

**Convergence in the US Airline Industry: A Unit Cost and Productivity Analysis**

by

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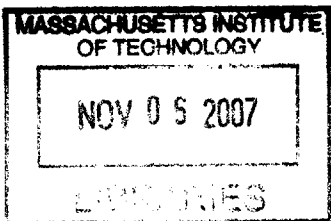
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**AERO**



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## *ABSTRACT*

The last decade has been a period of fundamental transformations for the US airline industry and has caused many carriers to make significant changes in their operational strategies. The traditional US network or “Legacy” carriers have had to deal with many new challenges including the devastating effects of 9/11, increased competition from low-cost airlines and increased volatility in fuel prices, to name a few. These setbacks have pushed many carriers into a financial crisis. In fact, four out of the six major airlines in the United States filed for bankruptcy protection between 2001 and 2005. In the midst of this crisis, these traditional carriers have had to concentrate on reducing their unit costs and improving their productivity levels in order to survive.

The goal of the thesis is to examine to what extent these changes have led to a convergence in terms of unit costs and productivity levels between the Legacy carriers and their low-cost counterparts. Specifically we analyze and break down unit costs and productivity measures into their underlying components in order to identify what is driving change in the industry. We compare the different results at various levels of detail, including aggregate industry group trends, individual airline results and fleet-level based results comparing wide-body to narrow-body aircraft.

We find that there are both qualitative and quantitative signs of convergence in several different categories in which LCCs have traditionally held a competitive advantage. These include unit costs excluding fuel and transport-related expenses, labor unit costs and employee wage productivity. On the Legacy side, the key forces driving improved efficiency have been dramatic labor cuts and higher stage lengths. The former has been achieved by utilizing the bankruptcy while the latter results from the shifting of capacity towards international markets. On the LCC side we find that a significant increase in labor wages resulting from increased staff seniority has been the main source of losses in certain productivity results. Despite these signs of convergence, our fleet-level based analysis also showed that LCCs still retain a significant competitive advantage when isolating narrow-body fleets which are usually flown in the domestic US markets.

Thesis supervisor: Peter P. Belobaba  
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*A recession is when you have to tighten your belt; depression is when you have no belt to tighten. When you've lost your trousers - you're in the airline business.*

*Sir Adam Thomson*



# Acknowledgements

I arrived at MIT two years ago, confident that my calling was in the development of plasma propulsion engines in one of those labs in 37-xx, known for their averseness to light. So when I sat into Doctor Belobaba's introductory class to the airline industry in September of 2005, it was supposed to be as a side-note intended simply to satisfy my curiosity. I would have never guessed at the time that I would find myself totally immersed in this field, just one year later. Although my first year at MIT can only be described as a "wild roller-coaster ride", I was very fortunate to sit in that first 16.71 class because it unlocked a whole new set of opportunities.

I believe the former Chairman of Air Florida, Ed Acker, said it best: *Once you get hooked on the airline business, it's worse than dope.* Looking back at the last two years I realize how much this is true. But there is also no doubt that my advisor, Peter Belobaba, played an undeniable role in making sure that I get "hooked" and once that was done, that I stay "hooked". His passion for the industry and his immense talent as teacher and a researcher convinced me to shift my own academic focus to this field. I consider myself very lucky to have had him as an advisor and my experience at MIT would definitely not have been as enjoyable as it was without his guidance and support. So it is without much hesitation that I would like to thank him first and foremost. I would also like to mention his open-mindedness with regards to my own academic objectives. I don't know many advisors that would agree to let their research assistants take up dual graduate programs at MIT. If it weren't for the trust he placed in me, I would have not been able to fulfill my desire to obtain a degree in Financial Engineering in parallel to my work in the Aero/Astro department.

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I dedicate this thesis to the loving memory of my grandmother – I know I always held a special place in her heart, and she will always hold one in mine.



