trended above both NLCs and ULCCs from 2004 to 2007, decreased by 1.57 hours/day from 2007 to 2009, and dipped under NLCs' utilization in 2009. The utilization gap between LCCs and NLCs decreased from 0.92 hours/day in 2004 to -0.2 hours/day in 2009. LCCs gained their edge in utilization in 2010, and the utilization gap between LCCs and NLCs increased to 1.56 hours/day in 2012. ULCCs trended above NLCs from 2006 to 2010 and recently trended down, diverging to a utilization gap of 1.12 hours/day under NLCs.

High utilization implies short turnaround times and better usage of the airlines' biggest asset, their aircraft. Legacy carriers require longer turnaround times due to their congested hubs and larger aircraft. Stage length is an advantage of legacy carriers, because longer stage length directly translates into longer flying time in the air. As Figure 37 shows, NLCs consistently operate about 500 miles longer average stage length than LCCs. In order to compensate for flying lower stage lengths, LCCs and ULCCs increase aircraft utilization by keeping their turnaround times short, which leads to performing greater number of flights. Although the low cost carriers are comparatively smaller in network size and use smaller aircraft, having excess capacity and expanding their fleet faster than the ASMs they can produce could result in a decrease in utilization.

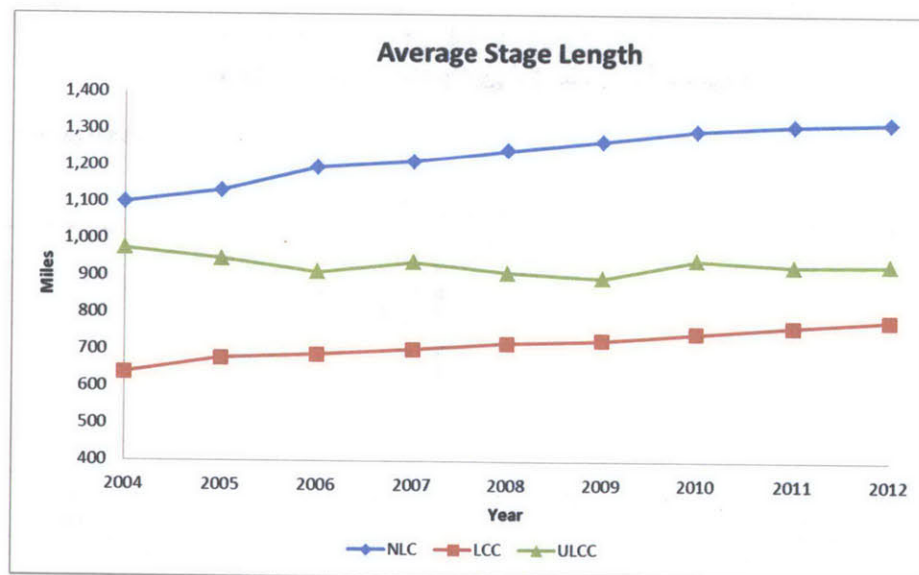


Figure 37 System Aggregate: Average Stage Length

Figure 38 shows trends of aircraft productivity of the three groups. NLCs' consistently had the highest aircraft productivity, which increased by 9.3% from 2004 to 2012. The three

factors that affect ASMs are stage length, number of departures performed, and number of seats per aircraft. Flying longer stage lengths, carrying more passengers on board, and perform greater number of departures per day can increase ASMs and aircraft productivity.

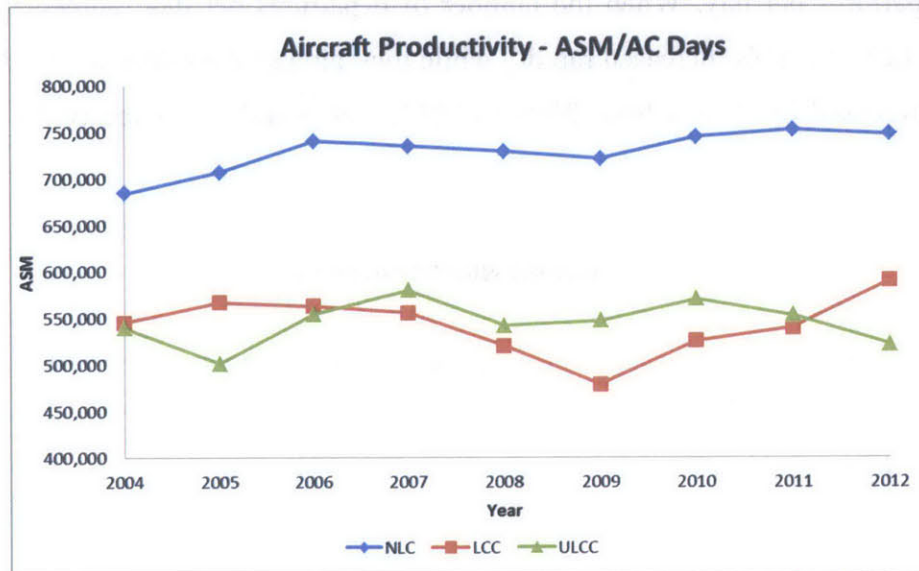


Figure 38 System Aggregate: Aircraft Productivity

As Figure 37, Figure 39, and Figure 40 show, NLCs had most significant increase in average stage length and average number of seats per aircraft. NLCs’ stage length increased by 20% from 1,100 miles in 2004 to 1,319 miles in 2012, and their average number of seats increased by 5.7% from 170 seats in 2004 to 180 seats in 2012. NLCs’ number of departures per aircraft per day decreased by 14.44% from 3.6 departures in 2004 to 3.1 departures in 2012. Larger airplanes and less number of departures per aircraft per day reflect NLCs’ shift of focus to international markets. Overall, NLCs’ total ASMs decreased at a slower rate than their aircraft days, and their aircraft productivity increased by 9.3% from 2004 to 2012.

LCCs’ average stage length increased by 22.43% from 639 miles in 2004 to 783 miles in 2012, and their average number of seats stayed flat about 137 seats per aircraft from 2004 to 2012. LCCs’ number of departures per aircraft per day decreased by 22.23% from 6.2 departures in 2004 to 4.9 departures in 2009 but increased to 5.5 departures in 2012. The significant decrease in the number of departures from 2004 to 2009 resulted in the slow growth in ASMs, which was outpaced by the growth in aircraft days, and LCCs’ aircraft productivity decreased by 12.2%. Since LCCs had been increasing their average stage length while keeping their average

number of seats constant, they were expanding their flying into long haul flights, and the tradeoff for longer average stage length was the decrease in the number of departures per aircraft day. From 2004 to 2009, LCCs' increased average stage length did not offset the decrease in the number of departures per day. When the number of departures per day ramped back up from 2010 to 2012, LCCs' ASMs increased rapidly while their aircraft days decreased. LCCs' aircraft productivity increased by 23.3% from 2009 to 2012, and overall, it increased by 8.28% from 2004 to 2012.

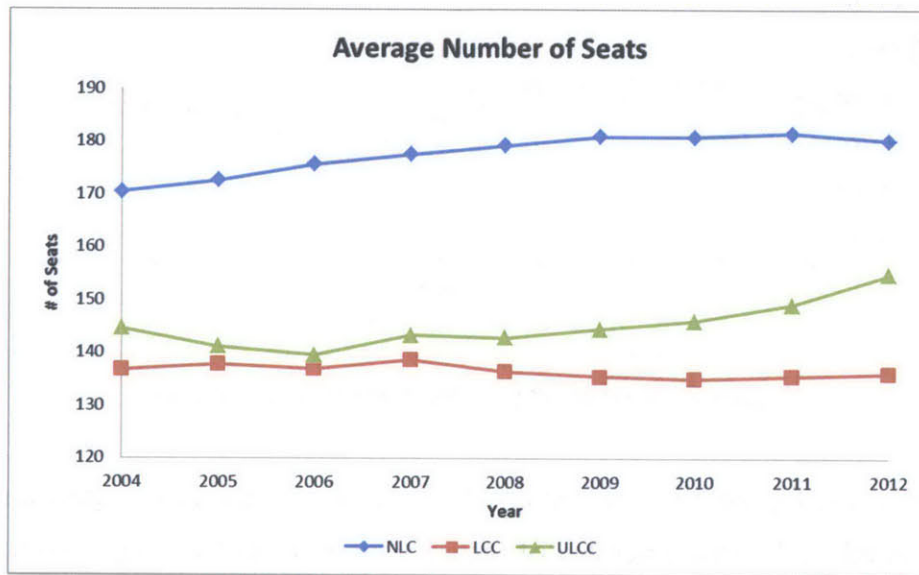


Figure 39 System Aggregate: Average Number of Seats per Aircraft

ULCCs' average stage length decreased by 6.63% from 975 miles in 2004 to 93 miles in 2012 and their average number of seats per aircraft increased by 7.11% from 144 seats in 2004 to 155 seats in 2012. ULCCs' number of departures per aircraft per day increased sharply from 3.95 departures in 2005 to 4.6 departures in 2006, but declined to 3.6 departures per aircraft per day in 2012, a 20.4% decrease from 2006. Since ULCCs did not increase their average stage length but added capacity from 2004 to 2012. The decrease in the number of departures per aircraft day was likely due to longer turnaround times for larger airplanes. Overall, ULCCs' increase in aircraft days outpaced their increase in production of ASMs. ULCCs' aircraft productivity decreased from 2004 to 2012 by 3.32%. There was no sign of significant aircraft productivity improvement, and ULCCs were not able to produce more ASMs with their significant increase in capacity.

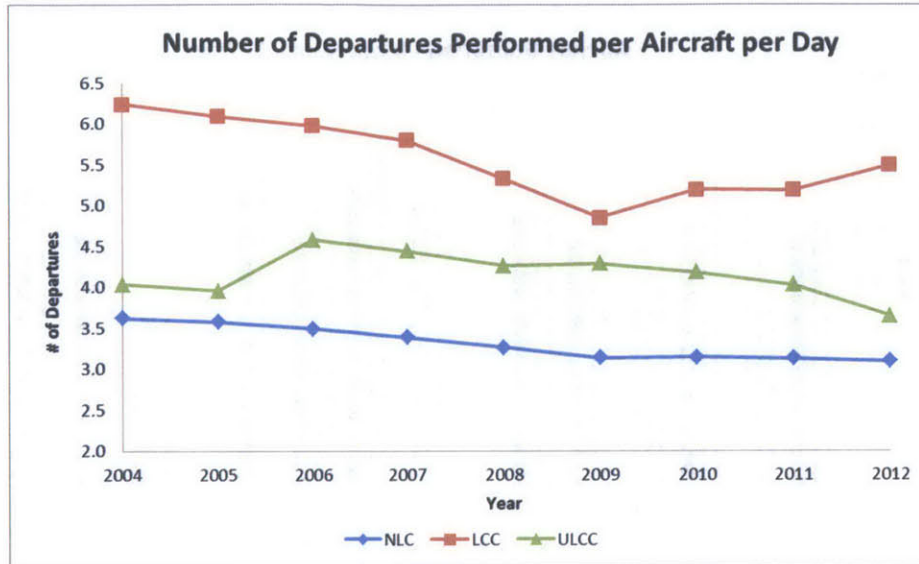


Figure 40 System Aggregate: Number of Departures per Aircraft per Day

Overall NLCs’ longer average stage length and larger airplanes contributed to their advantage in aircraft productivity over the other two groups. LCCs’ number of departures per aircraft per day has consistently been the highest, but its decrease from 2007 to 2011 positioned LCCs at the lowest aircraft productivity among the three groups. ULCCs added more seats to their airplanes but did not fly longer stage length and performed more departures per aircraft per day. The trending down of ULCCs’ aircraft utilization and productivity from 2009 to 2012 shows a decline in efficiency.

4.1.2 System Aggregate Aircraft Productivity Comparisons for Individual Airlines

In this section, we look at individual airlines’ aircraft utilization and productivity, and how these two measures changed from 2004 to 2012. Figure 41 and Figure 42 show the aircraft utilization and productivity for all airlines in 2004, 2009, and 2012, and Figure 43 shows the percent change of these two measures from 2004 to 2012. Table 7 shows the rankings of aircraft utilization and productivity for all airlines.

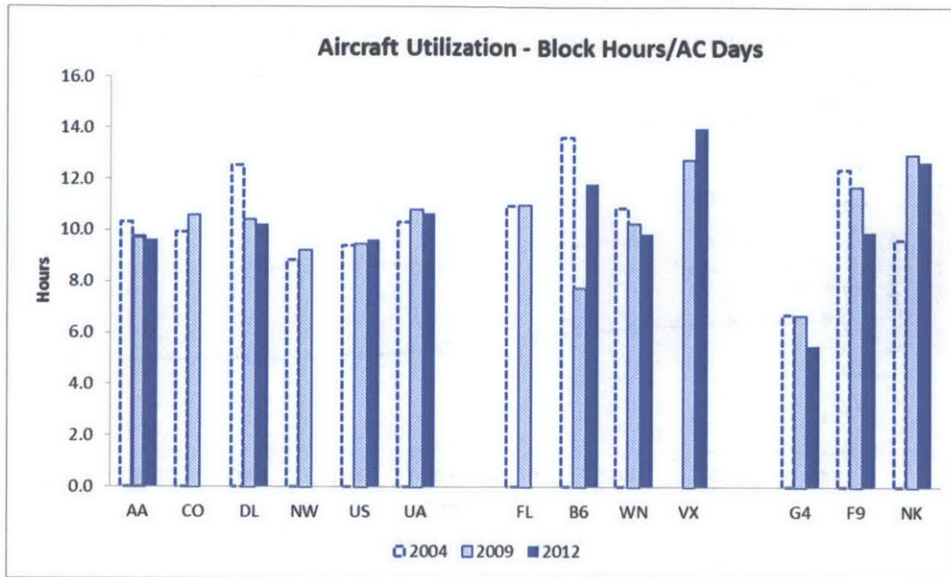


Figure 41 Aircraft Utilization for Individual Airlines 2004, 2009, and 2012

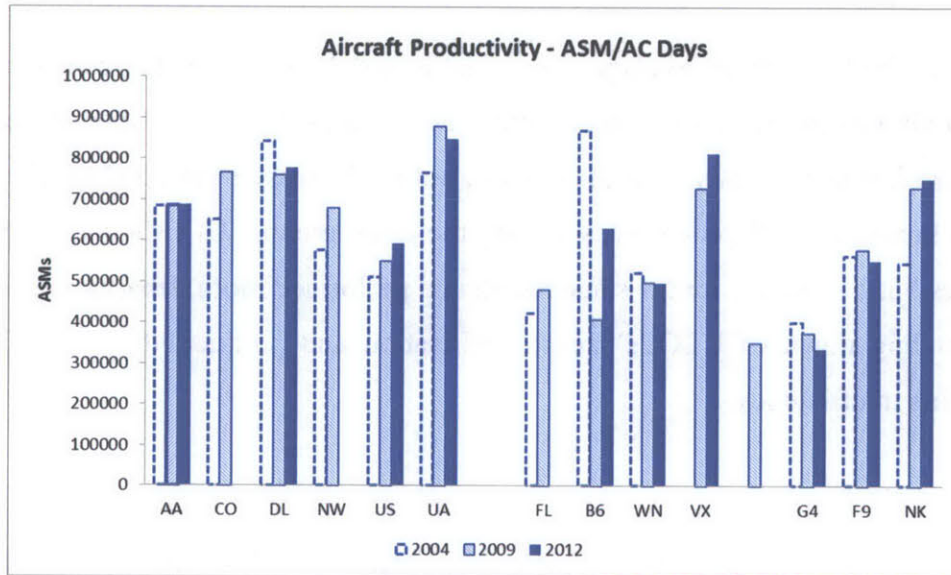


Figure 42 Aircraft Productivity for Individual Airlines 2004, 2009, and 2012

2012 Aircraft Utilization		2012 Aircraft Productivity	
Airline	Block Hours/AC Day	Airline	ASMs/AC Day
1 Virgin America	14.0	1 United Airlines	847558
2 Spirit Airlines	12.7	2 Virgin America	811420
3 JetBlue Airways	11.8	3 Delta Airlines	776086
4 United Airlines	10.7	4 Spirit Airlines	749675
5 Delta Airlines	10.2	5 American Airlines	687939
6 Frontier Airlines	9.9	6 JetBlue Airways	629959
7 Southwest Airlines	9.9	7 US Airways	592894
8 American Airlines	9.6	8 Frontier Airlines	551528
9 US Airways	9.6	9 Southwest Airlines	495568
10 Allegiant Air	5.5	10 Allegiant Air	334642

Table 7 2012 System: Aircraft Utilization and Productivity Rankings for All Airlines

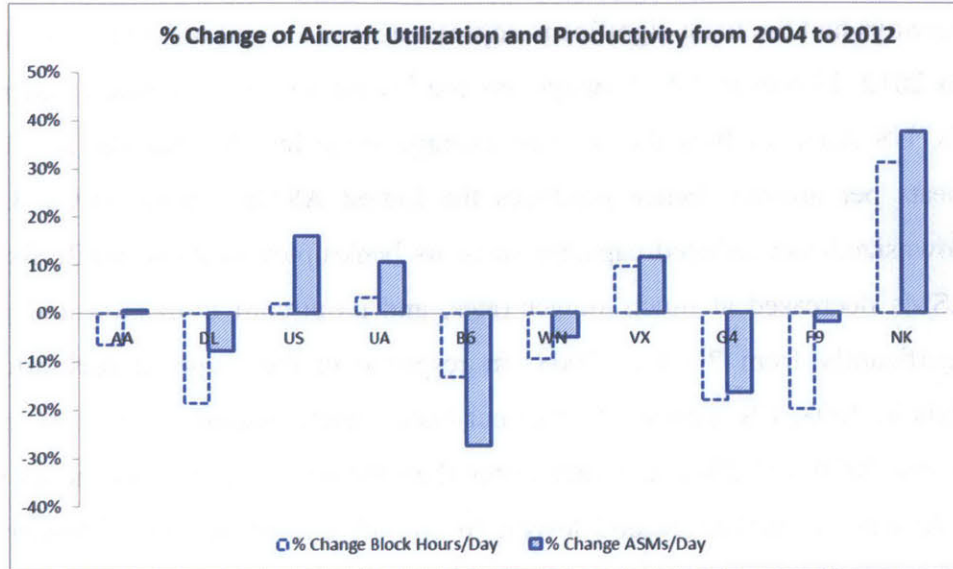


Figure 43 Percent Change of Aircraft Utilization and Productivity from 2004 to 2012

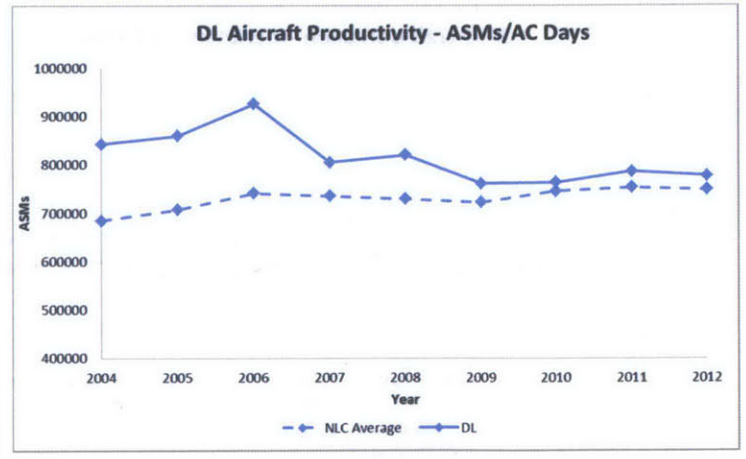
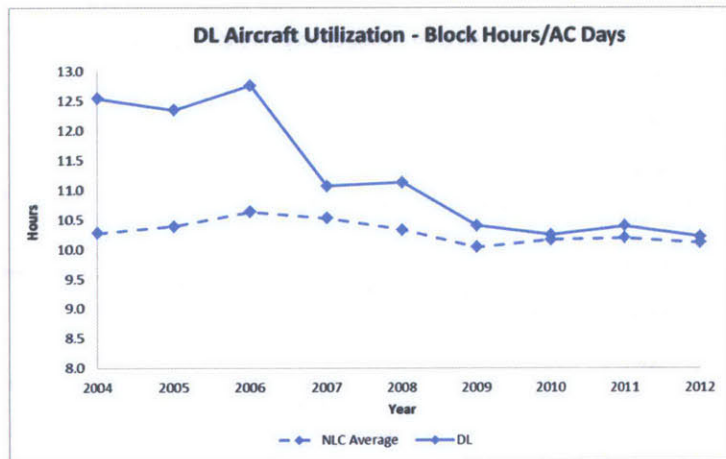
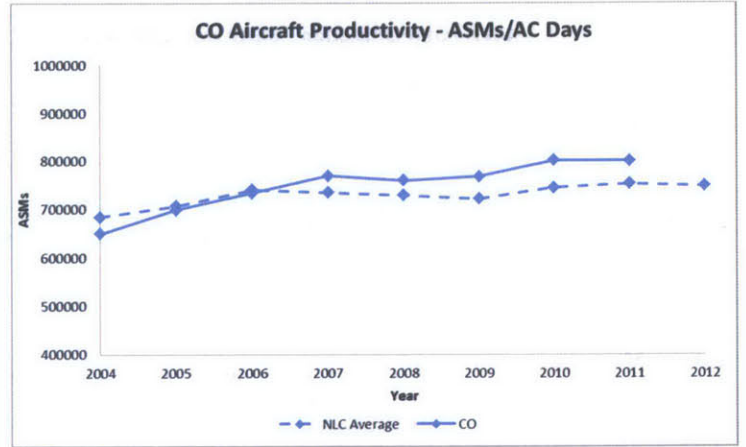
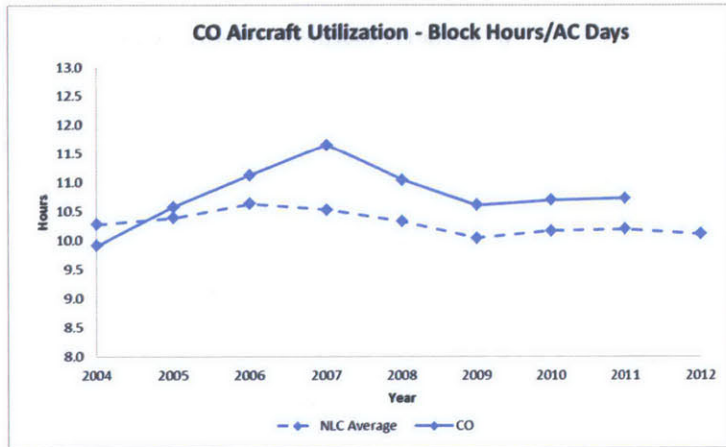
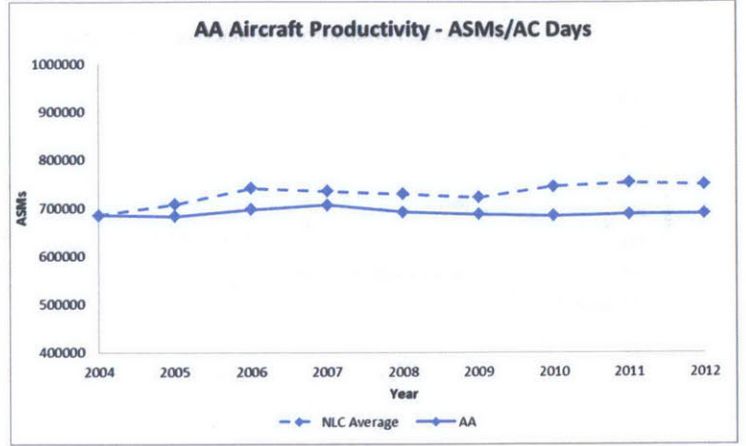
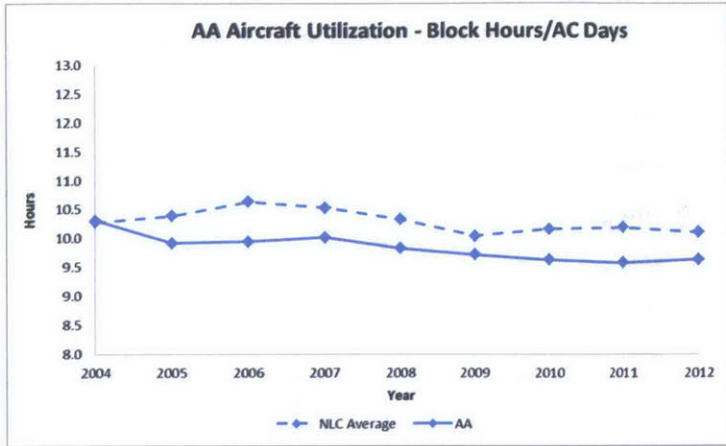
4.1.2.1 Individual Network Legacy Carriers Aircraft Productivity

Figure 44 shows aircraft utilization and productivity trends for individual network legacy carriers plotted with NLCs' group average. Continental, Delta, and United consistently maintained above NLCs' group average utilization and productivity, while American, Northwest and US trended below group average. From 2004 to 2012, all of NLCs but American and Delta successfully increased their aircraft utilization and productivity.