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# Chapter 1

## Introduction

Over the last three decades there has been a dramatic reshaping of the US airline industry caused by a variety of factors. These include: the Deregulation Act of 1978, the shift towards Hub-and-Spoke networks, the emergence of Low-Cost Carriers (LCCs) as an alternative business model, the terrorist attacks of 9/11 and the increasing volatility in fuel prices. Although the airline industry has always been cyclical, its complexity and sensitivity to external factors such as the ones mentioned above has always made any sort of stability impossible. This in turn implies that it is crucial for airline companies to be able to adapt dynamically to changing market conditions on a constant basis - something that is of course easier said than done.

Some of the recent issues airlines have had to address include a downturn in average fares and passenger demand coupled with surging fuel costs which have pushed several Legacy carriers<sup>1</sup> to file for bankruptcy and to undertake restructuring efforts. In this turbulent environment which has been in place since 2000, these carriers have had to rethink their business models: Being limited in their ability to stimulate enough passenger demand, and seeing the success of certain LCCs such as Southwest and JetBlue throughout these unstable times, these long-standing airlines have concentrated their efforts into cutting costs and improving their productivity.

It is the goal of this thesis to examine to what extent Legacy carriers have been successful at coping with these changes and to evaluate their success in bridging the cost and productivity gap that historically exists between them and their low-cost rivals.

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<sup>1</sup> The term “Legacy carriers” refers to the traditional Major carriers most of which existed through the 1978 Deregulation Act. In the current period, we include the following airlines in this group: American, Continental, Delta, Northwest, United and US Airways

## 1.1. The Airline industry Cycles and Recent Trends

The US airline industry has experienced several up/down cycles since the Deregulation Act of 1978. The two most recent ones have occurred in the past decade:

### **The golden period of the 1990s**

The end of the 1990s saw airlines around the world bringing in record profits and the 1995-1999 period was particularly favorable to the US airline industry. US carriers benefited from a strong economy generating substantial passenger demand and healthy revenues. During this four year period, US carriers reported over \$22 billion in net profits<sup>2</sup>. It is also interesting to note that crude oil prices, which are heavily correlated with jet fuel prices, were relatively low over that same period ranging between \$15 and \$30 per barrel.

### **Downturn of 2000**

This profitable period was followed by a severe economic downturn starting in 2000. According to the Air Transport Association (ATA)<sup>3</sup>, US airlines reported cumulative net losses of over \$40 billion between 2001 and 2005. The price of oil climbed from under \$30 to over \$70 per barrel during the same period. Although oil – priced at twice the level of late 90's – is certainly one of the major reasons that plunged airlines into a downward cycle, there are many other factors that contributed to this trend.

### *Reduced traffic*

At the turn of the century, several of the world's major economies including the United States, experienced a slowdown. This put downward pressure on passenger traffic as measured by Revenue Passenger Kilometers (RPK), breaking the upward trend in place since the 1980's. Specifically, RPKs in the US airline industry dropped 6% from 2000 to 2001, and another 2% the year after<sup>2</sup>. These figures also include the effects of the September 11 2001 attacks which greatly accelerated and increased the downward pressure on traffic. A 2006 IATA<sup>4</sup> report on the effects of 9/11, states that domestic passenger traffic in the US has not yet recovered from this terrorist attack. US domestic enplanements for July 2001 were at 50 million, versus 44 million for July

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<sup>2</sup> Peter Belobaba, MIT Airline Industry Lecture Notes, *Introduction: Airline Industry Overview*, September 6, 2006

<sup>3</sup> John Heimlich, Air Transport Association, *2007 Outlook: "Reaching for the Skies?"*, www.airlines.org, Jan. 2007

<sup>4</sup> International Air Transport Association, *The Air Transport Industry Since 11 September 2001*, 2006

2006 (a 12% drop). Yearly domestic enplanements for 2006 were forecasted at 480 million versus actual traffic of 540 million in 2000 and 500 million in 2001 (respectively representing a 11% decrease from pre-9/11 levels and a 4% decrease from post-9/11). At the same US airlines also experienced a decline in capacity as measured by Available Seat Miles (ASMs). From 2000 to 2001 international ASMs dropped 3% and from 2001 to 2002 they dropped a further 3.6%. In terms of domestic ASMs, there was a 2.6% decrease from 2000 to 2001, and a further 4.6% decrease the year after.

### *Lowered yields*

In addition to this reduction in traffic and capacity, airlines had other pressures to face: Average fares and yields slipped during the same period, affected by the factors mentioned above but also by the internet startups debacle in late 2000. The collapse of the dot.coms heavily reduced business passenger traffic and as these passengers typically paid the highest fares, this pushed average fares and yields down. Geslin<sup>5</sup> (2005) showed that US airline fares decreased on average by 16.4% from 2000 to 2004. This decrease was even more severe in markets that had acquired new LCC competition during this time and was of the order of 31%. Concerning passenger yields, the IATA<sup>4</sup> reported an estimated 25% decrease in US domestic markets from 2000 to 2005. Furthermore during this period the developments in the field on information technology gave way to enhanced internet distribution channels which had a dual effect. They certainly helped to reduce the cost of booking however at the same time they created more fare transparency for passengers leading to increased competition and lower yields.

### *Increase in labor costs*

At the same time, an increase in labor costs was accentuating the losses in profits that airlines were experiencing. Prior to the golden period in the late 90s, airlines suffered yet another down-cycle in their history caused by an unfavorable economic environment from 1990 to 1995. During these crisis years, and more particularly towards the middle of the 1990s, US carriers renegotiated wage agreements with their unions and obtained important concessions which helped them survive through the turmoil. These renegotiations were typically planned out over the next three to five years. This set the stage for greater labor problems in the years ahead. In the end of the 90s, airlines were once again profitable benefiting from a rebounding US economy. By then, the contract concessions that were obtained at the end of the crisis years were expiring, and

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<sup>5</sup> Celia Geslin, *Pricing and Competition in the US Airline Markets: Changes in Air Travel Demand Since 2000*, Department of Civil and Environmental Engineering Thesis, MIT

as unions saw their airlines generating record profits, they pushed heavily to renegotiate their contracts once again. They wanted to benefit from this positive environment and recover some of the concessions they were forced to make half a decade earlier. As a result, several US carriers were forced to grant major wage increases: For example, United Airlines' pilots received an immediate wage increase between 21.5% to 28.5% in September 2000 followed by an annual 4% increase for at least four years, and Delta proposed a 17.5% increase to its pilots in November 2000<sup>6</sup>. As the down-cycle hit yet again in late 2000 – early 2001, labor costs were at a peak and heavily accelerated the losses experienced after 9/11.

#### *Initial schedule and labor cuts*

One of the first reactions to 9/11 was that Legacy carriers started to cut capacity. Almost immediately after the attacks, flights were cut by around 20%<sup>7</sup>. In the aftermath of 9/11 schedules were reduced and many companies started laying-off employees in order to remain competitive. From 2000 to 2001, employment numbers for Legacy airlines decreased by nearly 10%<sup>8</sup> translating into more than 64,000 jobs lost in a single year. From 2001 to 2005, the number of employees working for Legacy carriers fell from just over 600K to under 530K, a further 13% decrease.

#### *Bankruptcy as a necessary step*

Despite initial efforts at reducing capacity and workforce, the losses kept stacking up and several of the large US Legacy carriers proceeded to file for Bankruptcy protection under Chapter 11. Two of the first were United Airlines which filed for protection in December 2002 and US Airways which filed twice over a two year period (the first in 2002 and the other in Sept. 2004). They were followed by Delta and Northwest who both filed in Sept. 2005. The other two major carriers: American Airlines and Continental have not filed for bankruptcy but they certainly took advantage of the tone set by their competitors to undertake major restructuring efforts and obtain concessions from their unions.

Although bankruptcy is usually reserved as a last resort and has negative impacts far beyond simply destroying shareholder value, it is often argued by airline analysts and especially by the airlines themselves, that it might be a feasible solution to get some of the Legacy carriers

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<sup>6</sup> Allbusiness.com, *United Airlines flight attendants seek wage rise*, <http://www.allbusiness.com/operations/shipping-air-freight/636972-1.html>, September 25 2000.