From 2004 to 2012, Delta had the greatest decline in both aircraft utilization and productivity, and the most significant decline was from 2004 to 2007, the time period when Delta was going through its bankruptcy and significantly downsized and cut back its flights. Delta has the highest number of aircraft days among NLCs. From 2004 to 2009, its aircraft utilization decreased because its rate of increase in aircraft days was much greater than the rate of increase in block hour. In response to the high fuel prices and the economic crisis, Delta further reduced its capacity from 2009 to 2012. Delta's aircraft productivity decreased during the same time period, because it was unable to increase its ASM production as quickly as the rate of increase in its aircraft days. Delta's slower growth of its ASM was due to its significant reduction in number of departure performed from 4.7 departures per day in 2004 down to 3.3 departures per day in 2012. Delta's aircraft utilization and productivity have been stable since its merger with Northwest in 2010, which shows that the new Delta has been able to increase its ASMs and block hours as fast as its increase in capacity post-merger.

US Airways had the most significant improvement in aircraft utilization and productivity from 2004 to 2012. However, US Airways has the lowest aircraft utilization and productivity among NLCs. US Airways flies the shortest average stage length, has the smallest average number of seats per aircraft, hence produces the lowest ASMs among NLCs. US Airways significantly downsized and reduced capacity since its bankruptcy in 2004, while its total block hours and ASMs decreased at much slower rates, and its aircraft utilization and productivity increased significantly from 2004 to 2008. In response to the surge in fuel prices and the economic crisis in 2008, US Airways further cut back routes, grounded airplanes, and reduced capacity between 2010 and 2012 at a rate faster than the decrease in block hours and ASMs. Overall, US Airways is ranked second lowest in aircraft utilization and 4th lowest in aircraft productivity among all of the airlines. American Airlines' aircraft productivity had been stable from 2004 to 2012, but its aircraft utilization decreased. Like other NLCs, American significantly reduced its capacity over the years in response to the rising fuel prices and the economic recession. American shifted its focus to international operations, and even though its total block hour decreased at a faster rate than its aircraft days, it was able to maintain its ASM production. Although American filed bankruptcy in 2011, there is no significant change in its aircraft utilization and productivity since then.

United Airlines had the second most significant improvement in aircraft utilization and productivity from 2004 to 2012, and it has the highest aircraft utilization and productivity among NLCs. United's aircraft utilization increased most significantly from 2004 to 2006 due to the reduction in the number of aircraft and downsizing it implemented since its bankruptcy in 2004, while its total block hours and ASMs decreased at slower rates. After it exited bankruptcy in 2006, the increase in its aircraft utilization and productivity slowed down but increased when further reduction in capacity was implemented between 2008 and 2010. After its merger with Continental Airlines, the new United struggled to increase its ASM production and block hours as fast as the increase in capacity from the merger, and its aircraft utilization and productivity decreased from 2010 to 2012. Despite the recent decline in these two measures, United flies the longest average stage length and has the largest average number of seats per aircraft among NLCs, and United also consistently has below NLCs' group average aircraft days. United has significant advantage in aircraft productivity over other airlines, and it is ranked the 4th highest in aircraft utilization and the highest in aircraft productivity among all of the airlines.



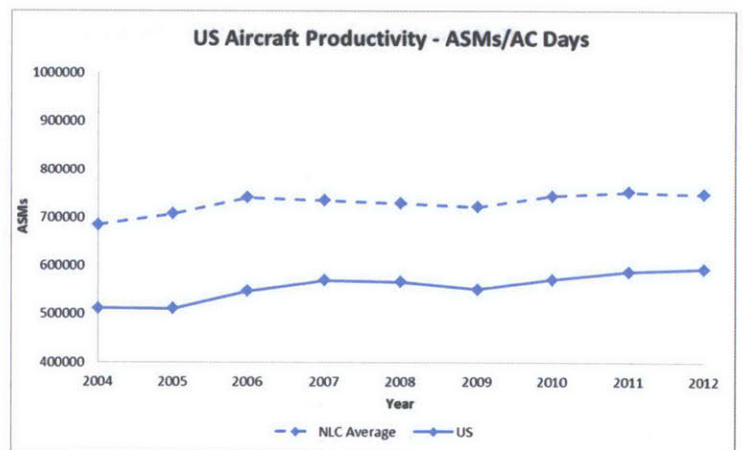
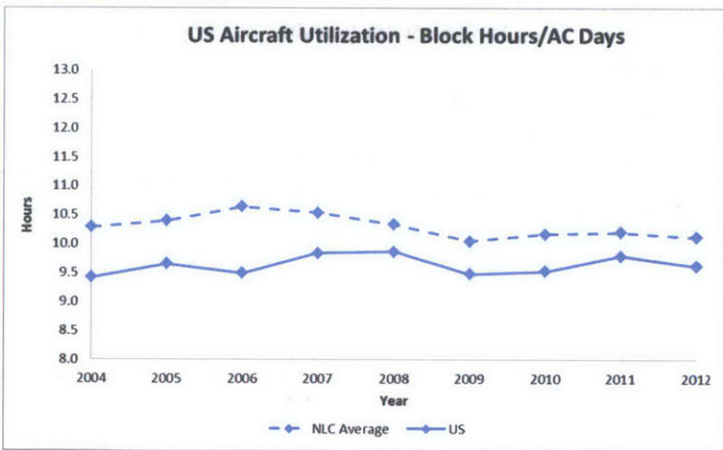
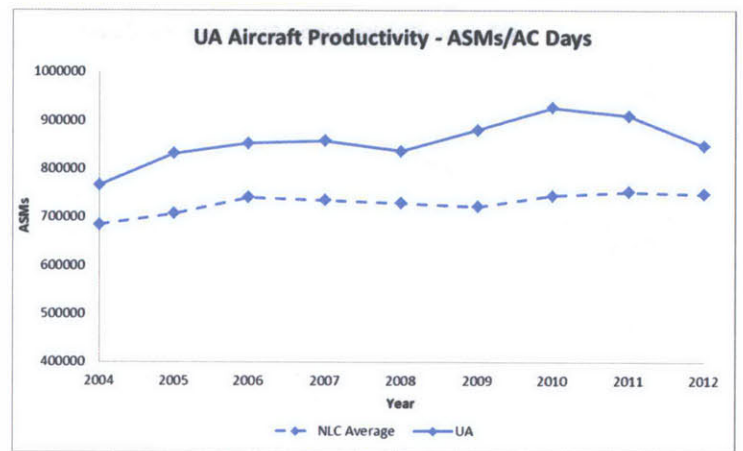
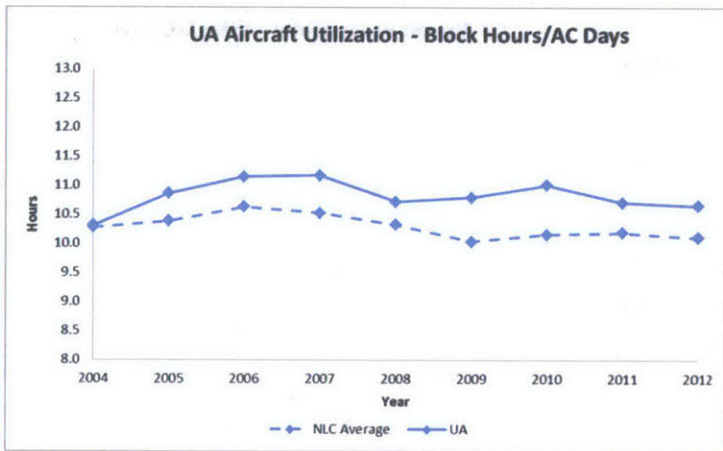
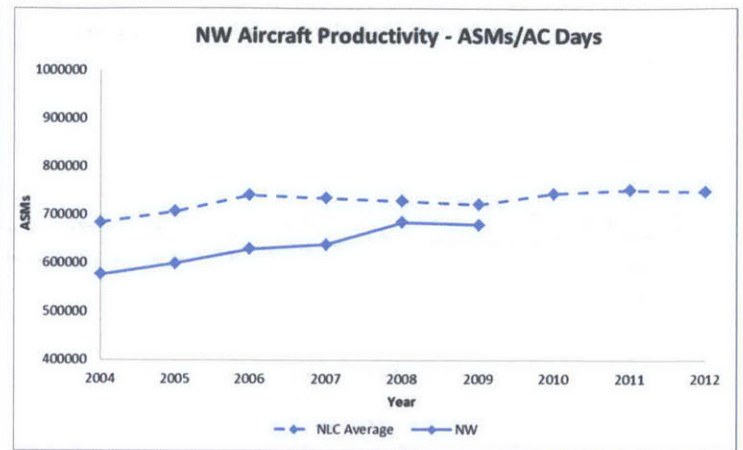
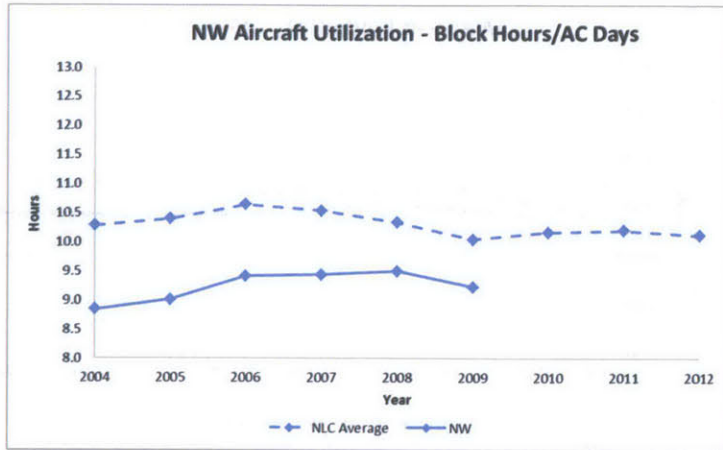


Figure 44 Individual Network Legacy Carriers: Aircraft Utilization and Productivity

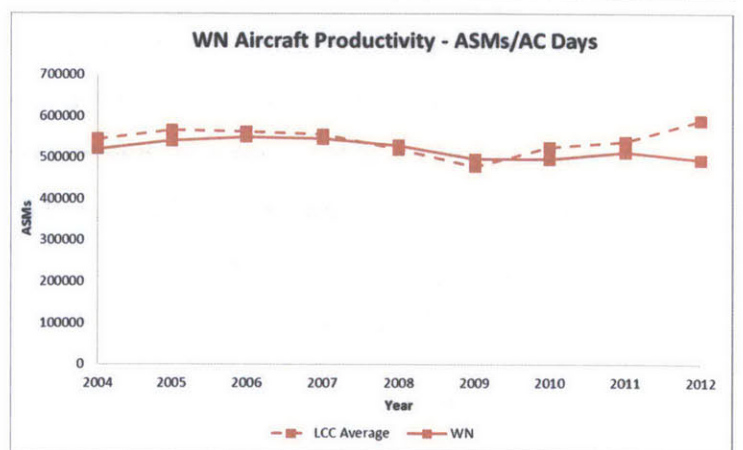
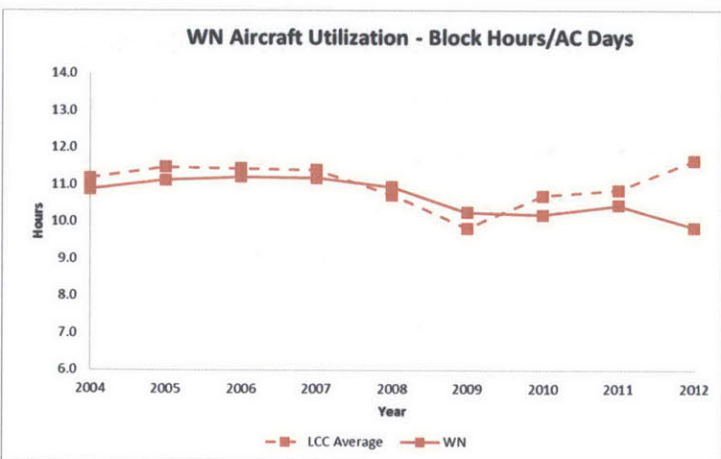
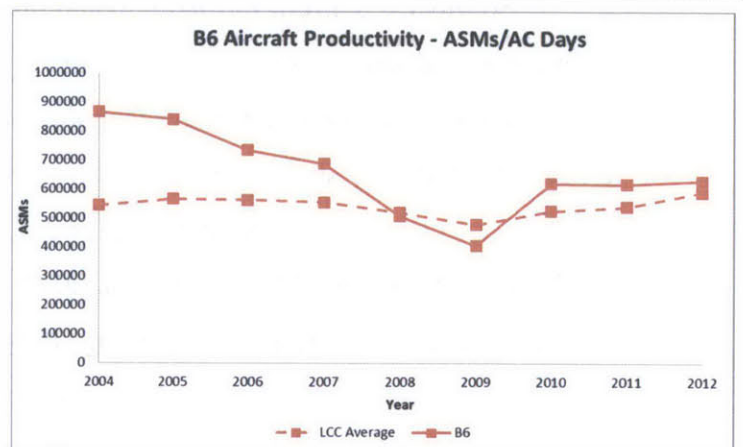
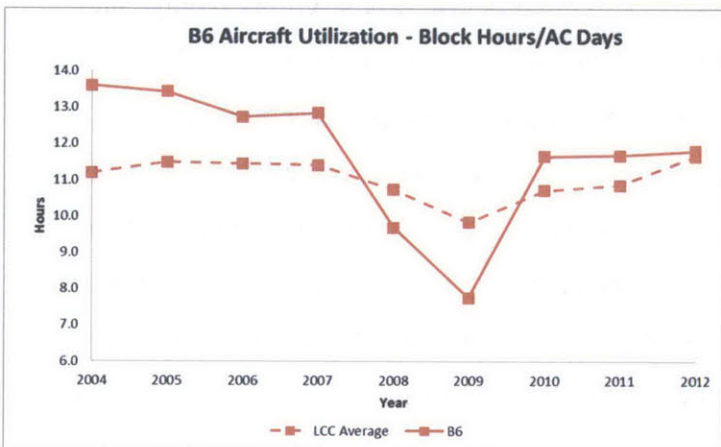
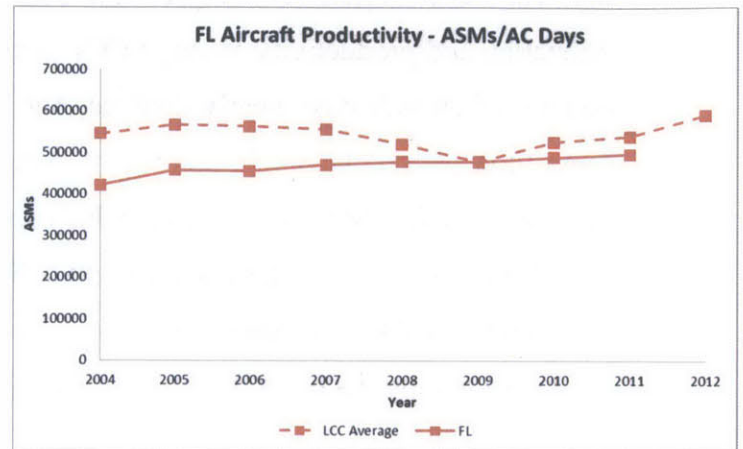
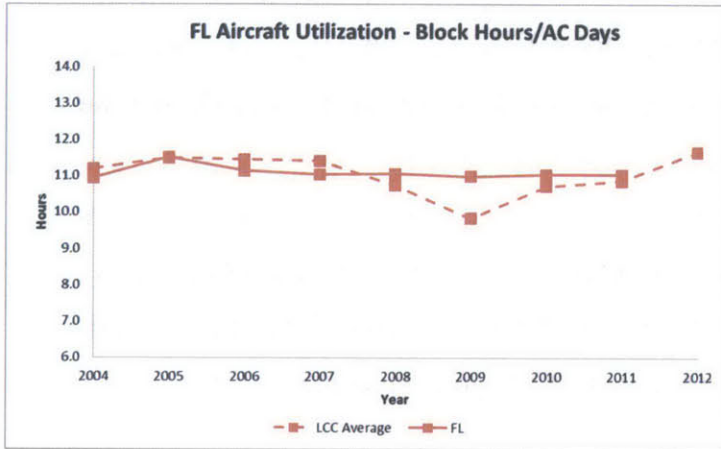
4.1.2.2 Individual Low Cost Carriers Aircraft Productivity

Figure 45 shows aircraft utilization and productivity trends for individual low cost carriers plotted with LCCs' group average. AirTran's aircraft utilization and productivity stayed flat from 2004 until its merger with Southwest in 2011. JetBlue had the highest aircraft utilization and productivity among LCCs from 2004 to 2007. Between 2007 and 2009, JetBlue's number of aircraft days nearly doubled, but its block hours only increased by 4%. During the same time period, JetBlue's number of departures per aircraft decreased from 4.2 to 2.7 and average stage length also decreased, which results in almost no increase in ASMs. These factors contributed to JetBlue's sharp decrease in both aircraft utilization and productivity between 2007 and 2009. JetBlue cut down 30% of its aircraft days in 2010, and since then, their aircraft utilization and productivity improved and trended above the LCC group average.

Southwest's aircraft utilization and productivity trended below LCCs' group average and both decreased since 2004. Since Southwest purchased the bankrupt ATA Airlines in 2008, its aircraft days increased much faster than the increase in block hours. The decrease in Southwest's aircraft productivity shows that the airline has not been able to increase its production of ASMs as quickly as its increase in aircraft days. Southwest's departures per aircraft per day decreased by 20% from 6.7 in 2004 to 5.3 in 2012 but has been flying longer stage lengths. Since Southwest flies the shortest average stage length among all of the airlines, it relied heavily on the quick turnaround times on the ground and high number of departures per aircraft per day to be competitive. The decrease in the number of departures per aircraft per day slowed down Southwest's production of ASMs. After Southwest's merger with AirTran in 2011, the new Southwest's aircraft utilization and productivity dipped down further in 2012 because it was unable to increase the output as quickly as the addition of resources and capacity from the merger. Overall, Southwest Airlines has the lowest aircraft utilization and productivity among LCCs, and it is ranked 4th lowest in aircraft utilization and 2nd lowest in aircraft productivity among all of the airlines.

Virgin America has the highest aircraft utilization and productivity among LCCs, and it is the only LCC that has improved its productivity since commencing service in 2007. Virgin consistently flies the largest aircraft and the longest average stage length among LCCs, which compensated for its lower number of departures per aircraft per day. Virgin's increase in block

hours and expansion in ASMs consistently outpaced its increase in aircraft days. Virgin is ranked the highest for aircraft utilization and 2nd highest for aircraft productivity among all of the airlines.



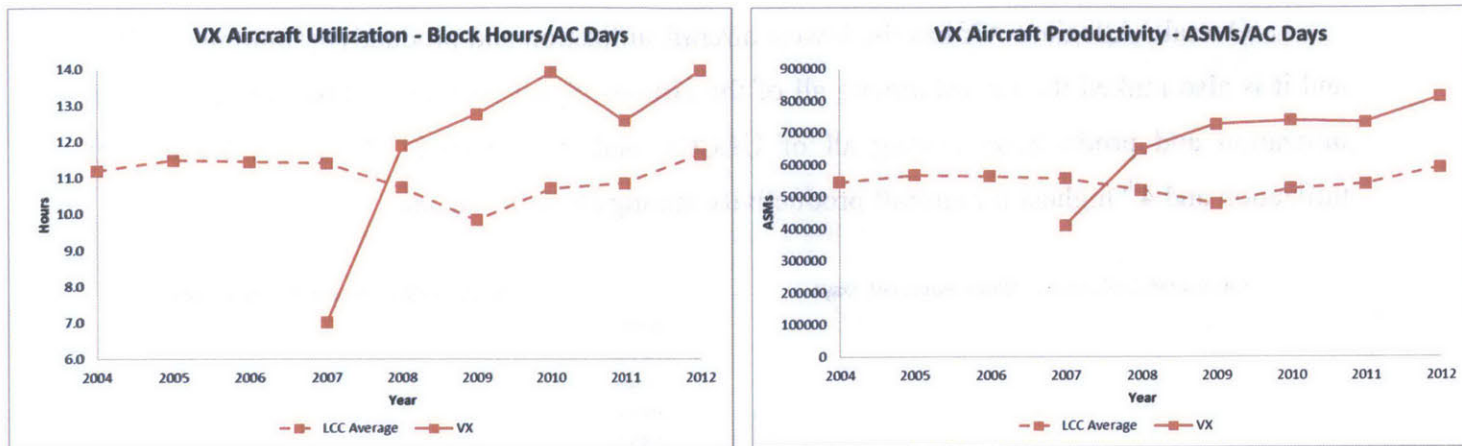


Figure 45 Individual Low Cost Carriers: Aircraft Utilization and Productivity

4.1.2.3 Individual Ultra Low Cost Carriers Aircraft Productivity

From 2004 to 2012, only Spirit has successfully increased its aircraft utilization and productivity, and both Allegiant and Frontier’s aircraft utilization and productivity decreased. Other than the year 2006, Allegiant’s aircraft utilization and productivity trended below ULCCs’ group average. Allegiant has the lowest number of departures per aircraft per day, the lowest number of block hours, and the lowest ASMs among all of the airlines. Allegiant’s growth in block hours and ASMs has been slower than its increase in aircraft days. Allegiant’s business model places less focus on aircraft utilization and productivity. Allegiant operates low frequency flights and strictly no frills and uses older aircraft to keep the ownership costs low.

Frontier consistently trended above ULCCs’ group average for aircraft utilization and productivity. In 2010, Frontier’s aircraft utilization and productivity increased significantly due to the significant downsizing and restructuring Frontier implemented after its merger with Midwest Airlines. Both measures decreased significantly from 2010 to 2012 because the increase in Frontier’s aircraft days outpaced the increase in its total block hours and ASMs produced.

Spirit has the most significant improvements in aircraft utilization and productivity in the recent years. Its number of departures per aircraft per day increased by 40% from 3.7 in 2006 to 5.2 in 2012, and it was also flying larger aircraft with higher average number of seats per plane. From 2006 to 2012, Spirit’s increase in block hours and expansion in ASMs outpaced its increase in capacity.

Overall, Allegiant Air has the lowest aircraft utilization and productivity among ULCCs, and it is also ranked the lowest among all of the airlines. Spirit Airlines has the highest aircraft utilization and productivity among all of ULCCs, and it is ranked 2nd highest for aircraft utilization and 4th highest for aircraft productivity among all of the airlines.

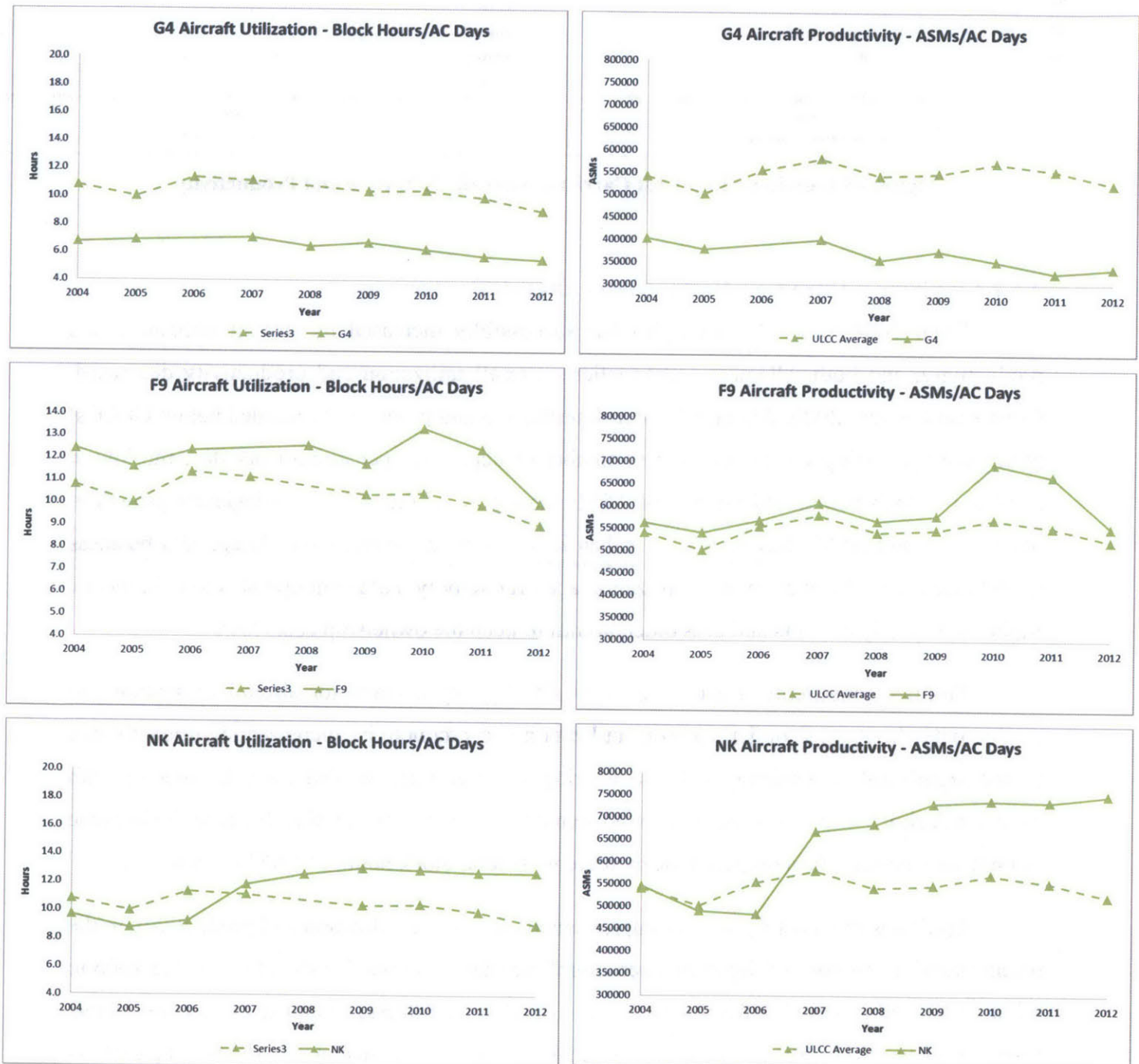


Figure 46 Individual Ultra Low Cost Carriers: Aircraft Utilization and Productivity

Summary:

At the system aggregate level, NLCs have the highest aircraft productivity. By flying longer stage lengths and using larger aircraft, NLCs have expanded their services to international markets and have a clear advantage in generating more ASMs with available capacity. NLCs have the lower aircraft utilization mainly because of the longer turnaround times needed for their large aircraft, which leads to overall smaller block hour per aircraft day ratios. From 2004 to 2012, NLCs' aircraft utilization decreased by 1.64% and aircraft productivity increased by 2.61%.

LCCs' utilization and productivity decreased from 2004 to 2009, and this was driven by the significant decreases in departures per aircraft day. LCCs have been increasing their average stage length and expanding into international markets, but their operations were not efficient enough to keep up with their network growth. However, they were able to have significant gains in aircraft utilization and productivity when their departures per aircraft day were improved from 2010 to 2012. Overall from 2004 to 2012, LCCs' aircraft utilization increased by 8.69%, and aircraft productivity increased by 8.28%.

ULCCs have been struggling to achieve high and stable utilization and productivity. ULCCs have been adding capacity and flying larger airplanes, but they do not seem to be producing more ASMs and maintaining high block hours. Overall from 2004 to 2012, ULCCs' aircraft utilization decreased by 16.59%, and aircraft productivity decreased by 3.32%.

4.2 Domestic Operations Aggregate Aircraft Productivity Comparisons

In this section, we present the general trends of domestic operations aggregate aircraft utilization and productivity for NLCs, LCCs, and ULCCs from 2004 to 2012. We compare the trends of domestic operations to those of system aggregate and examine the impact of domestic and international operations on aircraft utilization and productivity.

Figure 47 shows the domestic operation comparisons of aircraft utilization for NLCs, LCCs, and ULCCs. NLCs' aircraft utilization decreased by 3.9% from 10 hours/day in 2004 to 9.61 hours/day in 2012. LCCs' aircraft utilization consistently trended above both NLCs and ULCCs despite ULCCs' sudden peak in 2008, and overall, it increased by 3.18% from 2004 to 2012. The aircraft utilization gap between NLCs and LCCs decreased from 1.17 hours/day in 2004 to 0.94 hours/day in 2009 and then increased to 1.92 hours/day in 2012. Similar to the trend at the system level, ULCCs' aircraft utilization has fluctuated from 2004 to 2012 and peaked in 2008 due to Frontier's sudden increase in block hours in 2008. Overall, ULCCs' aircraft utilization has trended downward and decreased by 17.96% from 2004 to 2012. While NLCs has been keeping their aircraft utilization stable, LCCs' and ULCCs' trends diverged. In 2012, the aircraft utilization gap between LCCs and ULCCs is 2.89 hours/day, and the gap between NLCs and ULCCs is 0.98 hours/day.

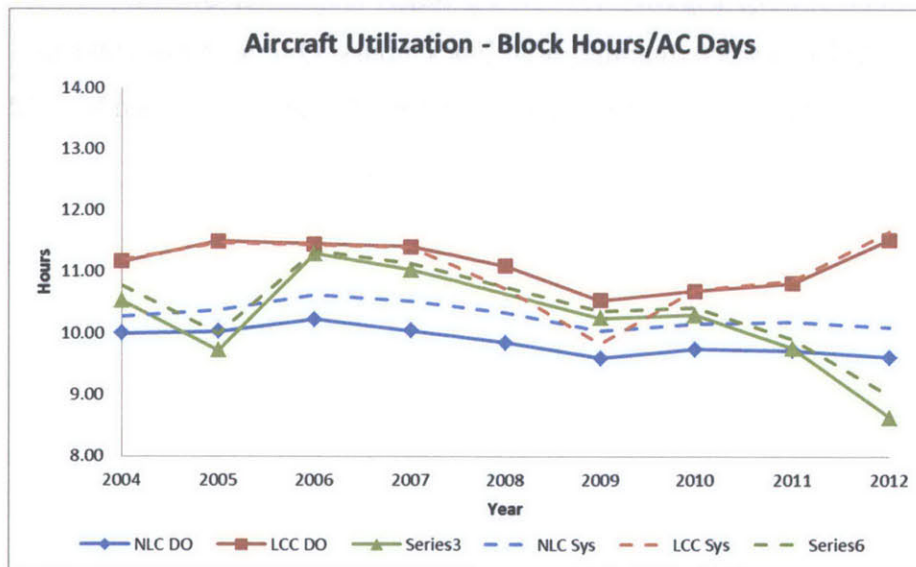


Figure 47 Domestic Operations Comparison: Aircraft Utilization*

*ULCC's aircraft utilization data point is removed for 2008 due to an incorrect reporting of Frontier's total block hours for 2008.

Figure 48 shows that NLCs are still flying the highest and LCCs are flying the shortest average stage length of the three groups in domestic operations. NLCs consistently fly an average of 270 miles longer than LCCs, and both of their average stage lengths increased from 2004 to 2012. The average stage length gap between NLCs and ULCCs increased from 61 miles in 2006 to 115 miles in 2012, as ULCCs' stage lengths decreased from 2004 to 2012.

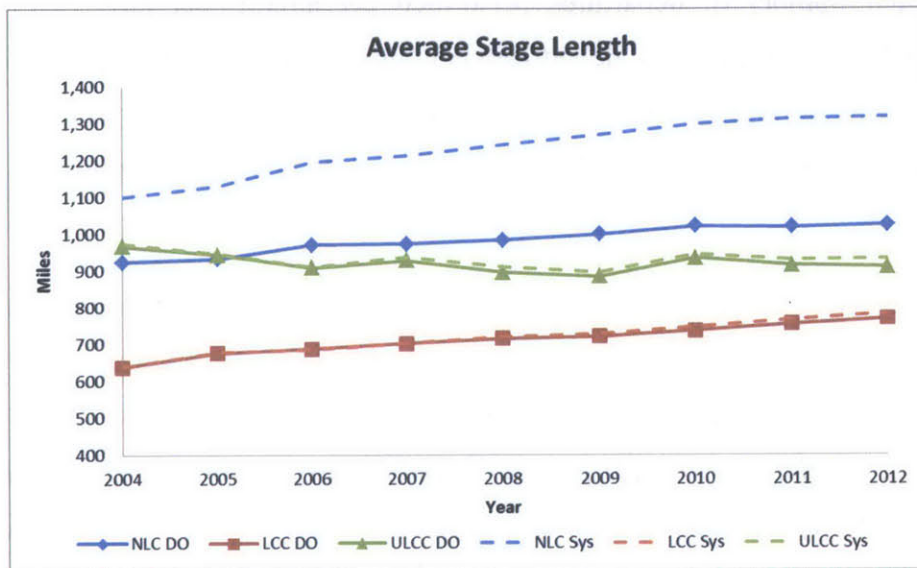


Figure 48 Domestic Operations: Average Stage Length

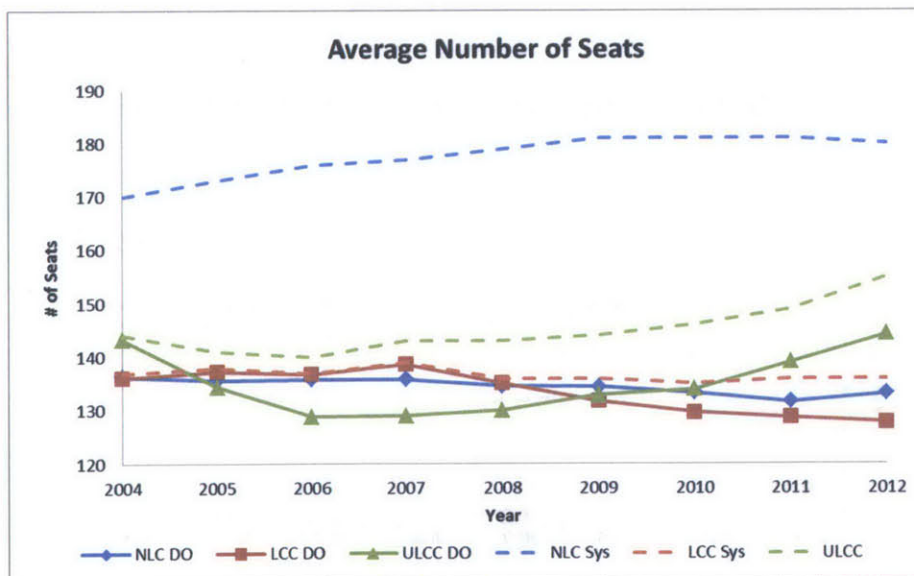


Figure 49 Domestic Operations: Average Number of Seats per Aircraft

Figure 49 shows that NLCs and LCCs both decreased their average number of seats per plane in their domestic operations and had a comparable average of 136 seats per plane, while ULCCs' average number of seats increased from 129 seats per plane in 2006 to 144 seats per plane in 2012. Figure 50 shows that LCCs' number of departures performed per aircraft per day decreased from 6.2 in 2004 to 5.3 in 2009 and increased to 5.7 in 2012. Despite the overall decrease in their number of departures performed per aircraft per day, LCCs consistently performed the highest number of departures per aircraft per day among the airline groups. ULCCs had an average of 0.62 departure per aircraft per day more than NLCs in 2007 but this gap has been decreasing since then. In 2012, NLCs was 0.42 departures per aircraft per day more than ULCCs.

Figure 51 shows the aircraft productivity trends for the three groups. NLCs' aircraft productivity has been consistently higher than the other two groups and increased by 3.32% from 2004 to 2012. LCCs' aircraft productivity decreased by 6% from 2004 to 2009 and has been increasing since, and the overall increase in productivity was 6.76% from 2004 to 2012. The gap in aircraft productivity between NLCs and LCCs has converged in 2012 largely due to LCCs' improvement in aircraft productivity from 2009 to 2012. ULCCs' aircraft productivity fluctuated throughout the years, and overall it decreased by 5.6% from 2004 to 2012.

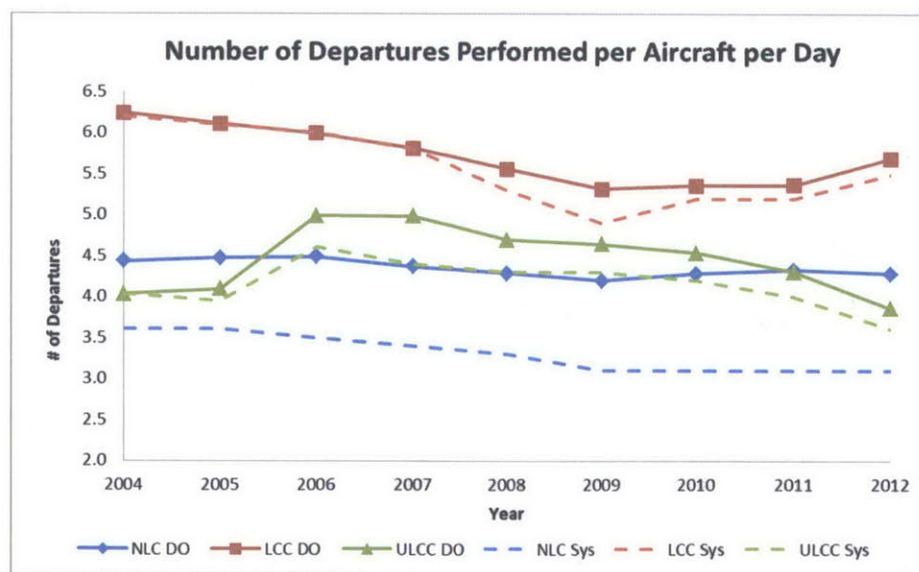


Figure 50 Domestic Operations: Number of Departures per Aircraft per Day

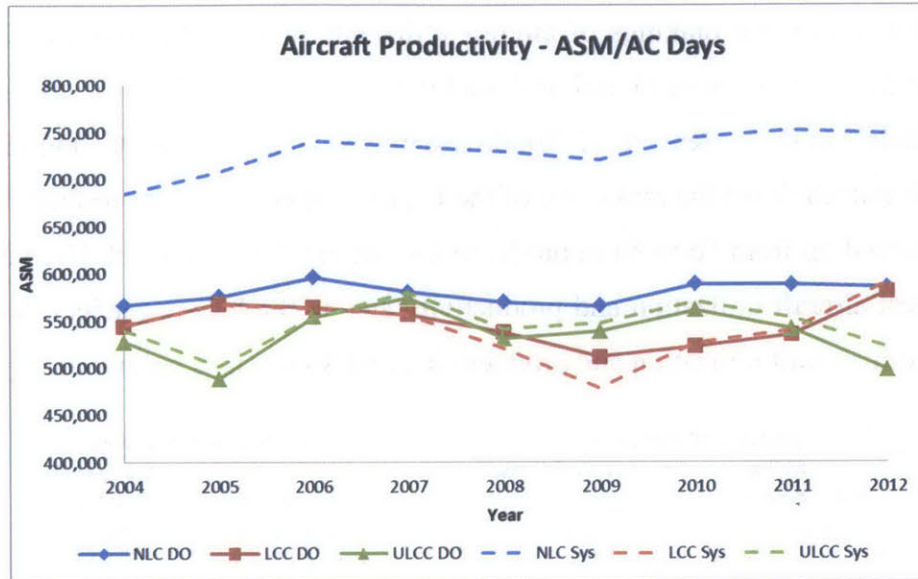


Figure 51 Domestic Operations Comparison: Aircraft Productivity

System aggregate trends for aircraft utilization and productivity are plotted as dotted lines in the figures in this section. Comparing these domestic operations trends to system aggregate's, we see that LCCs have a greater advantage in aircraft utilization over NLCs and ULCCs at the domestic operations level, and NLCs have the most significant advantage over LCCs and ULCCs in aircraft productivity at the system level. When international operations are excluded for the domestic operations analysis, LCCs' aircraft utilization and productivity at the domestic operations level did not drop as significantly as they did at the system level in 2008 and 2009. LCCs shifted their focus to international markets and were expanding aggressively internationally in those two years, and the drop in departures per aircraft day was due to international operations. Domestically, on average, LCCs fly smaller airplanes and perform greater number of departures per aircraft per day than they do at the system level.

On the other hand, when international operations are excluded for NLCs and ULCCs, their aircraft utilization and productivity decreased and most significantly for NLCs. On average, NLCs fly 200 miles shorter average stage length, operate 40 seats smaller airplanes, and perform 1 additional departure per aircraft per day at the domestic operations level than they do at the system level. Overall the effect of shorter stage length and small airplanes have a greater impact on NLCs' drop in aircraft productivity.

Table 8 shows the rankings of aircraft utilization and productivity for all airlines for domestic operations only. Several airlines' rankings in aircraft utilization changed from the rankings in Table 7 at the systems level. Southwest moved up from #7 to #5, and in turn Frontier and Delta both moved down the ranks. All of the legacy carriers' aircraft productivity decreased, and JetBlue moved up from #6 to #4 in productivity. At the domestic level, United continues to have the highest aircraft utilization and productivity among the legacy carriers. Virgin tops the rankings for both aircraft utilization and productivity, and Spirit ranks second best.

2012 Aircraft Utilization		2012 Aircraft Productivity	
Airline	Block Hours/AC Day	Airline	ASMs/AC Day
1 Virgin America	13.9	1 Virgin America	808417
2 Spirit Airlines	12.7	2 Spirit Airlines	745774
3 JetBlue Airways	11.8	3 United Airlines	659251
4 United Airlines	10.3	4 JetBlue Airways	621185
5 Southwest Airlines	9.9	5 Delta Airlines	577947
6 Delta Airlines	9.6	6 American Airlines	567890
7 Frontier Airlines	9.4	7 Frontier Airlines	513864
8 American Airlines	9.3	8 US Airways	506031
9 US Airways	9.2	9 Southwest Airlines	495568
10 Allegiant Air	5.5	10 Allegiant Air	334464

Table 8 2012 Domestic Operations: Aircraft Utilization and Productivity Rankings for All Airlines

Summary:

At domestic operations level, NLCs still have the highest aircraft productivity and fly longer stage lengths on average. LCCs have the highest aircraft utilization and exhibit high operational efficiency by achieving quick turnaround times at the domestic operations level. LCCs improved their aircraft productivity since 2009, and ramped up their ASMs production by performing more departures per aircraft per day and flying longer stage lengths. ULCCs place less focus on achieving and maintaining high aircraft utilization, and both measures trended downward since 2010.

4.3 Stage Length Adjusted Aircraft Productivity Comparisons for Individual Airlines

When airlines fly longer stage lengths, their aircraft productivity would increase because economies of scale are achieved by producing higher ASMs. As we have already found in the previous chapter, NLCs fly longer stage lengths and depend on international operations to keep their unit costs low. The previous sections in this chapter show that flying longer stage lengths has boosted NLCs' ability to achieve greater aircraft productivity at both the system and domestic operations level than LCCs and ULCCs. In this section, we adjust individual airlines' aircraft utilization and productivity for their differences in average stage lengths, and we compare the stage length adjusted measures at the system level.

Figure 52 and Figure 53 depict individual airlines' aircraft utilization and productivity changes with respect to their average stage lengths from 2009 to 2012. The year 2009 is pivotal because airlines began to recover from the economic crisis in 2009. In Figure 33 and Figure 38, we see improvements in aircraft utilization and productivity for NLCs and LCCs and a decline in aircraft productivity for ULCCs from 2009 to 2012.