<sup>7</sup> John Rossheim, *September 11's Impact on the Workplace*, <http://featuredreports.monster.com/911/world/>

<sup>8</sup> Bureau of Transportation Statistics (BTS), *Number of Employees for Major carriers 2000-2005*, [http://www.bts.gov/programs/airline\\_information/number\\_of\\_employees/certificated\\_carriers/index.html](http://www.bts.gov/programs/airline_information/number_of_employees/certificated_carriers/index.html)



back on track. Even though it is not clear to what extent this is true, it is an effective way for airline carriers to rethink their business models and gives them the opportunity to adapt to the changing market conditions mentioned earlier. Arguably the ones that suffer the most are the employees themselves as airlines use Chapter 11 to reduce the workforce and renegotiate or even terminate contracts with unions. One example is that of US Airways: One month after their second bankruptcy filing, a judge granted the company the authority to cut the pay of its union workers by 21% (US Airways had asked for 23%) comparing the airline's financial outlook to a "fiscal time bomb"<sup>9</sup>. Another example is Delta: Just one week after filing for Chapter 11, the company reported its plan to cut 9,000 jobs through 2007 (nearly 20% of its 52,000 workforce) through attrition and layoffs, to reduce its less-profitable flights in the domestic markets by as much as 20% (in part by downsizing hubs in Atlanta, Cincinnati and Salt Lake City) and to cut the number of aircraft types in its fleet to seven from eleven<sup>10</sup>.

#### *Increased interest in consolidation*

During this period, in addition to filing for Chapter 11, consolidation was seen as a complementary viable solution. US Airways merged with America West and exited bankruptcy in May 2005. Just under two years later, they made a hostile bid of \$10 billion to acquire Delta in Nov. 2006. Delta Management rejected the bid immediately arguing that it was too low and that the Delta restructuring plan that was being put together would create greater value for shareholders. Had the merger gone through it would have certainly raised a bigger issue: The US regulatory authorities are facing a delicate situation because agreeing to one merger might spark a wave of consolidation across the industry. In fact, rumors in Oct. 2006 were that Continental could merge with United Airlines, although official press releases from both companies denied this was true. In this feverish merger environment, LCCs have not remained passive. In Nov. 2006, AirTran made a hostile bid to acquire Midwest airlines. The Midwest Management team rejected the offer, however as recently as Jan. 2007, AirTran addressed a letter directly to the Midwest shareholders urging them to take matters into their own hands and push this merger forward.

A wave of consolidation might allow Legacy carriers to exit from their bankruptcy very much like how US Airways did with America West, but it is not clear if it is in the best interest of

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<sup>9</sup> Matthew Barakat, Associated Press, *Airline Permitted to Slash Pay by 21%*, The Honolulu Advertiser, Gannett Co. Inc., <http://the.honoluluadvertiser.com/article/2004/Oct/16/bz/bz07p.html>, 10/16/2004

<sup>10</sup> Marilyn Adams, USA Today, *Delta announces significant job, pay and benefit cuts*, [http://www.usatoday.com/money/biztravel/2005-09-22-delta-cuts\\_x.htm](http://www.usatoday.com/money/biztravel/2005-09-22-delta-cuts_x.htm), 9/22/2005

the passengers or the employees to reduce the number of competitors in the market. From a regulatory perspective, the prospects for consolidation although tempting, may be limited for this reason.

### **The road back to profitability**

In summary, the most recent shifts that have been discussed above could be driving the airline industry into a new era of its evolution. Passenger traffic has rebounded and exceeded pre 9/11 levels by over 14% in 2006. The profitability results for 2006 have been on the positive side for most carriers and according to the ATA the US industry as a whole posted an aggregate net profit of \$3 billion (excluding restructuring and bankruptcy costs). It thus seems that the initial results of the painstaking restructuring and cost-reductions are coming through and project a positive economic outlook for the first time since 2000. In addition to these changes, the industry has also benefited from an improving revenue environment and a recent downturn in crude prices which had oil futures trading at around \$50 per barrel in January 2007 (down from their \$75 price range during the summer of 2006). In fact, the ATA is projecting a \$4 billion aggregate net profit in 2007.