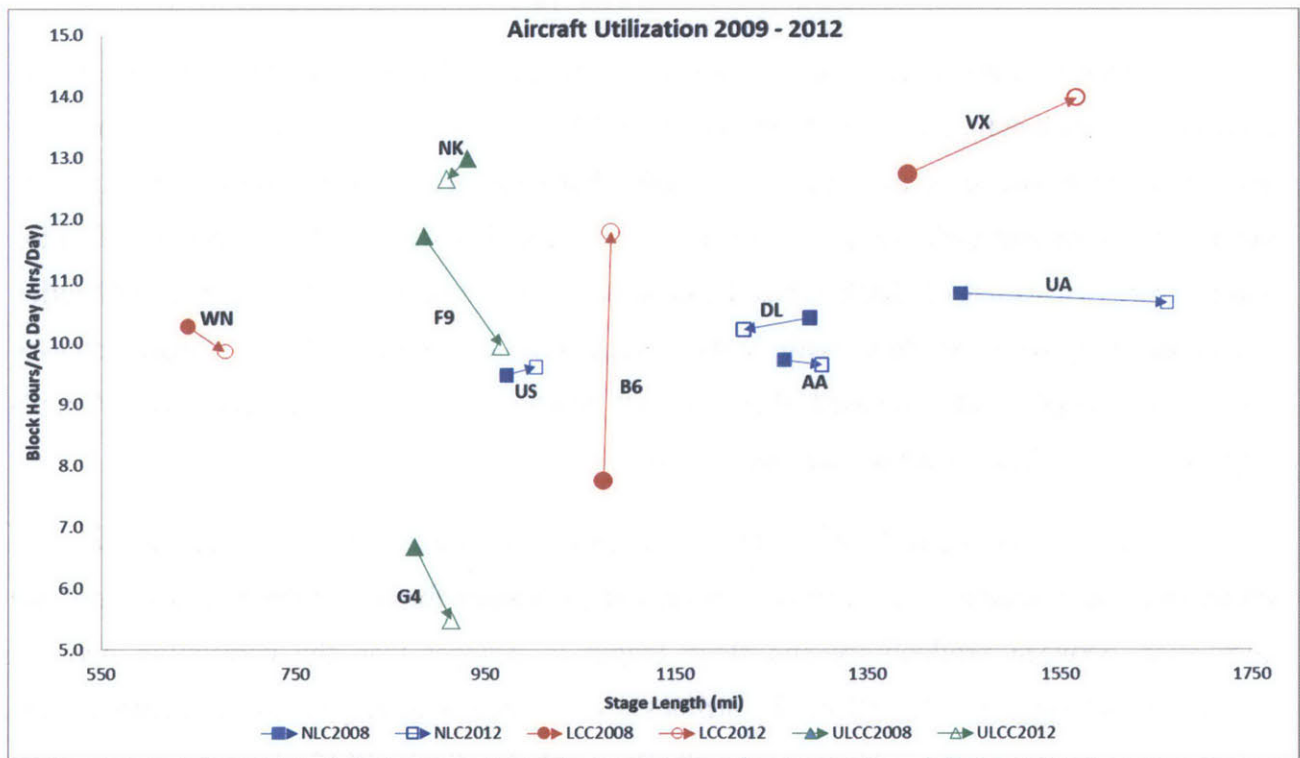


Figure 52 Aircraft Utilization vs Stage Length: Change from 2009 to 2012

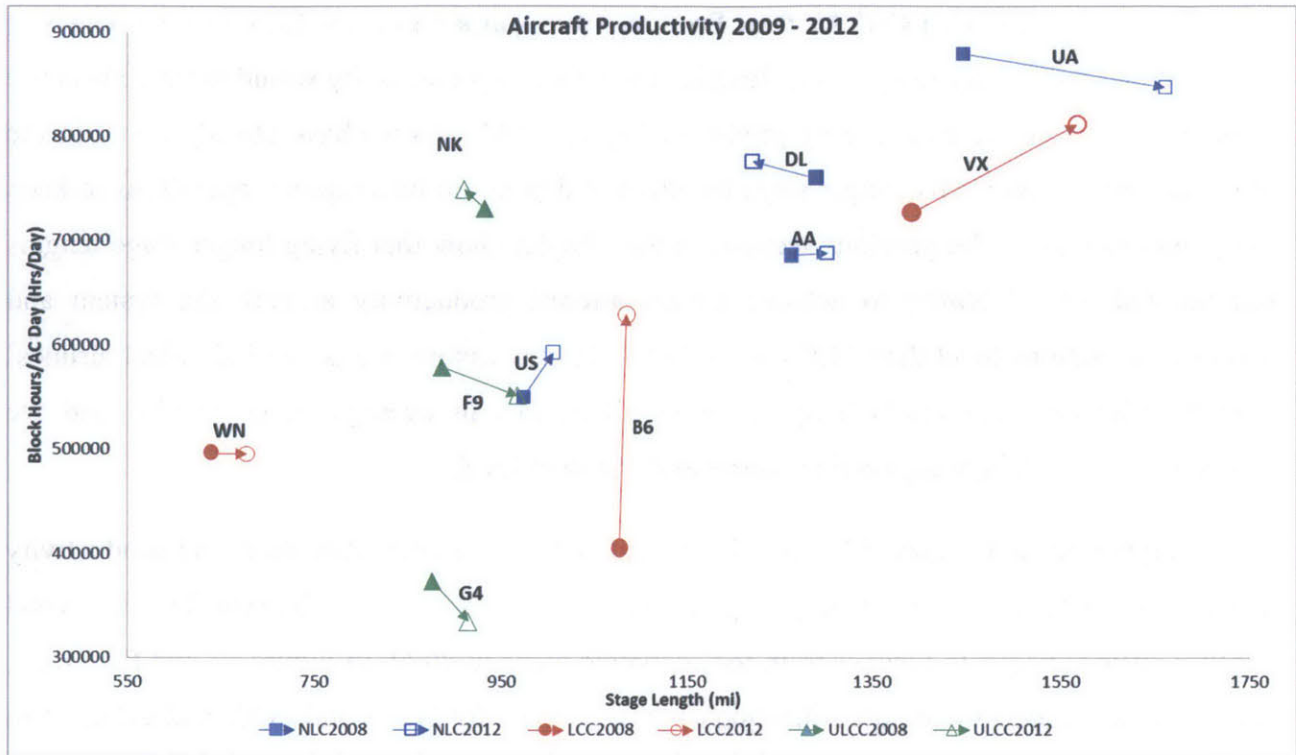


Figure 53 Aircraft Productivity vs Stage Length: Change from 2009 to 2012

In general, we expect to see an increase in aircraft utilization and productivity with an increase in stage length. However, from 2009 to 2012, Southwest, Frontier, Allegiant, American, and United increased their average stage lengths, but their aircraft utilization and productivity decreased. Spirit and Delta decreased their average stage lengths, and their aircraft utilization and productivity decreased. JetBlue has the most drastic improvement in both aircraft utilization and productivity with a slight increase in its average stage length. Both US and Virgin increased their stage length and increased their aircraft utilization and productivity, and Virgin's improvements in these measures are more significant.

Figure 54 and Figure 55 depict the linear regressions used to adjust each airline's aircraft utilization and productivity with respect to their stage lengths for both 2009 and 2012, and the correlation between productivity and stage length is stronger than the correlation between utilization and stage length. All of the airlines are adjusted with respect to the average stage length of the entire sample, 1092 miles for 2009 and 1130 miles for 2012. The methodology for the linear regression analysis for stage length adjustment is explained in Chapter 2, section 2.4.3.

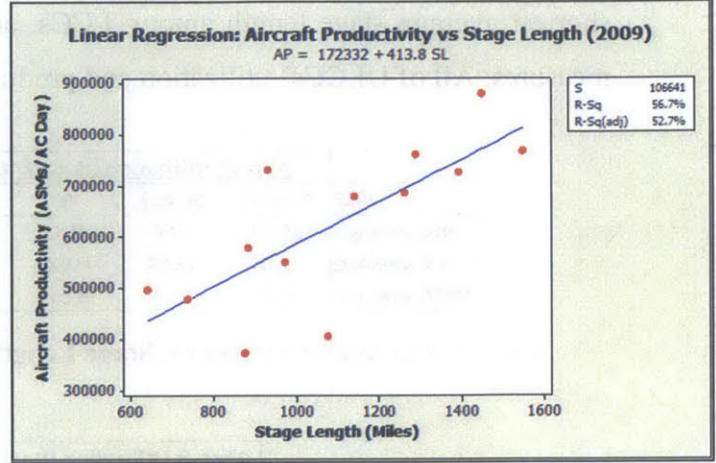
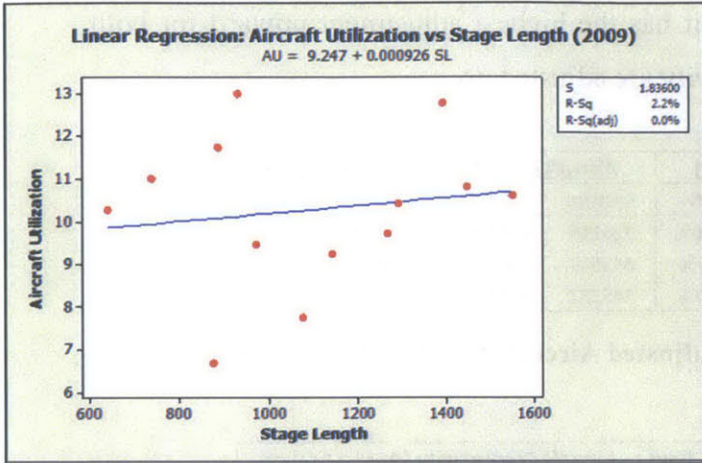


Figure 54 Aircraft Utilization and Productivity Linear Regressions for 2009

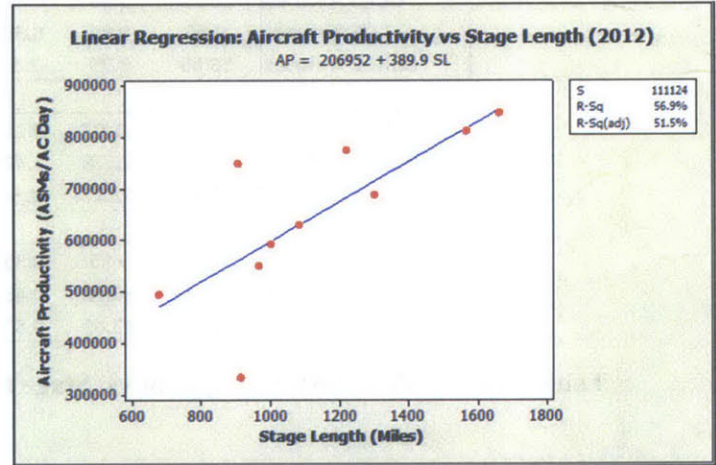
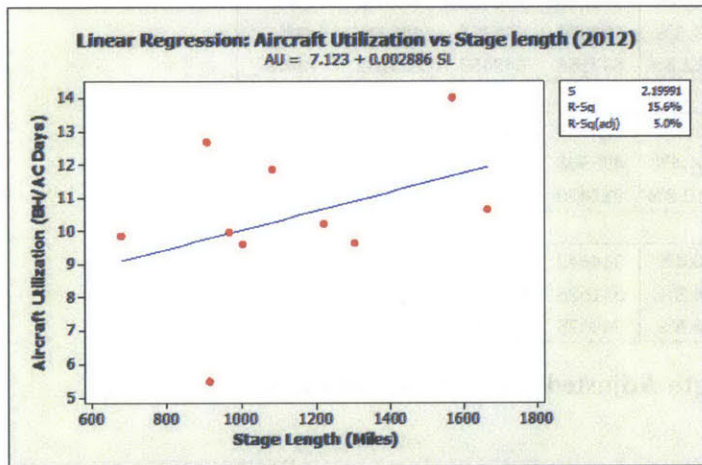


Figure 55 Aircraft Utilization and Productivity Linear Regressions for 2012

When all of the airlines are adjusted with respect to the average stage length of the entire sample, aircraft utilization and productivity of airlines with stage lengths longer than the average stage length of the sample are adjusted downward, discounting the productivity advantage from flying longer stage lengths. Aircraft utilization and productivity of airlines with stage lengths shorter than the average stage length of the sample are adjusted upward.

The difference between system level and stage length adjusted aircraft utilization and productivity for each aggregate group for 2012 is summarized in Table 9. NLCs' group averages for both measures are adjusted down, while ULCCs group averages are adjusted up. Table 10 shows the adjustments for individual airlines. Since United has the highest average stage length among NLCs, it has the highest adjustment downward for both measures. Southwest has the

shortest average stage length among LCCs, and it has the highest adjustment upward for both measures. All of ULCCs' utilization and productivity are adjusted up.

2012	Aircraft Utilization (Hours/ACDay)				Aircraft Productivity (ASMs/ACDay)			
	System	SL-Adj	Δ	%Δ	System	SL-Adj	Δ	%Δ
NLC average	10.02	9.60	-0.43	-4.26%	726119	660936	-65184	-9.0%
LCC average	11.89	11.91	0.02	0.17%	645649	657356	11707	1.8%
ULCC average	9.37	9.92	0.55	5.90%	545282	620677	75395	13.8%

Table 9 Aggregate: System vs. Stage Length Adjusted Aircraft Utilization & Productivity

2012	Aircraft Utilization (Hours/ACDay)				Aircraft Productivity (ASMs/ACDay)			
	System	SL-Adj	Δ	%Δ	System	SL-Adj	Δ	%Δ
American Airlines	9.63	9.19	-0.44	-4.6%	687939	623509	-64430	-9%
Delta Airlines	10.21	9.96	-0.25	-2.5%	776086	736015	-40071	-5%
US Airways	9.60	9.95	0.35	3.6%	592894	641765	48871	8%
United Airlines	10.65	9.29	-1.37	-12.8%	847558	642453	-205105	-24%
JetBlue Airways	11.81	11.97	0.16	1.3%	629959	648461	18502	3%
Southwest Airlines	9.86	11.28	1.42	14.4%	495568	681182	185614	37%
Virgin America	13.99	12.47	-1.51	-10.8%	811420	642425	-168995	-21%
Allegiant Air	5.50	5.85	0.35	6.4%	334642	384917	50275	15%
Frontier Airlines	9.94	10.42	0.48	4.8%	551528	612123	60595	11%
Spirit Airlines	12.66	13.49	0.83	6.6%	749675	864990	115316	15%

Table 10 Individual Airlines: System vs. Stage Length Adjusted Aircraft Utilization & Productivity

Table 11 shows the rankings of the stage length adjusted aircraft utilization and productivity by individual airlines. Comparing the rankings here with those in Table 7, several airlines' ranking positions have changed. Southwest and United have the most notable changes. Southwest's aircraft utilization moved up from #7 to #4 and productivity moved up from #9 to #3 after adjusting for stage lengths, which shows Southwest's high aircraft productivity albeit operating shortest average stage length among all the airlines. Southwest is now ranked the highest in aircraft productivity among LCCs. United's aircraft utilization dropped from #4 to #8 and aircraft productivity dropped from #1 to #5, which shows United's great advantage in productivity over other airlines is their long average stage length. Delta is now ranked highest in both categories among NLCs. Allegiant Air continues to rank the lowest in aircraft utilization and productivity, and Spirit has topped the rankings for having the highest aircraft utilization and productivity among all of the airlines after stage length adjustment.

2012 Aircraft Utilization		2012 Aircraft Productivity	
Airline	Block Hours/AC Day	Airline	ASMs/AC Day
1 Spirit Airlines	13.5	1 Spirit Airlines	864990
2 Virgin America	12.5	2 Delta Airlines	736015
3 JetBlue Airways	12.0	3 Southwest Airlines	681182
4 Southwest Airlines	11.3	4 JetBlue Airways	648461
5 Frontier Airlines	10.4	5 United Airlines	642453
6 Delta Airlines	10.0	6 Virgin America	642425
7 US Airways	10.0	7 US Airways	641765
8 United Airlines	9.3	8 American Airlines	623509
9 American Airlines	9.2	9 Frontier Airlines	612123
10 Allegiant Air	5.8	10 Allegiant Air	384917

Table 11 2012 Stage Length Adjusted Aircraft Utilization and Productivity Rankings for All Airlines

Summary:

The results in this section show the influence of stage length on aircraft utilization and productivity. After stage length adjustment, LCCs moved up the ranks for both measures, while NLCs moved down. Without the stage length advantage, LCCs are more productive and are more efficient at utilizing their aircraft. It is hard to conclude for ULCCs as a group. Despite Spirit having the highest aircraft utilization and productivity among all the airlines, Allegiant and Frontier are not efficient at using their aircraft, and this could be that their business strategy places less focus on achieving high aircraft utilization and productivity.

Chapter 5: Employee Productivity Analysis

The last part of our analysis focuses on employee productivity. The structure of this chapter is similar to that of Chapter 3 and 4. We first present the overall industry trends at the system aggregate level comparing employee and wage productivity of NLCs, LCCs, and ULCCs. Next, we present results from comparisons of these productivity measures from domestic operations only. Lastly, we look at the effect of stage lengths on employee productivity and rank individual airlines' employee productivity after stage length adjustments.

5.1 System Aggregate Employee Productivity

5.1.1 Aggregate Industry Employee Productivity Comparisons for NLCs, LCCs, and ULCCs

In this section, we present the general trends of the system aggregate employee productivity measures for NLCs, LCCs, and ULCCs from 2004 to 2012. Looking at the number of employees from each group in Figure 56, NLCs reduced about 35,000 employees, more than 10% of their workforce, between 2004 and 2006. NLCs, especially those that filed bankruptcies between 2004 and 2006, significantly reduced their workforce. As the fuel prices continued to increase from 2006 to 2008, NLCs cut an additional 12,000 employees. Only until after the financial crisis in 2008 did NLCs begin to add employees, and they added a total of 1,000 employees between 2009 and 2012. On the other hand, the low cost carriers consistently expanded their labor force, and LCCs' and ULCCs' employment grew about 53% and 41%, respectively, from 2004 to 2012.

Figure 57 shows that on average, LCCs pay the highest salary per employee, whereas ULCCs pay the lowest. NLCs' salary per employee was the highest in 2004 and 2005 but declined by \$7,821 from 2004 to 2007 due to savings from labor cutting efforts. However, from 2007 to 2012, NLCs' salary per employee grew by \$16,665. From 2006 to 2011, the average compensation per employee gap between NLCs and LCCs increased from \$4,200 to \$11,500. NLCs' average compensation per employee has been about \$23,000 to \$33,000 higher than ULCCs', and LCCs' average compensation per employee has been about \$20,000 to \$39,000

higher than ULCCs'. The sudden drop in LCCs' average compensation per employee was due to the sudden increase in the number of employees in 2012. LCCs' rate of increase in the number of employees was greater than the additional ASMs produced.

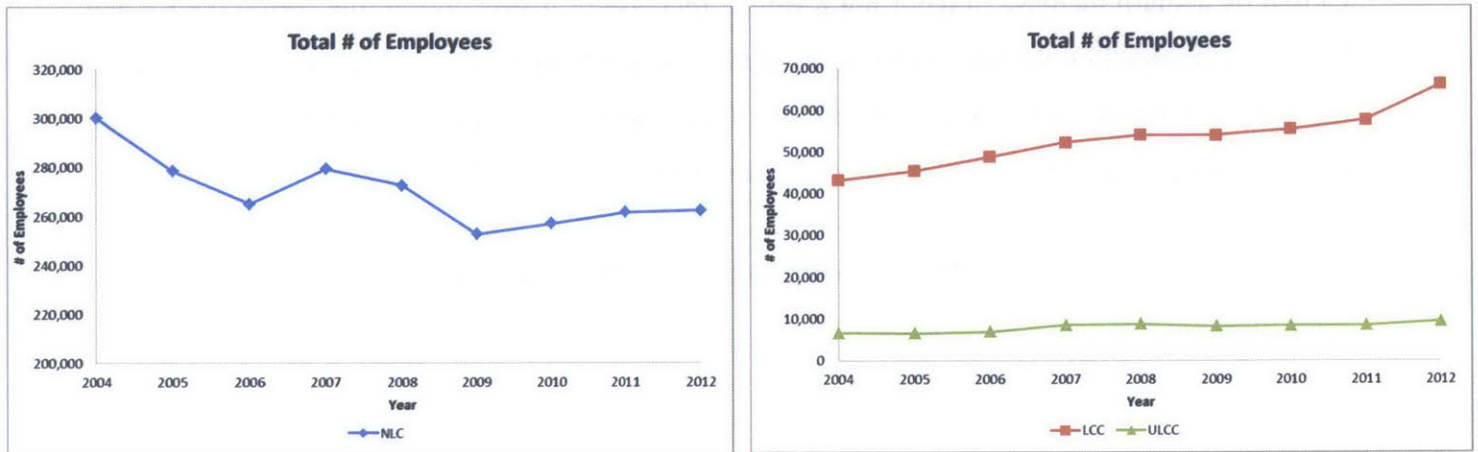


Figure 56 System Aggregate Comparison: Employment

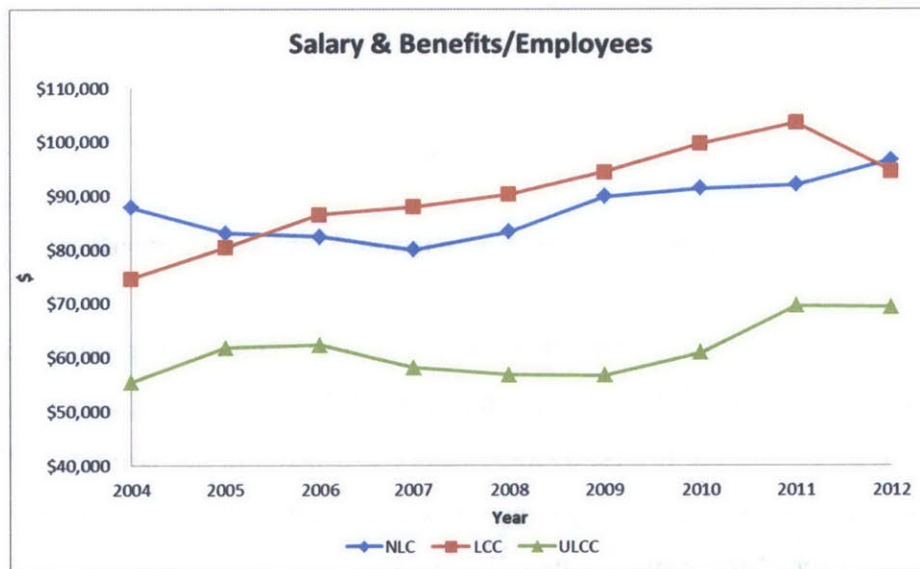


Figure 57 System Aggregate: Average Salary & Benefits per Employee

The primary measure analyzed in this chapter is employee productivity, which is measured in ASMs produced per employee, which is shown in Figure 58. ULCCs had the sharpest growth in employee productivity, which increased by 35% from 2004 to 2012. During the same time period, NLCs' employee productivity remained stable with a slight increase of 9%.

Referring back to Figure 36 of the previous chapter and Figure 56 of this chapter, NLCs' total ASMs dropped slower than their rate of reduction in labor. LCCs' employee productivity had a sharp growth of 12% from 2004 to 2008, but decreased by 10% from 2011 to 2012, which was caused by a sharp increase in labor but a slower increase in ASMs during this period. LCCs and ULCCs consistently outputted more ASMs per employee than NLCs, which was driven by their aggressive network and market expansions. The gap between ULCCs and NLCs more than tripled from 2004 to 2012, and ULCCs were leading LCCs by 20.4% in 2012.