While these changes are welcomed, airlines still remain vulnerable to many external factors including terrorism, pandemics and fuel price volatility. In addition, the current economic environment with high Federal Reserve interest rates has some analysts speculating that a possible economic recession could be at hand beyond 2007. In this time of change, where airlines begin harvesting some of the initial results of their efforts, examining airline performance indicators relating to costs and productivity is an essential part to understanding the dynamics of the air travel industry and where it is headed.

## **1.2. Thesis Objective and Structure**

### **1.2.1. Objective**

This thesis examines how **costs** and **productivity** have evolved in the US Airline industry from 1995 to 2006 and analyzes the underlying forces driving their change. We are specifically interested in the differences between the traditional Network Legacy Carriers (NLCs) and the Low-Cost Carriers (LCCs) on these two fronts. This interest is motivated by the apparent record that LCCs have held in staying a step ahead of Legacy Carriers through the 2000-2006

period. Indeed, despite having to deal with some of the same types of issues (such as surging fuel prices and unstable passenger demand) LCCs have managed to achieve greater profitability and sustained growth in a time where most Legacy carriers were plunging towards bankruptcy. Acknowledging that cost structures and productivity played key roles behind this competitive advantage, we conduct an in depth analysis breaking down these two factors into their various sub-categories. Through this breakdown we also intend to show that the Legacy carriers' reaction and cost-slashing strategy from 2000 to 2006 has greatly increased their future performance potential and is leading towards a cost and productivity convergence between them and their low-cost counterparts.

Coming out of a period of great economic turmoil, and entering what could be an era of sustainable positive profitability for the US airline industry as a whole, we believe that it is an opportune time to conduct this cost and productivity-based analysis in an effort to better understand the dynamics of the airline industry and to gain some insight on where it could be heading next.

### **1.2.2. Structure**

The thesis is composed of seven Chapters which are separated as follows:

In Chapter One we give an overview of the profitability cycles the airline industry has been dealing with for the past decade and discuss the most recent news regarding consolidation within the industry. We then provide our intentions and the goal of the thesis followed by the structure used.

Chapter Two is separated in two parts. The first contains key concepts and definitions that will be used throughout the thesis. The second is a literature review which looks at some of the historical factors that have played a key role in shaping the airline industry since the Deregulation Act of 1978. We explain how these changes have increased the importance of understanding performance measures for airline managers and why it is especially relevant to our thesis. We also describe the qualitative measures that are used across the industry and give a summary of the more quantitative methods commonly adopted in academic literature. A review

of the current standard in productivity performance measures stemming from the field of economics will also be detailed.

Chapter three is intended to describe in detail the dataset that we have used and the measures we have extracted. In this Chapter we also explain our methodology and we detail the process of airline and aircraft group selections, aggregation, regressions and stage length adjustments.

Chapter four concentrates on the analysis of unit costs and is broken down into three main parts: We first examine aggregate measures of unit costs and compare findings between Legacy carriers and LCCs. We then take a look at individual airlines in both groups and give more details explaining the convergence of unit costs that is observed. We also conduct a regression of unit cost vs. stage length in an effort to better understand the relationship between these two variables. The final part contains a detailed analysis done at the fleet level which compares unit costs across different aircraft sizes (small vs. large).

Chapter five concentrates on aircraft productivity and aircraft utilization. We look at aircraft productivity measures and these are analyzed following a similar structure to the previous Chapter. We start from an aggregate level, and then get into more details by comparing results between individual airlines. This section also includes further regressions which provide us with more information on the underlying forces driving productivity improvements for both Legacy carriers and LCCs. The final part contains the fleet level analysis.

Chapter six contains the analysis of employee productivity and is structured in the same way as Chapter five. We look at aggregate productivity results followed by carrier-specific results and finish by a brief section on employee productivity at the fleet level.

Chapter seven presents a summary of the findings and discusses some of the limitations that we have with our analysis. It also suggests further directions for future research.

## Chapter 2

# Definitions and Literature Review

This Chapter is separated into two sections. The first contains definitions of common terms that are widely used in the industry and that we will be referring to regularly throughout the thesis. The second section is a literature review of costs and productivity analysis in the airline industry. This section covers both qualitative and quantitative methods of establishing and analyzing cost and productivity measures.

### 2.1. Definitions

There are several terms that we will be using throughout the thesis which we are going to define in this section.

#### *Available Seat Miles or Available Seat Kilometers (ASMs or ASKs)*

Available seat miles measure the airline's output capacity in terms of seats and flight distance. It is equal to the number of total seats available multiplied by the distance flown. This measure is a commonly used indicator of airline output and is also used as a normalizing variable to remove the effects of capacity differences across airlines. Further examples are given in the definitions below.

### *Revenue Passenger Miles or Revenue Ton Miles (RPMs or RTMs)*

Revenue Passenger Miles measure the airline's traffic in terms of number of total passengers times the number of total miles they were flown. It is commonly used to compare traffic across different airlines. Revenue Ton Miles is a similar measure to RPMs but uses a fixed conversion ratio to calculate the total weight of the passengers carried rather than the total number of passengers carried. The conversion ratio assumes an average weight for each passenger. This measure is needed when comparing revenues generated from paying passengers to revenues generated from cargo which are naturally expressed in RTMs.

### *Block Hours (BH)*

Block hours are defined as the time from when an aircraft's leaves from the departure gate to when it reaches the destination gate. In addition to flight time, it thus also includes time spent waiting in the take-off queue and taxiing to the runway.

### *Aircraft Days (ACdays)*

Aircraft days are defined as the number of aircraft multiplied by the number of days they were utilized, or active in the fleet. For an aircraft to be considered active it must be available for service on the reporting carrier's routes or on routes of others under interchange agreements. This includes days during which the aircraft are in overhaul, or temporarily out of service due to schedule cancellations and excludes aircraft that are not available for productive use. This measure is an indicator of fleet size and is commonly used in productivity measures.

### *Average Stage Length (SL)*

The average stage length is defined as the average distance flown by each aircraft, from takeoff to landing. It is calculated as Total Revenue Aircraft Miles flown divided by Total Departures Performed. Stage length will thus differ by airline and fleet type and will influence productivity measures.

### *Unit Costs (CASM or CASK)*

Airlines are required to report their operating expenses to the US DOT on a quarterly basis. These are reported under two different forms: The P-6 which breaks down costs by objective grouping and the P-7 which breaks down costs by functional grouping. Although these breakdowns can be interesting to look at individually, accounting differences between airlines can

render direct comparisons across the different cost subcategories impossible. It is thus more common in the literature to find that cost comparisons across airlines are done at the aggregate total expenses level. A universal measure used to compare **cost efficiency** across airlines is unit cost also referred to as cost per available seat mile (CASM). Unit cost is defined as total operating expenses over available seat miles (ASM).

$$CASM = \frac{\text{Total Operating Expenses}}{\text{Total ASM}}$$

This measures the average cost of flying one seat for one mile and is thus a way to compare the cost efficiency of different airlines by adjusting for capacity output. This adjustment is needed to eliminate the bias resulting from the fact that operating costs depend directly on the aircraft capacities and the distances they are flown. In theory, the lower the CASM, the more potential the airline has to generate profits. As a side note, this measure is usually compared to the revenues per available seat mile (RASM), and their difference gives the airline's profit per available seat mile.

### ***Productivity***

There are several types of productivity measures commonly used in the airline industry. These usually involved differentiating between two main types of productivity categories: aircraft productivity and employee productivity.