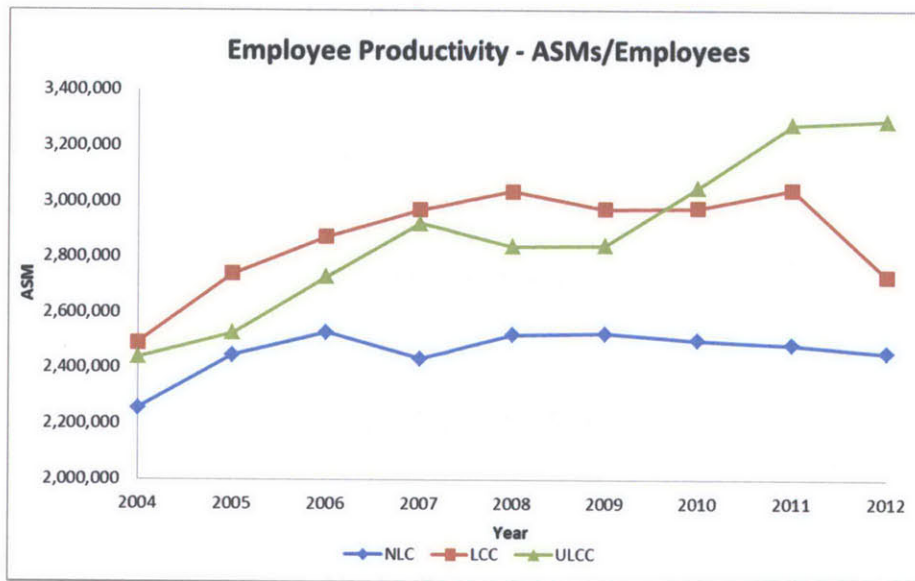


Figure 58 System Aggregate Comparison: Employee Productivity

Another measure that's important measure for employee productivity is wage productivity, which is measured in ASMs produced per dollar of salaries and benefits paid out to the employees. ULCCs pay the lowest average salary and benefits per employee. Because their ASM growth has been consistently outpacing the wage growth, ULCCs have the highest wage productivity among the three groups. Overall, ULCCs wage productivity increased by 7.84% from 2004 to 2012. On the contrary, LCCs' ASM growth is slower than their wage growth, and their wage productivity decreased by 13.5% from 2004 to 2012. NLCs' wage productivity increased from 2004 to 2008, which is a direct effect of their labor cost cutting efforts, but decreased from 2008 to 2012. The increase in NLCs' and LCCs' wage could be the effect of the increase in labor seniority. Overall, NLCs' wage productivity decreased from 2004 to 2012 by about 1%. The wage productivity gap between NLCs and LCCs has been converging from 7.7

ASMs per dollar to about 3 ASMs per dollar. LCCs are losing their historical wage productivity advantage over NLCs.

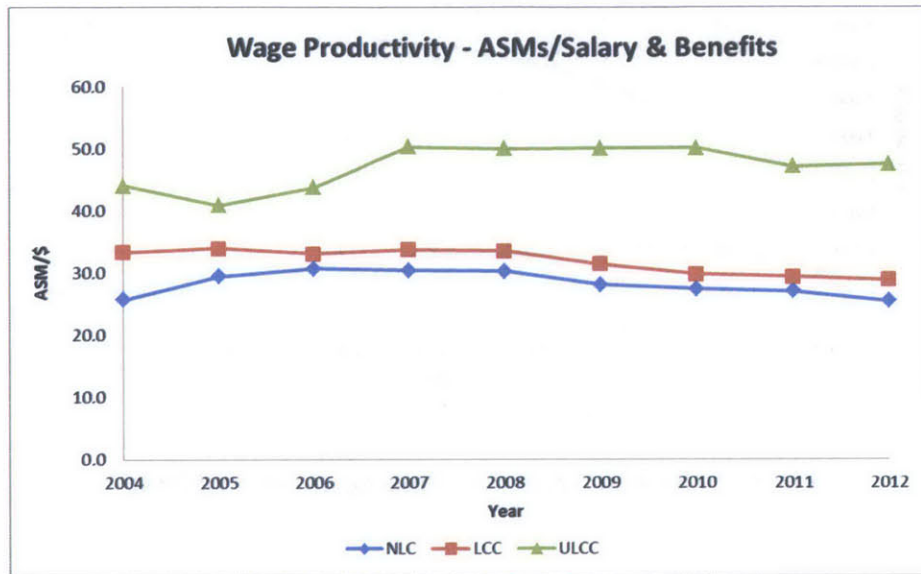


Figure 59 System Aggregate Comparison: Wage Productivity

Another measure of labor efficiency is the number of passengers served per employee, which is shown in Figure 60. LCCs have had a clear advantage over ULCCs and NLCs by serving the most passengers per employee, enplaning 1,200 to 1,660 more passengers on average than NLCs. LCCs used to enplane about 600 more passengers per employee than ULCCs in 2004, but that gap was closed in 2011. In 2012, ULCCs were serving 380 passengers more than LCCs. Again, the sudden drop in LCCs’ passenger to employee ratio was due to the surge in the number of employees in 2012, whose growth in employment outpaced the additional passengers served. NLCs’ passenger to employee ratio decreased by 105 passengers per employee from 2004 to 2012, and the passenger to employee ratio gap between ULCCs and NLCs increased from 510 passengers in 2004 to 1,704 passengers in 2012.

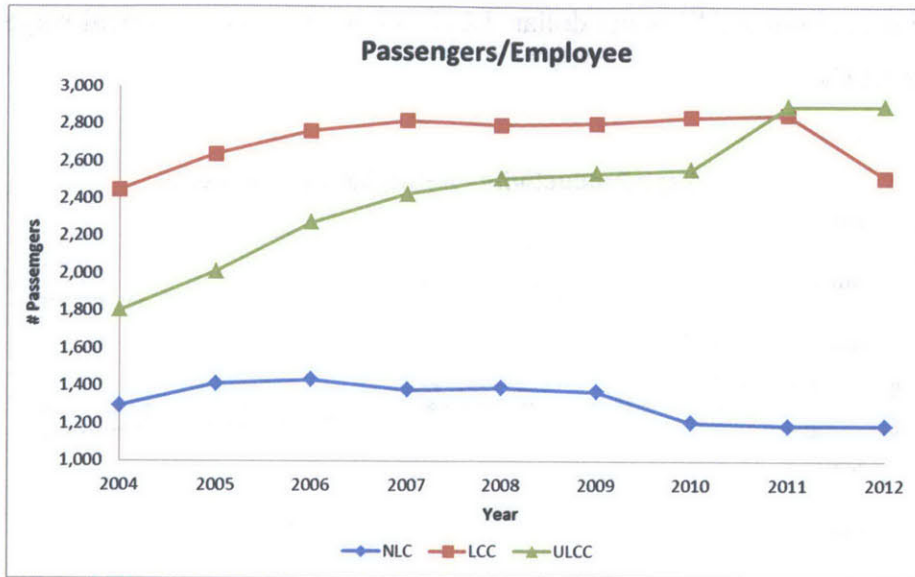


Figure 60 System Aggregate: Passengers per Employee

5.1.2 System Aggregate Employee Productivity Comparisons for Individual Airlines

In this section, we look at individual airlines employee and wage productivity, and how these two measures changed from 2004 to 2012. Figure 61 and Figure 62 show employee and wage productivity for all airlines in 2004, 2008, and 2012. Figure 63 and Figure 64 show the percent change in the number of employees and employee salary and benefits from 2004 to 2012. Table 12 shows the rankings of aircraft utilization and productivity for all airlines.

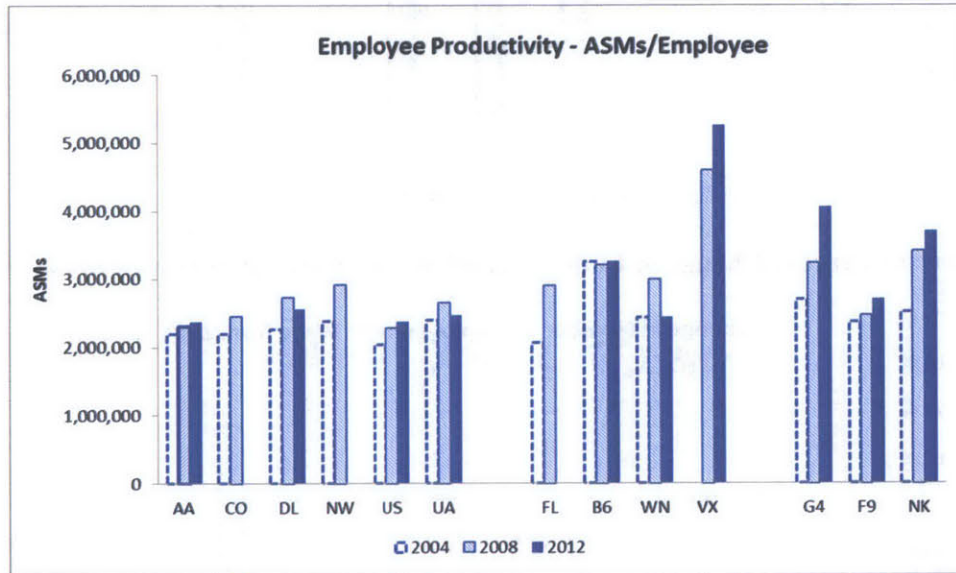


Figure 61 Employee Productivity for Individual Airlines, 2004, 2008, and 2012

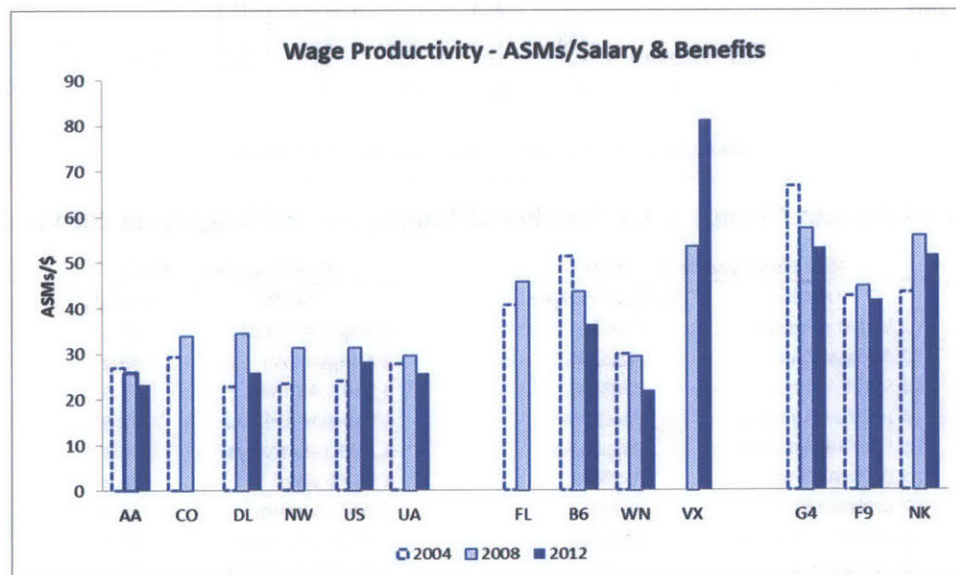


Figure 62 Wage Productivity for Individual Airlines 2004, 2008, and 2012

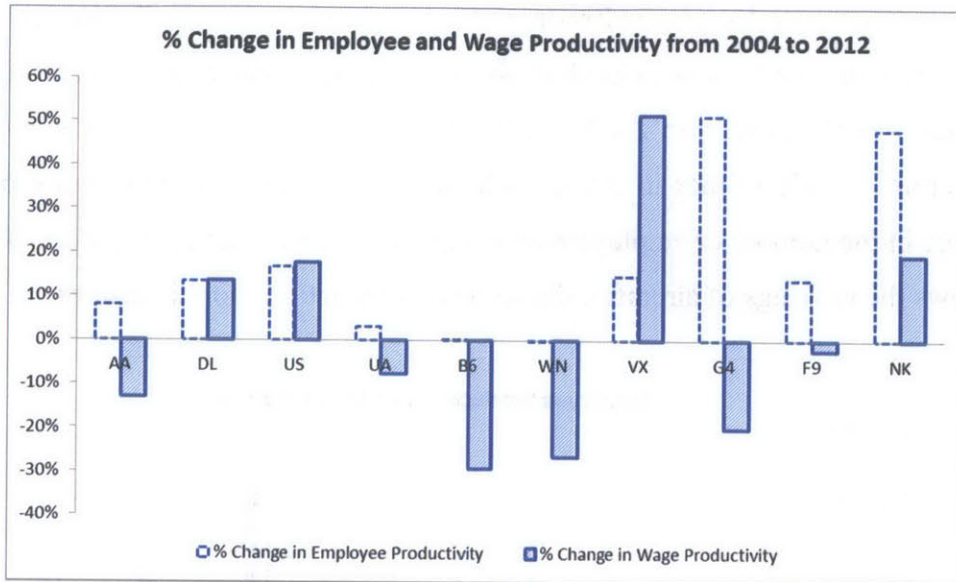


Figure 63 Percent Change in Employee and Wage Productivity from 2004 to 2012

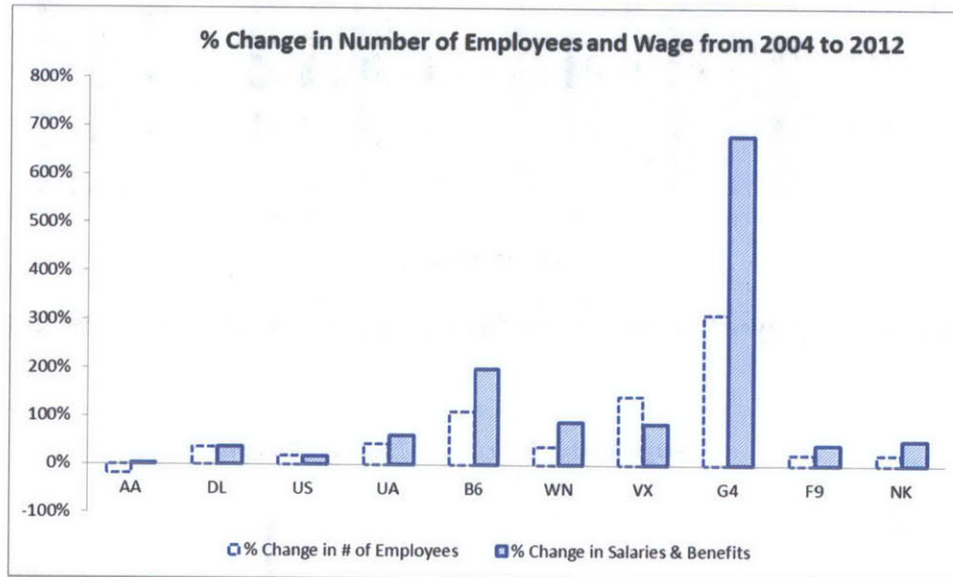


Figure 64 Percent Change in the Number of Employees and Wage from 2004 to 2012

2012 Employee Productivity		2012 Wage Productivity	
Airline	ASMs/Employee	Airline	ASMs/\$
1 Virgin America	5261450	1 Virgin America	81.1
2 Allegiant Air	4056254	2 Allegiant Air	53.1
3 Spirit Airlines	3703408	3 Spirit Airlines	51.6
4 JetBlue Airways	3247875	4 Frontier Airlines	41.6
5 Frontier Airlines	2693033	5 JetBlue Airways	36.3
6 Delta Airlines	2559043	6 US Airways	28.3
7 United Airlines	2458897	7 Delta Airlines	25.9
8 Southwest Airlines	2428962	8 United Airlines	25.6
9 US Airways	2375221	9 American Airlines	23.4
10 American Airlines	2365244	10 Southwest Airlines	22.0

Table 12 System: Employee and Wage Productivity Rankings for All Airlines

5.1.2.1 Individual Network Legacy Carriers Employee Productivity

Figure 65 shows employee and wage productivity trends for individual network legacy carriers plotted with the group averages. Delta and US consistently maintained above NLCs' group average employee and wage productivity, while American, Continental and United trended below the group average. Figure 63 shows From 2004 to 2012, all of the legacy carriers managed to increase their employee productivity, and US has the greatest percent increase in both employee and wage productivity, while American has the greatest percent decrease in wage productivity.

From 2004 to 2012, American's employee productivity increased slightly due consistent labor cuts every year and a slower decrease in ASMs. However, its total wage paid out to its employees stayed the same, which led to the decrease in wage productivity. American pays the highest average salary and benefits per employee among NLCs, and second highest among all of the airlines analyzed in this thesis, with Southwest being the highest. Overall, American's employee productivity increased by 8% and wage productivity decreased by 13% from 2004 to 2012. In 2012, American was ranked the lowest in both the employee and wage productivity among NLCs.

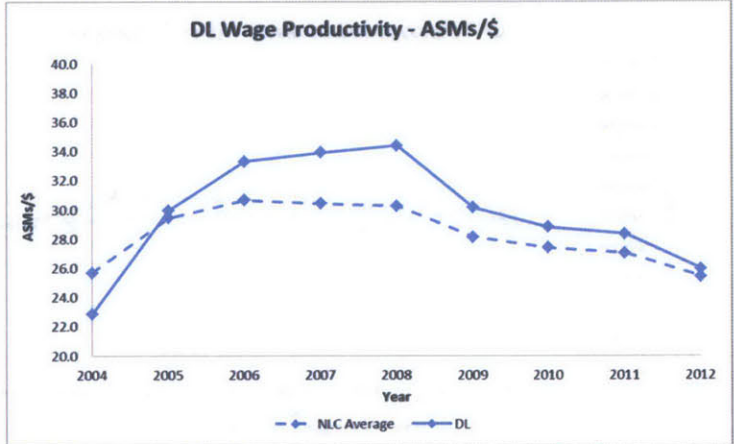
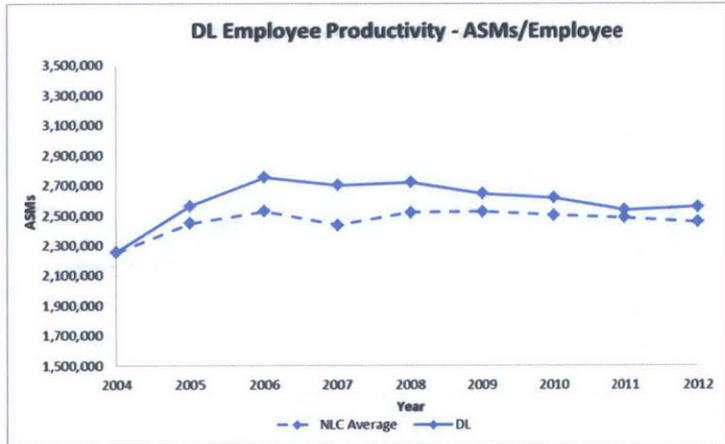
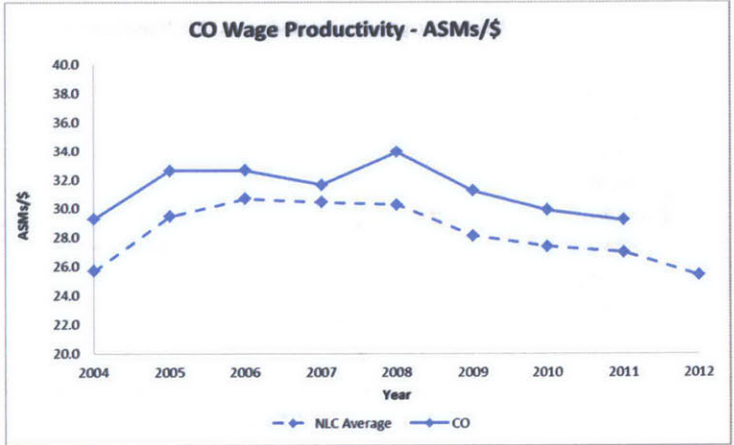
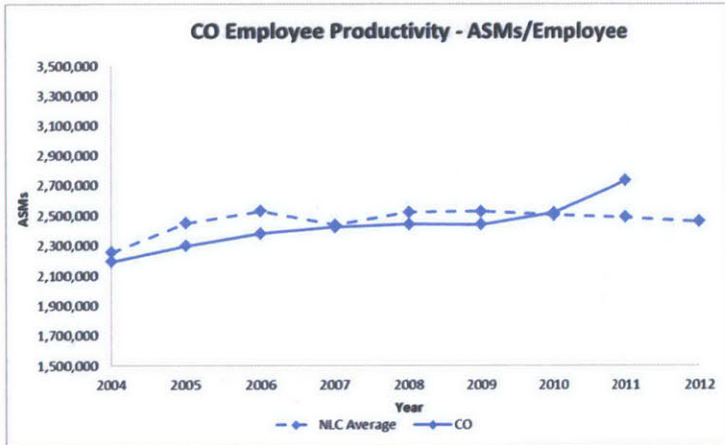
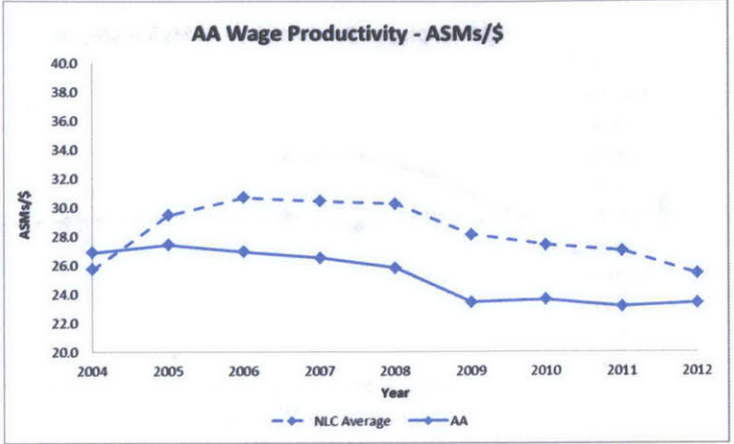
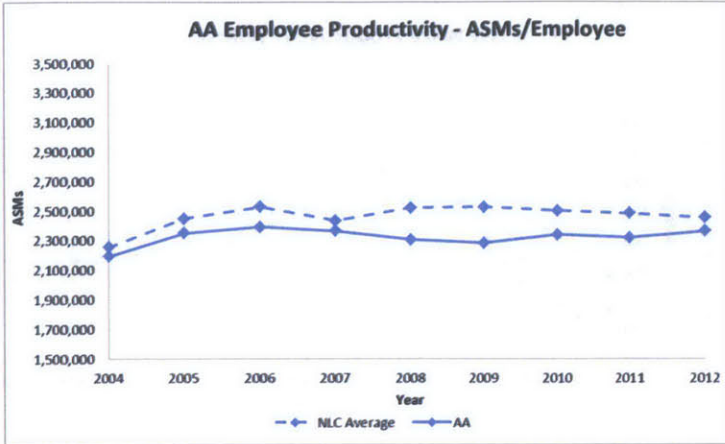
Continental's employee productivity was increasing before its merger with United. From 2004 to 2011, Continental's total number of employees decreased, but it had consistent growth in ASMs. However, its total wage paid out to its employees increased faster than its growth in ASMs, which led to the decrease in wage productivity.

Delta had significant growth in employee productivity from 2004 to 2006, which was due to its efforts in massive labor cuts and a slower decrease in ASMs during the time period when it was under bankruptcy protection. From 2006 to 2009, as Delta emerged from bankruptcy, it stopped its layoffs before its merger with Northwest, but Delta's ASMs continued to decrease, which led to the decrease in employee productivity during this time period. In 2010, Delta's total number of employees nearly doubled after its merger with Northwest, but its ASM production did not increase as quickly. Delta's employee productivity decreased from 2010 to 2012. The increase in Delta's wage productivity from 2004 to 2008 was due to the significant wage cuts, but the total salary and benefits paid out to its employees increased since, which explained the decrease in wage productivity from 2009 to 2012. Overall, Delta's employee productivity

increased by 13% and wage productivity increased by 14% from 2004 to 2012. In 2012, Delta was ranked the highest in employee productivity and the second highest in wage productivity among NLCs. Northwest had the highest employee productivity before its merger with Delta, which was due to deep cuts in the total number of employees and a slower decrease in its ASMs.

Despite the fact that US Airways had the greatest percent increase in productivity, its employee productivity was consistently below NLCs' group average. US's labor and wage cuts in 2005 led to the increase in employee and wage productivity from 2004 to 2005. US's employee productivity was the lowest in 2007, and with the additional number of employee from its merger with America West, US's ASM did not increase until 2008, which led to US's drop in employee productivity in 2007. When the new US began to produce more ASMs in 2008 and onward, its employee productivity increased. Similarly, because the wage increase due to merger was added in 2007, US's wage productivity dropped in 2007 and then decreased due to a more significant increase in wage than ASMs. Overall, US's employee productivity increased by 17% and wage productivity increased by 18% from 2004 to 2012.

From 2004 to 2012, United Airlines' employee productivity had been stable, and its total ASMs and number of employees decreased at a comparable rate. United's wage paid out to its employees was stable, which led to the decline in wage productivity. Overall, United's employee productivity increased by 3% and wage productivity decreased by 8% from 2004 to 2012.



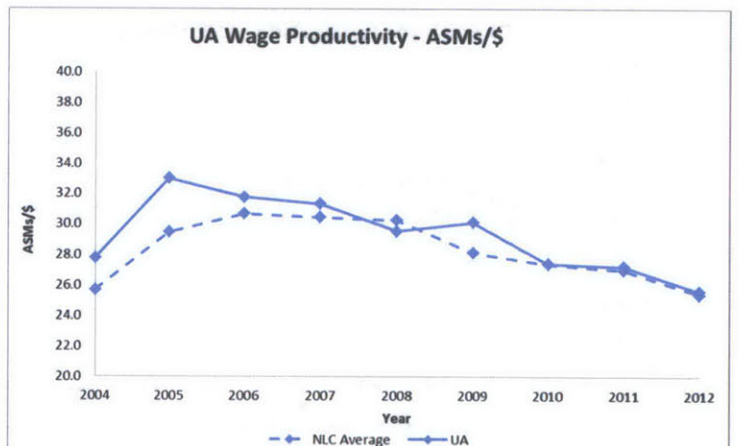
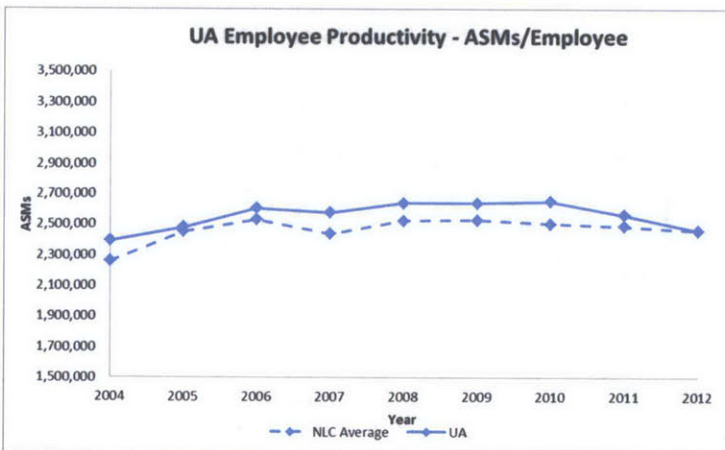
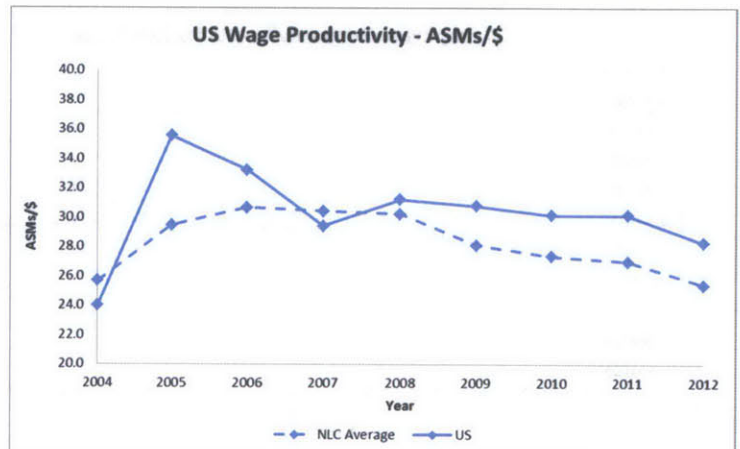
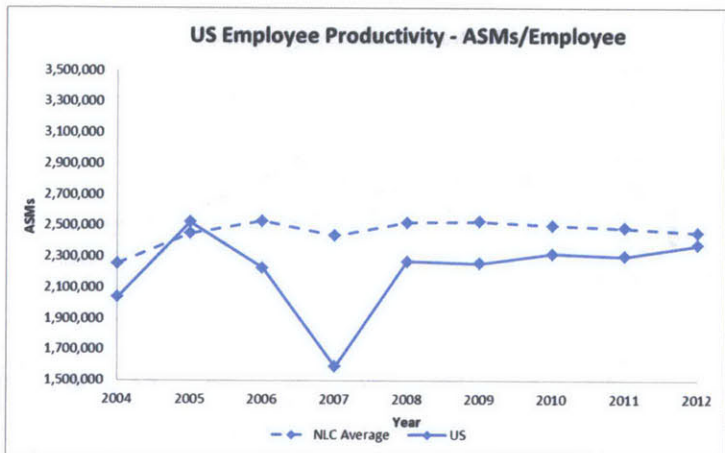
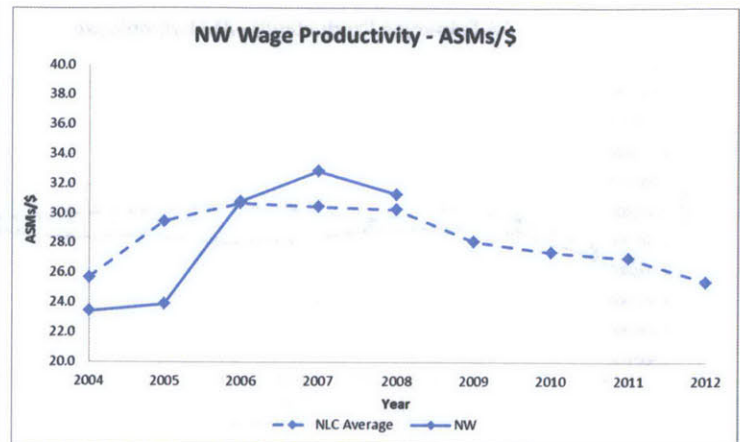
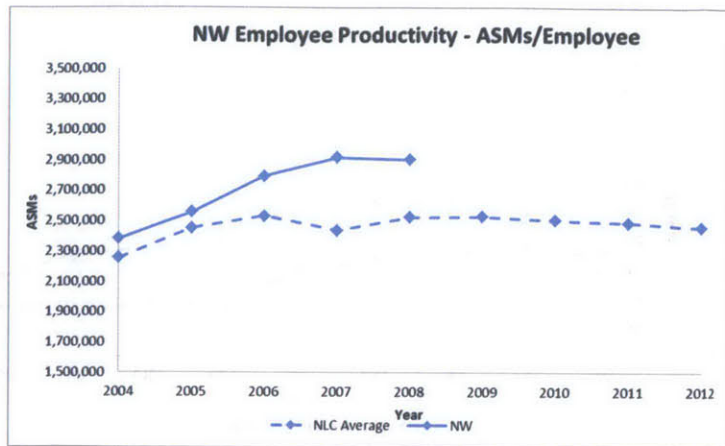


Figure 65 Individual Network Legacy Carriers: Employee and Wage Productivity

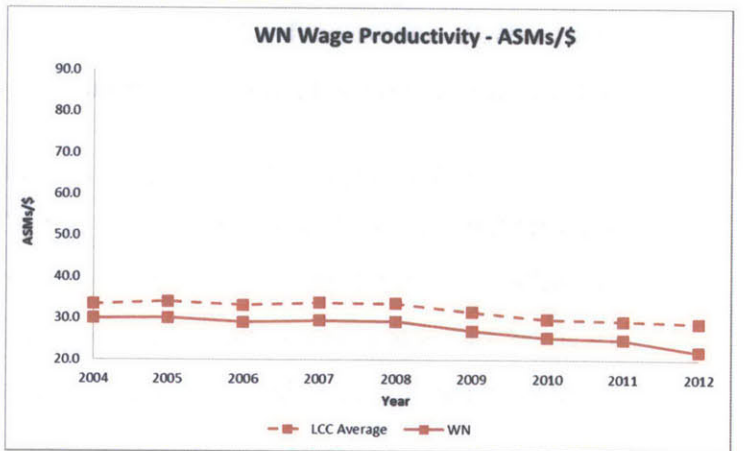
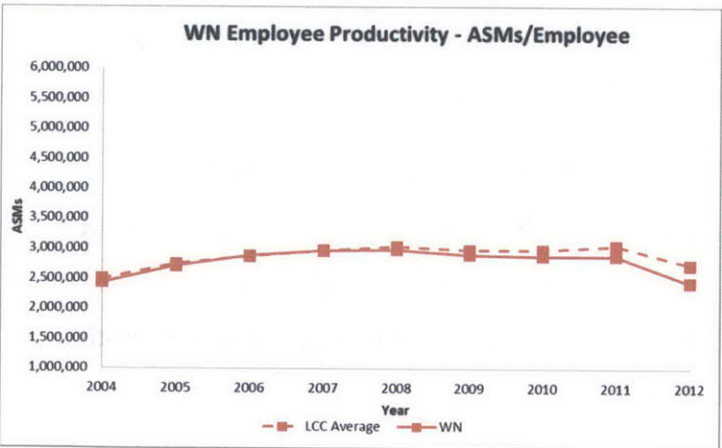
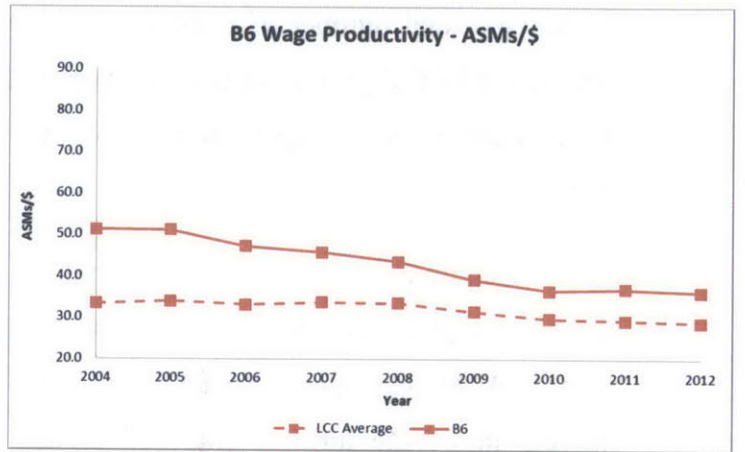
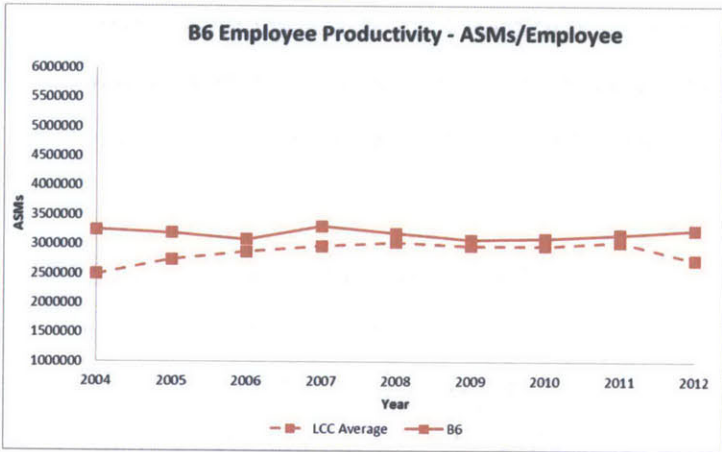
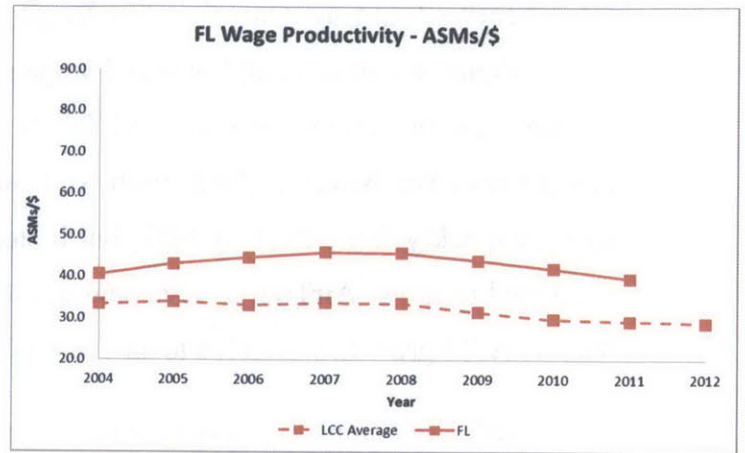
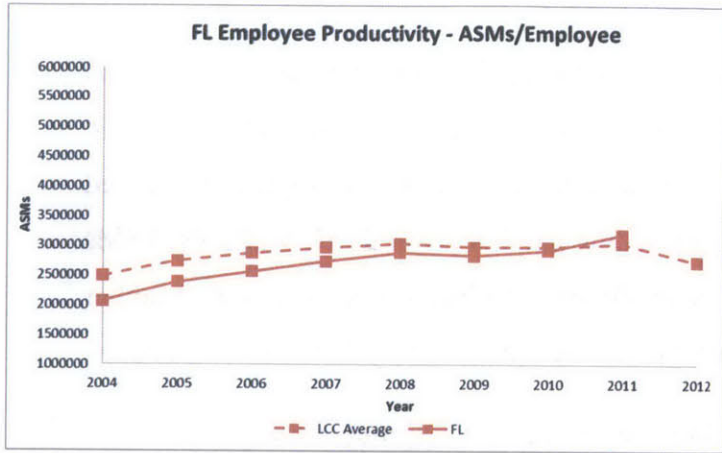
5.1.2.2 Individual Low Cost Carriers Employee Productivity

Figure 66 shows employee and wage productivity trends for individual low cost carriers plotted with the group averages. AirTran's employee productivity was increasing before it merged with Southwest in 2012. Both AirTran's ASMs and total number of employees ramped up very quickly from 2004 to 2007, but it stopped adding employees in 2007, while its ASMs continued to grow. AirTran's wage paid out to its employees continued to grow at a rate higher than its ASM growth, which led to an overall decrease in wage productivity from 2004 to 2011.

JetBlue's employee productivity was stable and above LCCs' group average. JetBlue's ASMs and total number of employees grew at a comparable rate. JetBlue's wage productivity was above LCCs' group average. Because JetBlue's wage paid out to its employees increased at a rate higher than the expansion in ASMs, its wage productivity decreased by 29% from 2004 to 2012.

Southwest's employee productivity increased from 2004 to 2011 but dropped in 2012, when it merged with AirTran. From 2011 to 2012, Southwest's labor force grew at a faster rate than its ASMs expansion. Southwest pays the highest average salary and benefits per employee among all of the airlines analyzed in this thesis. From 2004 to 2012, Southwest's wage productivity decreased by 27%. In 2012, it was ranked the lowest in employee productivity among LCCs, and the lowest wage productivity among all of the airlines.

Virgin's employee and wage productivity increased tremendously from 2004 to 2012. Despite the continual growth in the number of employees and increase in wage, Virgin expanded its ASMs at a much greater rate. From 2004 to 2012, Virgin's employee productivity increased by 15% and wage productivity increased by 52%. In 2012, Virgin was ranked highest in both employee and wage productivity among all of the airlines.



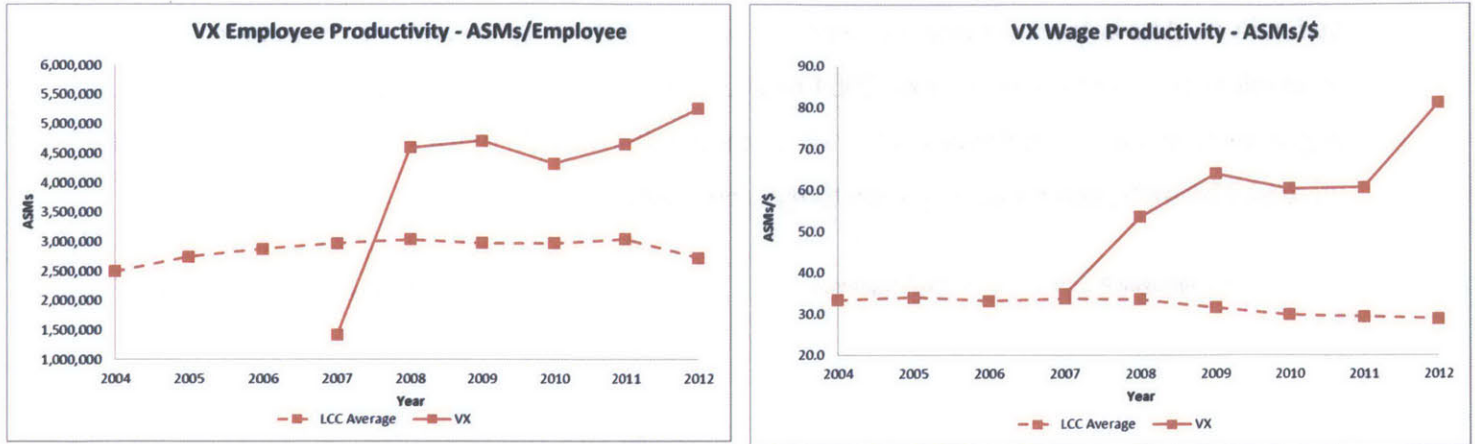


Figure 66 Individual Low Cost Carriers: Employee and Wage Productivity

5.1.2.3 Individual Ultra Low Cost Carriers Employee Productivity

Allegiant’s employee productivity increased by 51% from 2004 to 2012, and its rate of growth in ASMs was much greater than its rate of increase in the number of employees. However, because its rate of increase in wage paid to its employees was greater than its rate of growth in its ASMs, Allegiant’s wage productivity declined by 20% from 2004 to 2012. Allegiant pays the highest average salary and benefits per employee among ULCCs, and it was ranked second highest in both employee and wage productivity among all of the airlines analyzed in this thesis in 2012.

Frontier’s employee and wage productivity trended below ULCCs’ group average. Frontier’s ASMs decreased from 2007 to 2009 around the time it was going through bankruptcy and began to increase in 2010 after its merger with Midwest Airlines. With a series of layoffs post-merger and a continual increase in ASMs, Frontier’s employee productivity increased from 2010 to 2012. Frontier’s total wage paid to its employees decreased from 2007 to 2010 as a result of its downsizing and layoffs, and it increased at a comparable rate to its ASMs expansion from 2010 to 2012. Overall, its wage productivity was stable with a 2% decrease from 2004 to 2012. Frontier was ranked the lowest in both employee and wage productivity among ULCCs in 2012.

Like Allegiant, Spirit has managed to increase its ASMs at a much greater rate than its rate of increase in the number of employees. The spikes in employee productivity in 2007 and 2009 were due to the layoffs Spirit implemented in 2006 and 2008, and Spirit was still able to

maintain its ASMs level despite the decrease in size of its labor force. Spirit's wage paid out to its employees stayed constant from 2004 to 2009 and increased from 2010 to 2012 as the airline began to hire more employees. Overall from 2004 to 2012, Spirit's employee productivity increased by 48%, and its wage productivity increased by 19%.

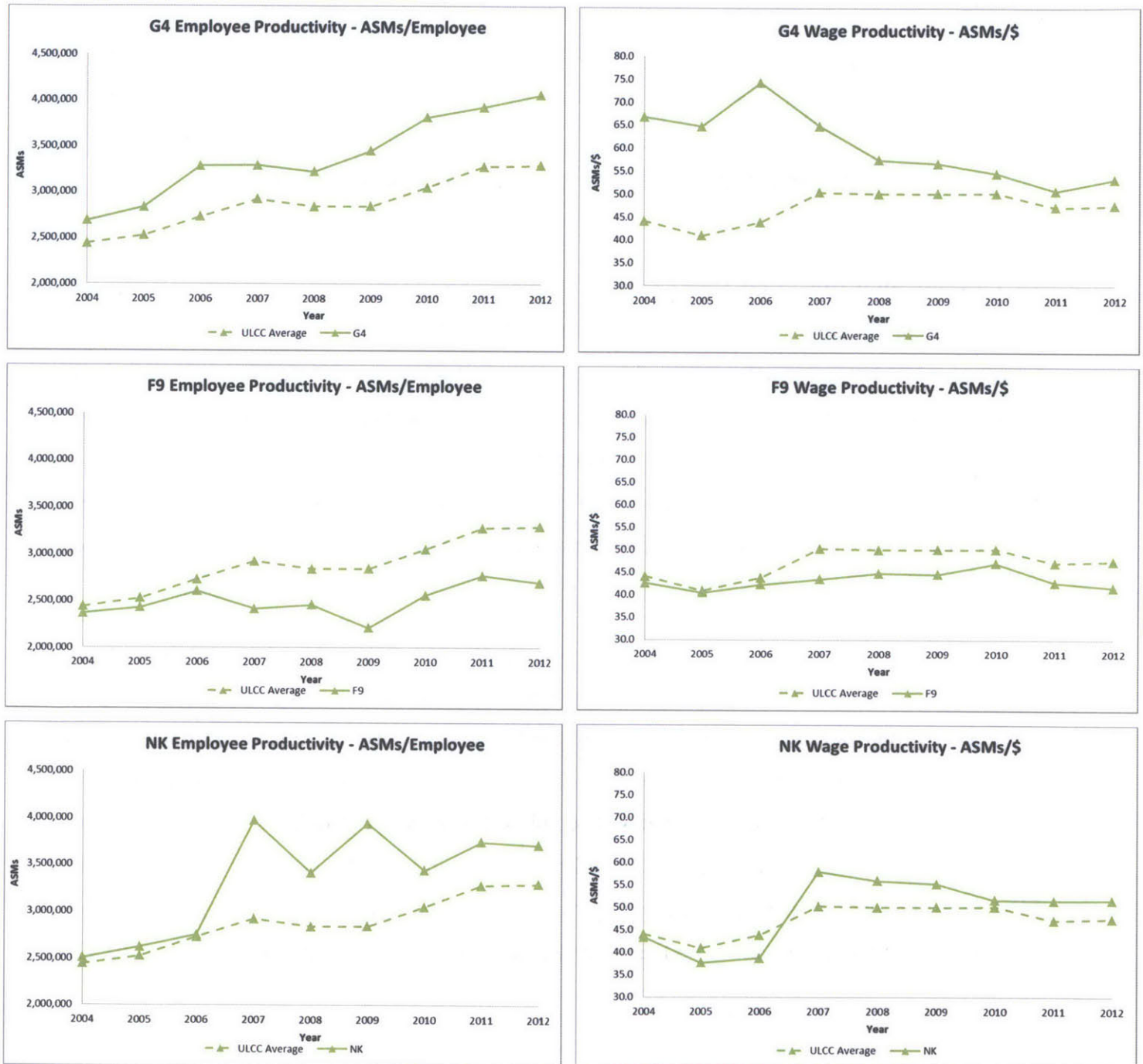


Figure 67 Individual Ultra Low Cost Carriers: Employee and Wage Productivity

Summary:

At the system aggregate level, NLCs' employee productivity increased mainly due to the continual labor cuts implemented from 2004 to 2012 and the reduction in labor was at a much greater rate than their decrease in ASMs. The deep labor cuts in the early 2000s brought down the salary and benefits paid out to the employees and led to temporary increase in wage productivity. Over time, NLCs' salary and benefits expenses increased due to the increase in their employees' seniority, and the increase in wages led to the recent decrease in wage productivity. Overall from 2004 to 2012, NLCs' employee productivity increased by 8.91% and wage productivity decreased by 1.05%.