#### *Aircraft Productivity*

Aircraft productivity indicators measure to what extent airlines have been utilizing their aircraft efficiently and define variables that allow a direct comparison across airlines. There are two main variables used:

- **Aircraft utilization:** Aircraft utilization is measured as Block-Hours per Aircraft per Day. This indicates how many block-hours each aircraft is being used, or is active per day, on

average. A high aircraft utilization rate typically is an indicator of low turn-around times at the gate or long average stage lengths.

$$BH / ACday = \frac{TotalBlockHours}{TotalAircraftDays}$$

- Aircraft output efficiency: Another important variable used is the average output produced by each aircraft per day. This is given in terms of ASMs per Aircraft Day.

$$ASM / ACday = \frac{TotalASM}{TotalAircraftDays} = (\#departures) * (avg.stage.length) * (\#seats)$$

Using the above definitions, we can see that there are several ways to improve aircraft productivity<sup>11</sup>:

- By increasing the number of departures performed per day (i.e. increasing frequency or improving turnaround times and/or taxi times)
- By flying more seats per aircraft (i.e. reducing first class and/or business class seats to leave more room for economy seats)
- By increasing the average distance flown by each aircraft (i.e. increasing stage length)

### *Employee Productivity*

There are several ways to assess employee productivity commonly adopted through the literature. We have specifically chosen four different variables to help us in our analysis:

- Employment: This is simply the total number of employees reported annually in the Form 41 filings. We will specifically be looking at and comparing the change in number of employees over time across different airlines.

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<sup>11</sup> Peter Belobaba, Notes from 16.71 Airline Industry Class, Fall 2007, Massachusetts Institute of Technology



*Employment = Total Number of Employees*

- Labor expenses per ASM: This is measured as total dollar salaries and benefits (or total compensation) per ASM and represents the labor portion of the cost of producing one available seat-mile. This is a good way to compare employee productivity across different airlines.

$$\text{Labor Unit Cost} = \frac{\text{Total Salaries and Benefits Paid}}{\text{Total ASMs}}$$

- Employee capacity output: This is measured as ASMs per employee. It is essentially an indication on how many seat-miles an employee can produce on average.

$$\text{Employee Output} = \frac{\text{Total ASMs}}{\text{Employment}}$$

- Wages capacity output: This is measured as ASMs per dollar salaries and benefits that are paid out to employees. This indicates how many seat-miles are produced per dollar of total compensation paid out to the employees. It is the inverse of Labor Unit Costs.

$$\text{Wages Capacity Output} = \frac{\text{TotalASM}}{\text{Total Labor Expenses}}$$

## 2.2. Literature Review

Establishing comparative airline performance measures has been a concern for airline managers and policy makers ever since the beginning of the business. Yet its significance truly surged in the post-regulation era after 1978. With the resulting increase in competition and as airline companies were given more freedom to develop their business plans and optimize their operations, they also developed a need to establish measures that could guide them in their decisions and projections.

It is thus not surprising to find literature from various sources covering this topic. Some of the researchers include the airlines themselves, government agencies (Department of Transportation, Bureau of Transportation Statistics and Federal Aviation Authority), airline consulting companies and academics from the fields of civil aeronautics, transportation science and economics. The types of studies that are conducted clearly depend on the originating organization but perhaps even more so on the trends prevailing in the industry at the time. For example, during the decade that followed the Deregulation Act, most studies focused on the effects of this deregulation and the resulting change in competition. In the late 1980's, a lot of effort was put into understanding economies of scale and in the early 1990's the focus was shifted towards the importance of the Hub-and-Spoke model. In the late 1990's many studies looked at LCCs and their effects on revenues and average fares. After the turn of the century, the interest shifted to the impacts of 9/11, the down-cycle of the industry and the effects of high fuel prices.