LCCs' employee productivity increased from 2004 to 2008 because their ASMs expansion consistently outpaced the increase in the size of their labor force. However, their productivity plateaued between 2008 and 2011 due to a much slower growth of their ASMs than their addition of workforce. LCCs' recent drop in employee productivity in 2012 was due to the sudden increase in their employment and a much slower growth of their ASM production. LCCs' wage productivity was decreasing because the total salary and benefits paid out to their employees increased at a rate greater than the increase of their ASMs. LCCs' wages were increasing due to the increase in seniority of their employees. LCCs' average compensation per employee was greater than NLCs', and it was also increasing at a much greater rate than NLCs'. The wage productivity gap between LCCs and NLCs' decreased from 2004 to 2012, and LCCs are losing the advantage in wage productivity over NLCs in the past. Overall from 2004 to 2012, LCCs' employee productivity increased by 9.6% and wage productivity decreased by 13.5%.

ULCCs had the greatest increase in employee and wage productivity. It was mainly due to the rapid expansion in ASMs and a slower increase in employment and wage. ULCCs are relatively younger than NLCs and LCCs and have a younger labor force. ULCCs' employees have been paid the cheapest on average, and ULCCs have significant advantage in wage productivity over both NLCs and LCCs. Overall from 2004 to 2012, ULCCs' employee productivity increased by 34.9% and wage productivity increased by 7.84%.

5.2 Domestic Operations Aggregate Employee Productivity Comparisons

In this section, we present the general trends of domestic operations aggregate employee and wage productivity for NLCs, LCCs, and ULCCs from 2004 to 2012. Even though the employment data for domestic operations is extracted from BTS the same way as other measures analyzed in previous chapters, domestic operation allocation of employees is questionable, and it is difficult to segregate employment related data by region cleanly. We compare the trends of domestic operations to those of system aggregate and examine the impact of domestic and international operations on employee and wage productivity. Figure 68 and Figure 69 depict the total number of employees and average salary and benefits per employee paid for NLCs, LCCs, and ULCCs.



Figure 68 Domestic Operations Comparison: Employment

A little more than two thirds of NLCs' employees serve domestic operations, and the average salary and benefits per employee at the domestic operations level is about \$10,000 less than it is at the system level. LCCs' and ULCCs' employment for domestic operations level does not differ much from their employment at the system level. Compared to the average compensation per employee at the system level, LCCs' average compensation per employee is higher at the domestic operations level, while ULCCs' average compensation per employee is lower at the domestic operations level. On average, LCCs pay the highest salary and benefits among the three airline groups, and the compensation per employee gaps between LCCs and the other two groups are much greater at the domestic operations level than at the system level.

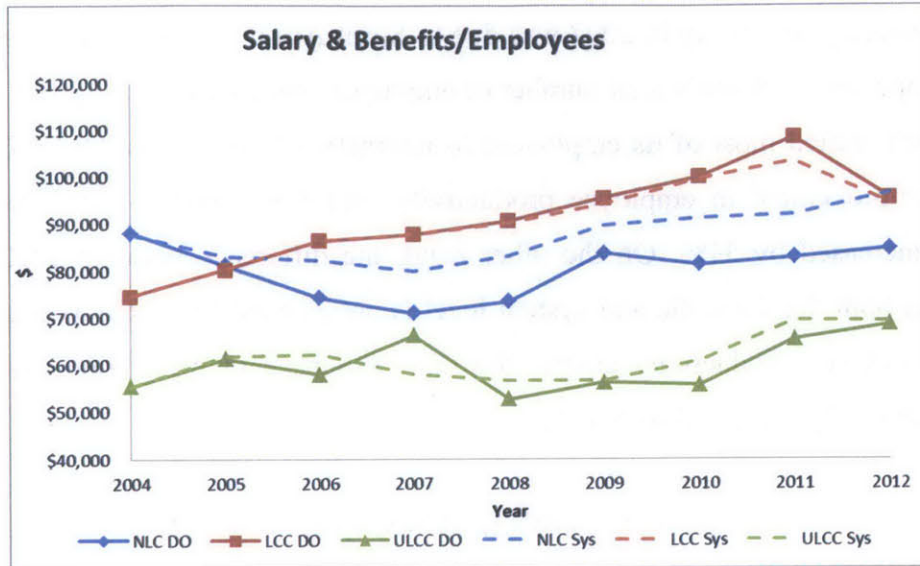


Figure 69 Domestic Operations: Average Salary & Benefits per Employee

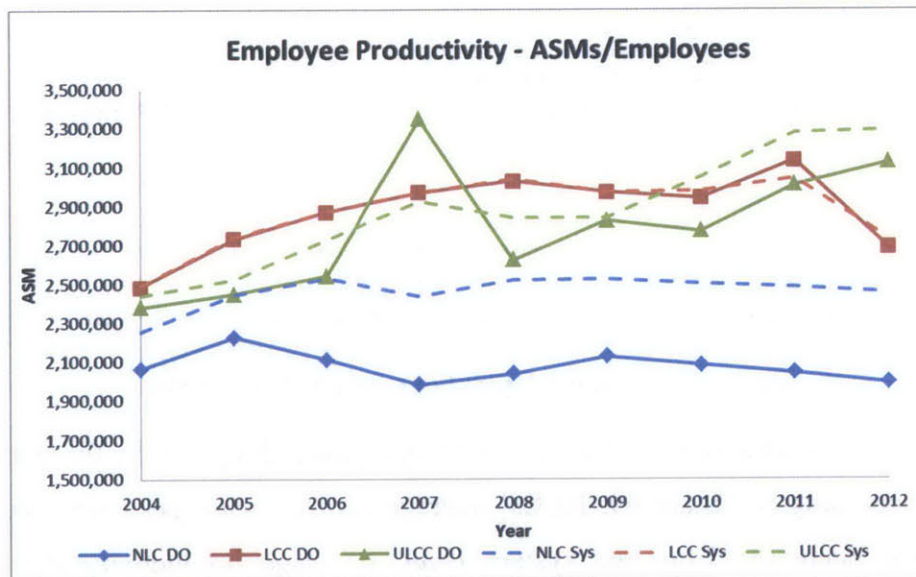


Figure 70 Domestic Operations: Employee Productivity

Figure 70 shows the employee productivity for domestic operations only for NLCs, LCCs, and ULCCs. Without the long stage length international operations, NLCs' employee productivity is 400,000 ASMs lower on average. From 2004 to 2012, even though NLCs' employee productivity increased at the system level, it decreased at the domestic operations level by 3.44%. Similarly, without international operations ULCCs' employee productivity for domestic operations is reduced by 100,000 ASMs on average from system level. The spike in

ULCCs' employee productivity in 2007 was due to Spirit Airlines' reduction in its employment for domestic operations. Spirit's total number of employees increased at the system level, but for that year, Spirit shifted most of its employees to international operations. Overall, ULCCs had the greatest improvement in employee productivity, and from 2004 to 2012 their employee productivity increased by 31%. On the other hand, the difference between LCCs' employee productivity at both the domestic and system level is not as significant. On average, LCCs had the highest employee productivity among the three groups, and from 2004 to 2012, LCCs' employee productivity increased by 8.13%.

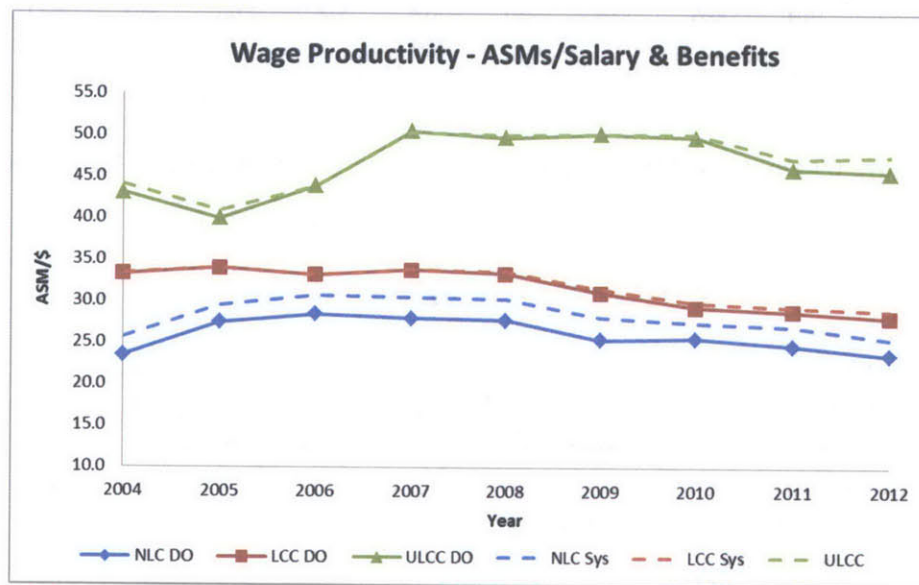


Figure 71 Domestic Operations: Wage Productivity

Figure 71 shows the domestic operations wage productivity for the three airline groups. Even though according to Figure 69, NLCs' average compensation per employee at domestic operations level decreased from the system level, its wage productivity did not increase proportionally because the drop in ASMs is more significant when NLCs' international operations are excluded. There has been no significant change between LCCs' and ULCCs' wage productivity at both the domestic and system level. The wage productivity gap between NLCs and LCCs decreased as LCCs keep increasing wages paid to their employees at a greater rate than NLCs. Because ULCCs labor force is relatively younger than LCCs and NLCs, ULCCs pay the lowest wages to their employees compared to LCCs and NLCs. ULCCs have the greatest advantage in wage productivity and labor unit cost, as we have seen in Chapter 3, at both domestic and system level.

Table 13 shows the rankings of employee and wage productivity for all airlines for domestic operations only in 2012. Without international operations, legacy carriers, having the lowest employee and wage productivity, dropped to the bottom of the rankings. Legacy carriers that had a greater portion of their operations internationally, such as United and Delta, dropped most significantly in employee and wage productivity. There isn't much change in rankings for LCCs' and ULCCs' employee and wage productivity between domestic and system level. However, it is interesting to note that Southwest's employee and wage productivity are the lowest among LCCs and ULCCs, and they are more comparable to those of NLCs. Virgin consistently tops the ranking for employee and wage productivity at both domestic and system level, and Allegiant ranks second best.

2012 Employee Productivity		2012 Wage Productivity	
Airline	ASMs/Employee	Airline	ASMs/\$
1 Virgin America	5062365	1 Virgin America	59.7
2 Allegiant Air	4054099	2 Allegiant Air	53.1
3 JetBlue Airways	3208943	3 Spirit Airlines	51.3
4 Spirit Airlines	3174488	4 Frontier Airlines	37.8
5 Frontier Airlines	2657610	5 JetBlue Airways	35.0
6 Southwest Airlines	2451498	6 US Airways	27.3
7 Delta Airlines	2142690	7 United Airlines	24.5
8 American Airlines	2122439	8 American Airlines	23.0
9 US Airways	2069940	9 Southwest Airlines	22.1
10 United Airlines	1754365	10 Delta Airlines	21.5

Table 13 2012 Domestic Operations: Employee and Wage Productivity Rankings for All Airlines

Summary:

At domestic operations level, LCCs have the highest employee productivity on average, while NLCs have the lowest, and LCCs have a more significant employee productivity advantage over NLCs. NLCs' employee productivity is much lower when international operations are excluded, which shows labor inefficiencies in NLCs' domestic operations. ULCCs have the most significant improvement in employee productivity and continue to have the highest wage productivity at the domestic operations level. However, an overall decreasing trend in wage is observed for the three groups, which can be explained by the increase in wages paid to their employees due to the increase in seniority and employment.

5.3 Stage Length Adjusted Employee Productivity Comparisons for Individual Airlines

When airlines fly longer stage lengths, their employee and wage productivity would increase because they can achieve economies of scale by producing more ASMs. In this section, we adjust individual airlines' employee and wage productivity in 2012 and rank the stage length adjusted measures at the system level.

Figure 72 and Figure 73 depict individual airlines' employee and wage productivity changes with respect to their average stage lengths from 2009 to 2012. In general we expect to see an increase in employee and wage productivity with increase in stage length. From 2009 to 2012, American, US, Virgin, JetBlue, Allegiant, and Frontier increased their average stage length, and their employee productivity also increased. However, United and Southwest had the opposite, and their employee productivity decreased even though their average stage length increased. United and Southwest rate of ASMs expansion was lower than the rate of employment increase.

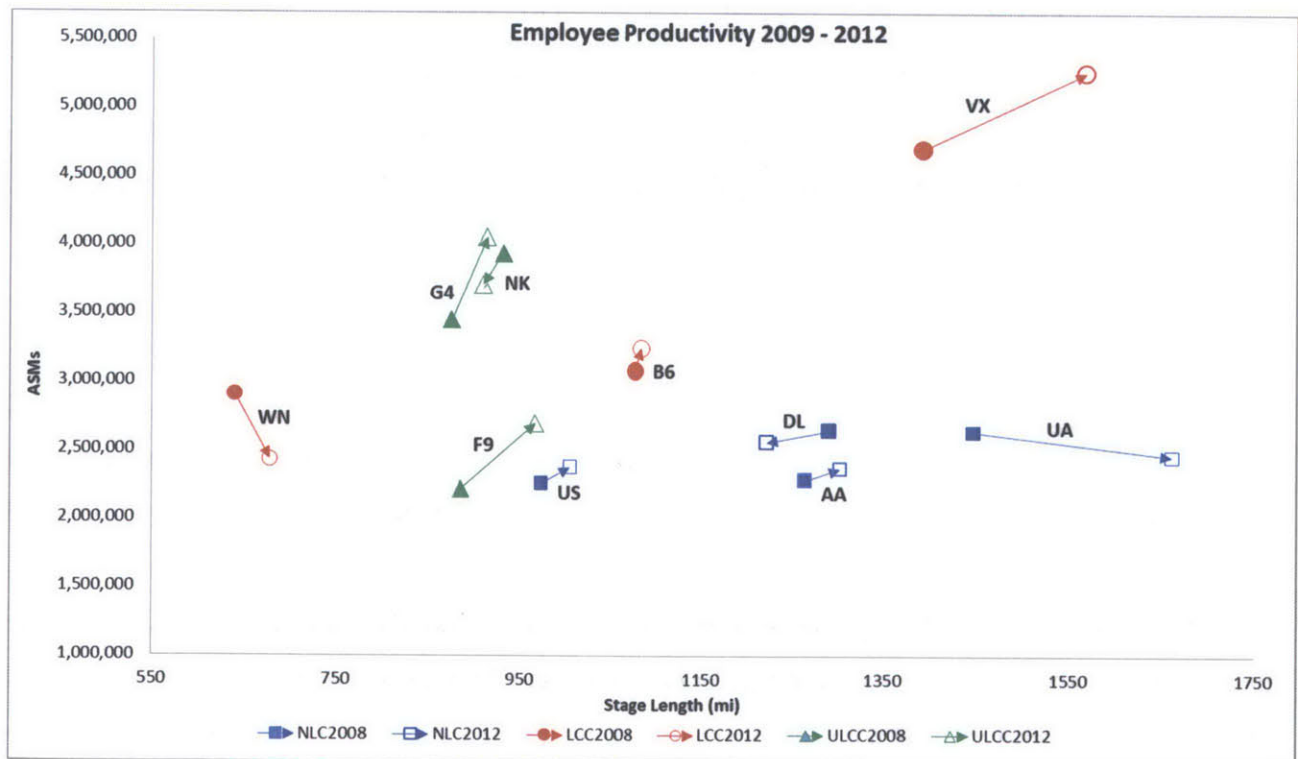


Figure 72 Employee Productivity vs Stage Length: Change from 2009 to 2012

Virgin was the only airline whose wage productivity increased as its average stage length increased from 2009 to 2012. US, American, United, JetBlue, Southwest, Allegiant, and Frontier’s wage productivity decreased even though their average stage length increased. Delta and Spirit decreased their average stage length, and both of their employee and wage productivity decreased. Virgin’s improvements in both employee and wage productivity were most significant.

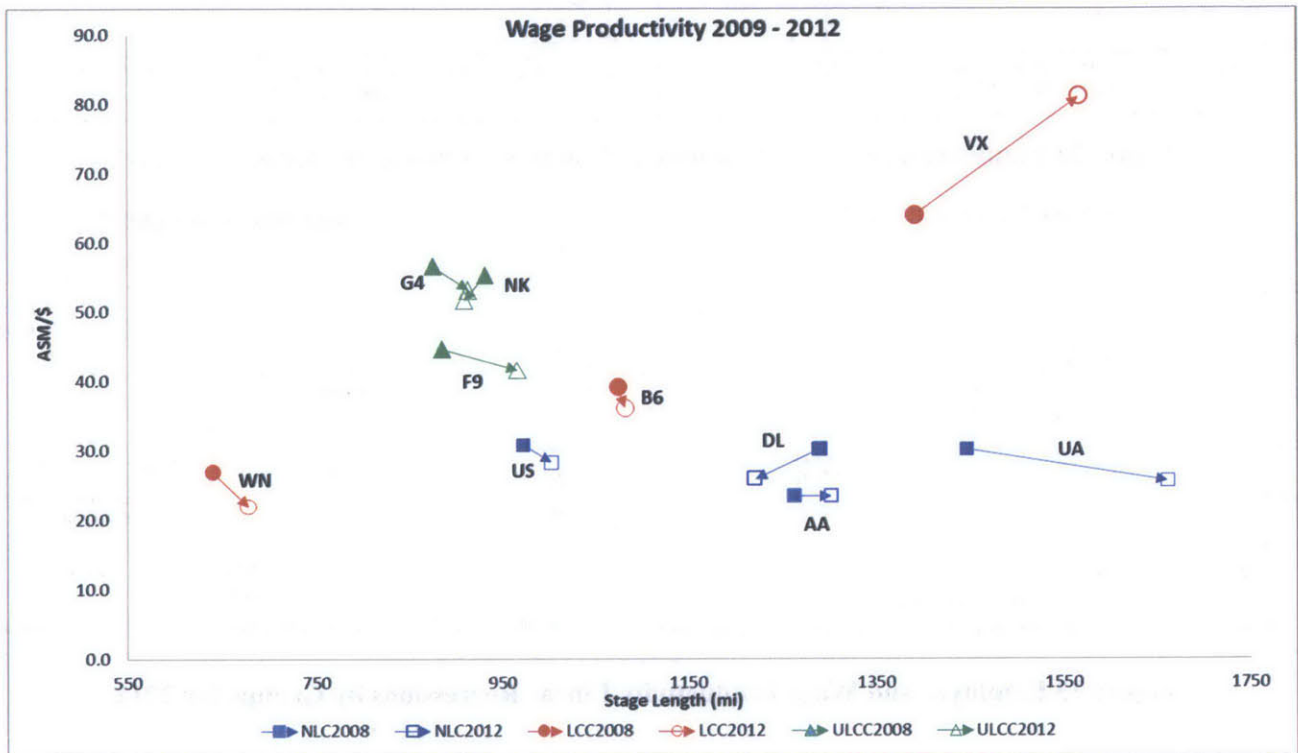


Figure 73 Wage Productivity vs Stage Length: Change from 2009 to 2012

Figure 74 depicts the linear regressions used to adjust each airline’s employee and wage productivity with respect to their stage lengths for 2012. The correlations between employee and wage productivity and stage length are not strongly correlated when all the airlines are looked at as one group, but they are nonetheless positively correlated. Figure 75 shows the regressions for each airline groups, and LCCs is the only group that has strong positive correlations between the productivity measures and stage length. All of the airlines are adjusted with respect to the average stage length of the entire sample for 2012, which is 1130 miles. The methodology for the linear regression analysis for stage length adjustment is explained in Chapter 2, section 2.4.3.

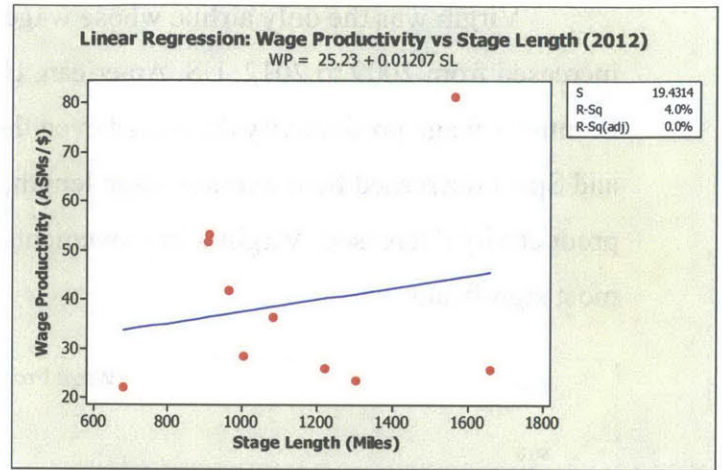
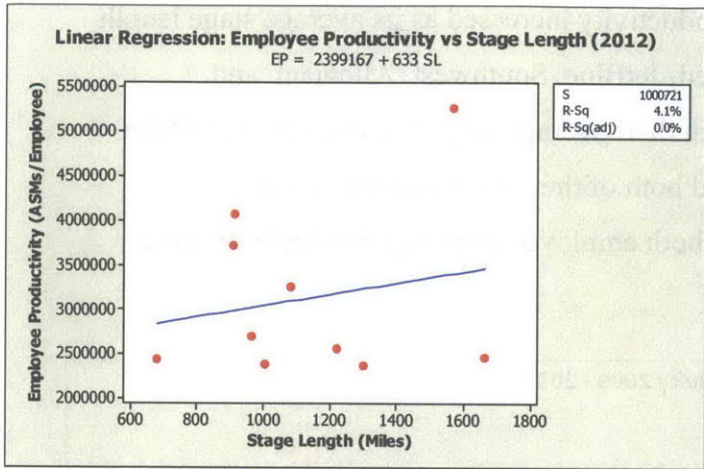


Figure 74 Employee and Wage Productivity Linear Regressions by Airlines for 2012

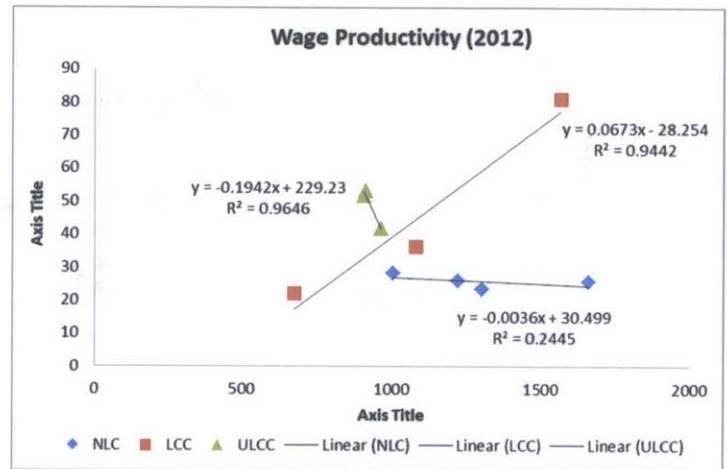
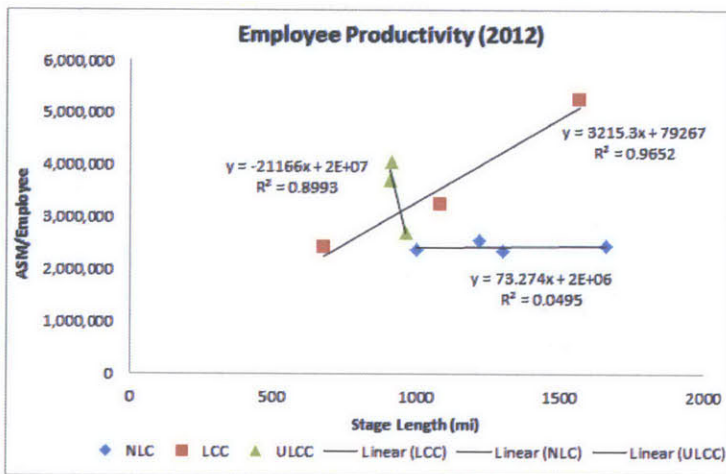


Figure 75 Employee and Wage Productivity Linear Regressions by Groups for 2012

When all of the airlines are adjusted with respect to the average stage length of the entire sample, employee and wage productivity of airlines with stage lengths greater than the average stage length of the sample are adjusted downward, discounting the productivity advantage from flying longer stage lengths. Employee and wage productivity of airlines with stage lengths shorter than the average stage length of the sample are adjusted upward.

The difference between system level and stage length adjusted employee and wage productivity for each aggregate group for 2012 is summarized in Table 14 . NLCs and LCCs group averages for both measures are adjusted down, while ULCCs group averages are adjusted up. Table 15 shows the adjustments for individual airlines. Since United has the highest average stage length among NLCs, it has the highest adjustment downward for both measures. Southwest

has the shortest average stage length among LCCs, and it has the highest adjustment upward for both measures. All of ULCCs' employee and wage are adjusted up.

2012	Employee Productivity (ASMs/Employee)				Wage Productivity (ASMs/\$)			
	System	SL-Adj	Δ	%Δ	System	SL-Adj	Δ	%Δ
NLC average	2439601	2363983	-75619	-3.10%	26	25	-1	-4.2%
LCC average	3646096	3595604	-50492	-1.38%	46	45	-2	-4.0%
ULCC average	3484232	3635815	151583	4.35%	49	52	3	6.8%

Table 14 Aggregate: System vs. Stage Length Adjusted Employee & Wage Productivity

2012	Employee Productivity (ASMs/Employee)				Wage Productivity (ASMs/\$)			
	System	SL-Adj	Δ	%Δ	System	SL-Adj	Δ	%Δ
American Airlines	2365244	2285513	-79731	-3.4%	23	22	-1	-5%
Delta Airlines	2559043	2512858	-46185	-1.8%	26	25	-1	-3%
US Airways	2375221	2437894	62673	2.6%	28	29	1	4%
United Airlines	2458897	2219666	-239231	-9.7%	26	22	-4	-14%
JetBlue Airways	3247875	3279463	31589	1.0%	36	37	1	1%
Southwest Airlines	2428962	2675041	246079	10.1%	22	26	4	16%
Virgin America	5261450	4832307	-429143	-8.2%	81	71	-10	-12%
Allegiant Air	4056254	4243361	187107	4.6%	53	57	4	7%
Frontier Airlines	2693033	2786143	93110	3.5%	42	44	2	5%
Spirit Airlines	3703408	3877940	174531	4.7%	52	55	4	7%

Table 15 Individual Airlines: System vs. Stage Length Adjusted Employee & Wage Productivity

Table 16 shows the rankings of the stage length adjusted employee and wage productivity by individual airlines. Comparing the rankings here with those in Table 12, Southwest and United have the most notable changes in their positions. United has the lowest employee and wage productivity among all of the airlines in the stage length adjusted results. Southwest has moved up the ranks but still has the lowest employee and wage productivity among all the low cost carriers. Virgin still ranks the highest despite having its employee and wage productivity adjusted down due to its longer than average stage length.

2012 Employee Productivity		2012 Wage Productivity	
Airline	ASMs/Employee	Airline	ASMs/\$
1 Virgin America	4832307	1 Virgin America	71.4
2 Allegiant Air	4243361	2 Allegiant Air	56.9
3 Spirit Airlines	3877940	3 Spirit Airlines	55.4
4 JetBlue Airways	3279463	4 Frontier Airlines	43.8
5 Frontier Airlines	2786143	5 JetBlue Airways	36.8
6 Southwest Airlines	2675041	6 US Airways	29.4
7 Delta Airlines	2512858	7 Southwest Airlines	25.5
8 US Airways	2437894	8 Delta Airlines	25.2
9 American Airlines	2285513	9 American Airlines	22.2
10 United Airlines	2219666	10 United Airlines	22.0

Table 16 2012 Stage Length Adjusted: Employee and Wage Productivity Rankings for All Airlines

Summary:

The results in this chapter show the influence of stage length on employee and wage productivity. After stage length adjustments, LCCs moved up the ranks for both measures, while NLCs moved down. With no stage length advantage, LCCs are more productive and efficient at utilizing their workforce. ULCCs still rank among the highest in both categories.

Chapter 6: Summary of Results and Conclusions

6.1 Summary of Results

The U.S. airline industry evolved tremendously during the period 2004 to 2012, and U.S. airlines faced major challenges such as the surge in fuel prices and economic recession. Legacy carriers had a more difficult time dealing with these challenges, and many declared bankruptcy and focused on restructuring to cut cost in order to be more competitive in the industry. Faced with the increase in competition from low cost carriers and the loss of market share in the U.S., legacy carriers shifted their focus to international market expansion. After a series of mergers, consolidations and changes in operational strategies, legacy carriers became more agile and competitive in a volatile market environment. While the legacy carriers struggled to regain profitability, low cost carriers had tremendous network and fleet expansion and captured significant U.S. domestic market share by offering lower fares. As traditional LCCs age and take on more legacy carriers' traits, they are faced with increases in costs. A new subset of the low cost carriers, ULCCs, has differentiated themselves by achieving the lowest unit costs in the industry.

When we break down the total unit cost into labor and non-labor components, we found that at the system aggregate level, labor and non-labor unit cost gaps between NLCs and LCCs have decreased significantly, and LCCs' cost advantage over NLCs has decreased. Most notably, Southwest Airlines' unit costs are comparable to NLCs', and Southwest's labor unit cost is the highest among all of the airlines analyzed in this thesis. From 2004 to 2008, NLCs' downsizing and labor cost cutting efforts brought down their unit costs substantially. Even though the overall aggregate unit cost at the system level grew from 2008 to 2012, the unit cost gap between NLCs and LCCs remained stable, which implies that NLCs have been controlling and reducing their costs continually. The remaining unit cost gap is the inherent structural difference between the two aggregate groups' operations. On the other hand, ULCCs' non-labor unit cost is comparable to LCCs', but ULCCs have the greatest labor cost advantage over both NLCs and LCCs, which is mainly because most ULCCs are new and have a relatively less senior workforce. When looking at domestic operations for all carriers, we found that LCCs and ULCCs have a greater cost advantage over NLCs, and that by focusing on international operations, NLCs have

achieved cost efficiencies. The cost and productivity advantage from flying longer stage lengths is apparent.

Our regression analysis showed strong positive correlations between stage length and aircraft and employee productivity, which also imply strong positive correlations between ASMs and these productivity measures. Flying longer stage lengths helped NLCs to achieve high aircraft and employee productivity at the system aggregate level, and LCCs and ULCCs have higher productivity at the domestic operations level. NLCs, especially those that filed for bankruptcy in the early 2000s, downsized and significantly reduced capacity from 2004 to 2006. In response to the high fuel prices and a significant decrease in air traffic demand from the economic crisis in 2008, NLCs performed further capacity reduction from 2008 to 2012. Overall, NLCs' aircraft utilization (BHs/ACDay) decreased from 2004 to 2012, but their aircraft productivity (ASMs/ACDay) improved mainly because of their increased focus on international market expansion and flying longer average stage lengths. Since NLCs fly longer stage

Since NLCs fly larger airplanes, they have significant aircraft productivity advantage over LCCs and ULCCs. From 2004 to 2009, LCCs had difficulties keeping up with their rapid growth in capacity, outputting ASMs at a slower rate, and their aircraft utilization and productivity both decreased significantly. From 2009 to 2012, LCCs reduced their capacity, and their aircraft utilization and productivity improved. Overall, LCCs have the highest aircraft utilization at both system and domestic operations level because of their quick turnaround times, and their utilization efficiencies are even greater at the domestic operations level. Lastly, ULCCs have lowest aircraft utilization and productivity on average and place less focus on these two measures. Allegiant Air, for example, operates low frequency flights in leisure markets and uses older aircraft to keep their ownership costs low.

On the labor front, as a part of downsizing and cost cutting efforts, NLCs significantly reduced their workforce. From 2004 to 2009, about 48,000 employees, which were more than 15% of the total NLCs' workforce, were cut. NLCs gained substantial employee productivity and labor cost savings from labor cuts. On the other hand, from 2004 to 2012 LCCs and ULCCs increased their workforce by 53% and 41%, respectively. NLCs' employee productivity (ASMs/employee) has been the lowest and remained stable with a slight improvement from 2004 to 2012. LCCs' employee productivity improved from 2004 to 2011, but had a recent decline,

which was caused by a sharp increase in the number of employees but a slower increase in ASMs. ULCCs consistently managed to increase their ASMs faster than their employees, and their employee productivity had the sharpest growth of 35% from 2004 to 2012. From the employee productivity analysis, we saw that NLCs and LCCs were increasing their productivities at a comparable rate, while ULCCs had a much greater rate of output per employee than both NLCs and LCCs. LCCs had the highest employee productivity from 2004 to 2009, and were surpassed by ULCCs in 2010. On average, LCCs have paid the highest average salary per employee and had the lowest wage productivity among the three groups, while ULCCs have paid the lowest and had the highest wage productivity. NLCs' wage productivity increased from 2004 to 2008 because of their labor cost savings but decreased from 2008 to 2012. Since LCCs experienced the sharpest increase in wages, their wage productivity decreased from 2004 to 2012. The overall decrease in NLCs and LCCs wage productivity was a direct effect of the increase in wage due to the increase in seniority of their workforce.

In conclusion, we found that NLCs' and LCCs' costs and productivities have become comparable, and the gaps between the two groups have reduced significantly. NLCs achieved significant advantage in aircraft and employee productivity with their large international market operations. ULCCs have the most significant advantage over NLCs and LCCs on the labor front, which is directly because of the fact that most ULCCs are young and have relatively less senior workforce. The increase in seniority has a greater impact on NLCs and LCCs than ULCCs. LCCs are clearly losing their historical unit cost, wage and employee productivity advantage to ULCCs. The gaps for labor unit cost, employee productivity, and wage productivity between ULCCs and the other two airline groups have been widening. ULCCs have truly achieved lowest unit cost with highest labor efficiency in the industry.

6.2 Further Research

As LCCs further evolve and expand their network, their network structure is no longer strictly point-to-point. The difference between hub-and-spoke and point-to-point network structures has greatly influenced cost and operational efficiency. We classified all the airlines analyzed here into three categories based on their size and business model. Network structure differences exist among the low cost carriers, and it is difficult to classify them into strictly point-to-point or hub-and-spoke network structure categories. The network structural differences between the airlines were not analyzed in this thesis, and further studies can be done on classifying airlines by network structure may quantify the impact of the differences on cost and productivity measures.

As NLCs recover from bankruptcies, merge and consolidate their resources, and slowly becoming more profitable, LCCs will not be able to gain domestic market share as fast as they did in the 2000s. LCCs may look to expand internationally, and they will need to grow into larger networks and possibly a hub-and-spoke structure. The point-to-point network structure is not as efficient as the hub-and-spoke structure for accommodating long haul flight connections and routing passengers, but LCCs could lose the aircraft utilization advantage they currently have over NLCs because of hub-and-spoke structure's slower turnaround times. The unit cost gap between NLCs and LCCs due to structural differences will disappear. Furthermore, if LCCs morph into hub-and-spoke networks, the number of direct flights will decrease, and they might lose their appeal to some customers. If LCCs do decide on grow into the hub-and-spoke network and compete with NLCs in international markets, future studies on the evolution of LCCs' network structure and quantifying the change with the change in cost and utilization will be interesting.

Our analysis of unit cost does not include revenue and profit. Even though LCCs and ULCCs still have cost advantage over NLCs, it would be interesting to incorporate revenue into the study and look at profit margins, in particular for LCCs and ULCCs. How have low cost carriers' average fare prices changed over the past few years, and how are they compared to legacy carriers'? Even though ULCCs have the lowest unit cost, how are their profit levels

compared to LCCs'? By answering these questions, we gain insights to how different low cost business strategies impact revenue and profitability in domestic markets.

Works Cited

- "American Airlines Cuts Flights from Reagan, LaGuardia Airports." *Chicago Tribune*. 15 Jan. 2014. <<http://www.chicagotribune.com/news/sns-rt-us-americanairlines-usairways-flights-20140115,0,77124.story>>.
- "Continental Flight Attendants Approve Labor Deal." *msnbc.com*. 30 Jan. 2006. <http://www.nbcnews.com/id/11102868/ns/business-us_business/t/continental-flight-attendants-approve-labor-deal/>.
- "Delta to Connect Northeast Business Centers with Significant Boston Expansion." Delta News Archive, 21 Dec. 2006. Web. 30 Mar. 2014.
- "Feds to Extend Financing to US Airways." *Msnbc.com*. 13 Jan. 2005. <http://www.nbcnews.com/id/6821347/ns/business-us_business/t/feds-extend-financing-us-airways/>.
- "Frontier Airlines to Cut about 450 Milwaukee-area Employees." 13 Feb. 2012. <<http://www.jsonline.com/business/frontier-airlines-to-cut-500-milwaukeearea-employees-cv46bem-139239153.html>>.
- "United and Continental Airlines to Merge." *BBC News*. 03 May 2010. <<http://www.bbc.co.uk/news/10095080>>.
- "US Ultra Low-cost Airlines Capitalise on Opportunities Created by Consolidation: Part 1." Centre for Aviation, 25 June 2013. <<http://centreforaviation.com/analysis/us-ultra-low-cost-airlines-capitalise-on-opportunities-created-by-consolidation-part-1-115834>>.
- "Timeline of United Airlines' Bankruptcy." *USA Today*. 1 Feb 2006. <http://usatoday30.usatoday.com/travel/flights/2006-02-01-united-timeline_x.htm>.
- Adams, Marilyn. "USA TODAY Today in the Sky." USA TODAY, 30 Jan. 2009. <http://usatoday30.usatoday.com/travel/flights/2009-01-29-profit-loss-airlines_N.htm>.
- Airlines for America. 22 Aug. 2013. <<http://www.airlines.org/Pages/U.S.-Airlines-Achieve-2-Percent-Net-Profit-Margin-in-First-Half-of-2013-and-Deliver-Solid-Operational-Performance.aspx>>.
- Alamdari, Fariba, and Simon Fagan. "Impact of the Adherence to the Original Low-cost Model on the Profitability of Low-cost Airlines." *Transport Reviews* 25.3 (2005): 377-92.
- Arnoult, Sandra. "How Low Can You Go?" *Air Transport World* Dec. 2007: 63-65.
- Blachly, Linda. "Delta Air Lines Retires Last Commercial DC-9 Aircraft." *ATWOnline*. 7 Jan. 2014. <<http://atwonline.com/airframes/delta-air-lines-retires-last-commercial-dc-9-aircraft>>.

Bomkamp, Samantha. "US Airlines Have Lost 54K Jobs in Last Two Years." Global Travel Industry News, 11 Aug. 2010. <<http://www.eturbonews.com/17818/us-airlines-have-lost-54k-jobs-last-two-years>>.

Bureau of Transportation Statistics (BTS) Glossary. < <http://www.transtats.bts.gov/glossary.asp>>

Department of Air Transportation, *Aviation Industry Performance: A Review of the Aviation Industry, 2008-2011*. Number: CC-2012-029. 24 September 2012.

Doganis, Rigas. *The Airline Business, Second Edition*, Routledge, 2006. p152.

Francis, G., I. Humphreys, S. Ison, and M. Aicken. "Where next for Low Cost Airlines? A Spatial and Temporal Comparative Study." *Journal of Transport Geography* 14.2 (2006): 83-94.

Franke, Marcus. "Competition between Network Carriers and Low-Cost Carriers: retreat Battle or Breakthrough to a New Level of Efficiency?" *Journal of Air Transport Management* 10.1 (2004): 15-21. Print.

Gillie, John. "The News Tribune." *Tacoma News Tribune*. 4 June 2008. <<http://blog.thenewstribune.com/business/2008/06/04/spirit-airlines-warns-of-layoffs/>>.

Hansson, T., Ringbeck, J., Franke, M., 2003. "Flight for survival: a new business model for the airline industry." *Strategy + Business*, Issue 31: 78-85. < <http://www.strategy-business.com/article/21966?pg=all>>

Heimlich, John. Air Transport Association, *2007 Outlook: "Reaching for the Skies?"*. < www.airlines.org>. January 2007.

Holder, Mark. "Cost Savings in Motion at Delta Air Lines." *The Motley Fool*. 3 Oct. 2013. <<http://www.fool.com/investing/general/2013/10/03/cost-saving-in-motion-at-delta-air-lines.aspx>>.

Isaacs, Jerry. "Unions for Flight Attendants, Pilots Agree to Huge Concessions at Northwest Airlines." 4 Mar. 2006. <<http://www.wsws.org/en/articles/2006/03/norw-m04.html>>.

Koenig, David. "Southwest Airlines to Add 20 Nonstop Flights to Major Cities including Las Vegas." *Las Vegas Review-Journal*. Las Vegas Review-Journal, 3 Feb. 2014. <<http://www.reviewjournal.com/business/southwest-airlines-add-20-nonstop-flights-major-cities-including-las-vegas>>.

KPMG, *2013 Airline Disclosures Handbook*, 2013. <<https://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/airline-disclosures-handbook-2013-v2.pdf>>.

Lewis, Alan, and Dan McKone. "HBR Blog Network." Harvard Business Review, 26 Sept. 2013. <<http://blogs.hbr.org/2013/09/how-the-u-s-airline-industry-found-its-edge/>>.

Mainline Operations: Continental Airlines, Airline Financials. <http://www.airlinefinancials.com/uploads/2002-2009_Continental_mainline.pdf>.

Mainline Operations: United Airlines, Airline Financials. <http://www.airlinefinancials.com/uploads/United_2002-2010__mainline_ops_.pdf>.

Maynard, Cicheline. "United Air Wins Right to Default on Its Employee Pension Plans." *The New York Times*. 11 May 2005. <<http://www.nytimes.com/2005/05/11/business/11air.html?pagewanted=all>>.

Mufson, Steven. "American Airlines' Plan for Pension Bailout Draws Criticism." The Washington Post, 07 Feb. 2012. <http://www.washingtonpost.com/business/economy/american-airlines-request-for-pension-bailout-draws-criticism/2012/02/03/gIQAu1m1nQ_story.html>.

Mutzabaugh, Ben. "United Airlines Still Hearing Complaints after Merger Switchover." USA Today, 28 Mar. 2012. <<http://travel.usatoday.com/flights/post/2012/03/united-airlines-still-leaving-passengers-on-hold-/658647/1>>.

Nicas, Jack. "As Southwest Goes Mainstream, Will Direct Flights Go Extinct?" Corporate Intelligence RSS. Wall Street Journal, 2 Apr. 2014. <<http://blogs.wsj.com/corporate-intelligence/2014/04/02/as-southwest-goes-mainstream-will-direct-flights-go-extinct/>>.

Nicas, Jack. "U.S. Airlines Add Service as Profits Grow." *The Wall Street Journal*, 22 Aug 2013. <<http://online.wsj.com/news/articles/SB10001424127887323980604579028922722699670>>.

Nicas, Jack. "United Airlines Aims for 42 Billion in Annual Cost Cuts." *The Wall Street Journal*, 19 Nov. 2013. <<http://online.wsj.com/news/articles/SB10001424052702304439804579207693313317838>>.

Notte, Jason. "Airline Mergers Mean More Pain for Passengers." MSNMoney, 13 Feb. 2013. <<http://money.msn.com/now/post.aspx?post=c9573475-1893-4cac-953f-9183bc62a01f>>.

Oliver Wyman, *Airline Economic Analysis*, Nov, 2013. <http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/files/archive/2013/2013_Airline_Economic_Analysis.pdf>.

Pearce, B., Smyth, M., *Airline Cost Performance, IATA Economics Briefing No.5*, International Air Transport Association, Jul, 2006. <http://www.iata.org/whatwedo/Documents/economics/airline_cost_performance.pdf>.

Reed, Dan, and Barbara De Lollis. "USATODAY.com - America West, US Airways Merger Goes for a Tight Fit." *USATODAY.com* 21 May 2005. <http://usatoday30.usatoday.com/money/biztravel/2005-05-19-merger_x.htm>.

Schlangenstein, Mary. "AMR Will Fire 13,000 as Part of Plan to Lower Costs by \$2 Billion a Year." Bloomberg, 1 Feb. 2012. <<http://www.bloomberg.com/news/2012-02-01/amr-poised-to-start-labor-talks-with-10-000-job-cuts-possible.html>>.

Sherman, Paul. "Massive Wage Cuts Imposed on American Airlines Workers." 18 Apr. 2003. <<http://www.wsws.org/en/articles/2003/04/aa-a18.html>>.

Swelbar, Bill. MIT Airline Industry Lecture Notes, *LCC Airlines: Cost and Productivity Convergence*, 2 October 2013. Slide 9.

Swelbar, Bill. MIT Airline Industry Lecture Notes, *LCC Airlines: Cost and Productivity Convergence*, 2 October 2013. Slide 6.

Swelbar, Bill. MIT Airline Management Lecture Notes, *Operating Cost, Productivity and Performance Analysis*, 20 February 2013. Slide 13.

Taneja, N.K., 2004. *Simpli-Flying: Optimizing the Airline Business Model*, Ashgate, p70.

Tang, Stanton. "Bankruptcy Court Approves Delta Union Concessions." 31 May 2006. <<http://www.wzzm13.com/news/story.aspx?storyid=55397>>.

Tsoukalas, Gerassimos, *Convergence in the US Airline Industry: A Unit Cost and Productivity Analysis*, Department of Aeronautics and Astronautics Thesis, MIT. 27 Aug, 2007.

US DOT Form 41 Airline Operational Cost Analysis Report Definitions

Vellucci, Justin. "US Airways' Pittsburgh Market Share under 40 Percent." *TribLIVE.com*. 15 Sept. 2007. <http://triblive.com/x/pittsburghtrib/business/s_527588.html>.

Winship, Tim. "Frontier Eyes Future as 'Ultra-Low-Cost Carrier'" Frontier Eyes Future as 'Ultra-Low-Cost Carrier' - SmarterTravel.com. N.p., 3 Oct. 2013. <<http://www.smartertravel.com/blogs/today-in-travel/frontier-eyes-future-as-ultra-low-cost-carrier.html?id=16309111>>.

Yeo, Ghim-Lay. "INTERVIEW: Spirit Airlines Chief Executive Ben Baldanza." INTERVIEW: Spirit Airlines Chief Executive Ben Baldanza. N.p., 26 Apr. 2012. <<http://www.flightglobal.com/news/articles/interview-spirit-airlines-chief-executive-ben-baldanza-371158/>>.