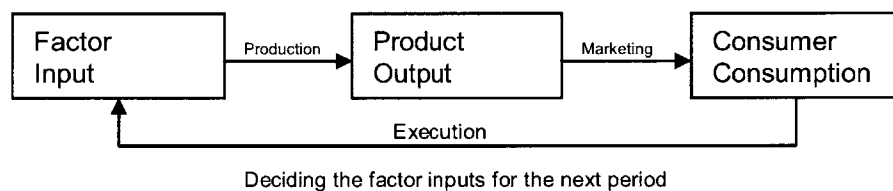
Looking more specifically at **productivity** and **costs**, although they have been a part of some of these studies, they tend to get the spotlight only during down-cycles and times of revenue/demand crisis when profits turn red. Yet given the cyclical and low profit-margin nature of the airline business, it is often argued in the literature that airlines should concentrate on long-term cost cutting strategies to ensure survival and sustainable growth. The most recent trend has been to focus on the differences between Legacy carriers and LCCs in an effort to understand what role costs and productivity have played in their operating results. This has been driven by the apparent sustainability of profits several LCCs have shown, but also by the increased importance that airlines themselves have placed onto controlling their costs and increasing productivity in this most recent economic downturn.

Given the inherent complexity of airline operations, there is no clear guide to establishing a comprehensive and integrated approach to performance evaluation. On the other hand, there exist a number of qualitative methods commonly accepted and used across the industry which give indications of cost and productivity performance in an isolated manner. Furthermore, several quantitative methods have been applied, stemming mostly from the field of econometrics, to create aggregate indices of costs and productivity. A comprehensive guide to these quantitative studies can be found in **Oum and Yu (1998)**<sup>12</sup>. Some of the popular methods described in this book include: the Partial Factor Productivity (PFP) model and Total Factor Productivity (TFP) model. A detailed description of these practices is provided in this section.

### 2.2.1. Airline Performance Indicators

#### *Definition of performance categories*

Performance studies measure how effective a company is at utilizing its costs (inputs) to produce its outputs and market them to consumers. **Feng and Wang (2000)**<sup>13</sup> provide a summary of the conventional breakdown of operations for an airline. The breakdown includes three categories: factor input, product output and consumer consumption, as shown in Figure 1.



**Figure 1 Breakdown of operations**  
Source: C.-M. Feng, R.-T. Wang<sup>13</sup>

The input factors include variables such as labor, fleet, capital, assets etc. The outputs for an airline include seat capacity and distance flown (or more conveniently ASMs). The inputs and outputs will be further detailed in the next section. Consumer consumption can refer to passengers flown and operating revenues.

<sup>12</sup> Tae Hoon Oum, Chunyan Yu, *WINNING AIRLINES, Productivity and Cost Competitiveness of the World's Major Airlines*, Kluwer Academic Publishers, Transportation Research, Economics and Policy (1998).

<sup>13</sup> Cheng-Min Feng, Rong-Tsu Wang, *Performance evaluation for airlines including the consideration of financial ratios*, *Journal of Air Transport Management* 6 (2000) 133-142

Figure 1 also classifies the three traditional types of performance categories:

- Production efficiency: This measure is more commonly referred to as productivity and is a measure of how effective an airline is at utilizing its inputs to produce its products (outputs). A conceptual definition of productivity is the ratio of output to the input used to produce it:

$$productivity = \frac{output}{input}$$

- Marketing efficiency: This measures how effective the company is in marketing its products (output) to consumers (consumption).
- Execution efficiency: This measures how effective the companies' management is at adjusting its production strategy to accommodate observed consumer consumption trends.

An idealistic approach of performance evaluation would have to consider and integrate all three of these categories, however the feasibility of such a study depends on the complexity of the company's operations. Typically for studies in the airline industry, these three categories are separated and examined at individually. Since our goal here is to concentrate on costs and productivity differences between Legacy carriers and LCCs, we will concentrate mostly on analyzing the literature related to production efficiency and costs.

#### *Airline Inputs and Outputs*

As measuring productivity compares outputs to the inputs utilized to produce them, both of these terms need to be defined relative to their use in the airline industry. In the literature what constitutes outputs and inputs is largely subjective and depends on the purpose of the study at hand.

This is especially the case in qualitative studies that can concentrate on a particular aspect of productivity. For example, a 2004 US Government Accountability Office report<sup>14</sup> on airline costs and profitability defines labor productivity as ASMs per employee. The output they use is therefore ASMs and the input is defined to be the number of employees used to produce those

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<sup>14</sup> United States Government Accountability Office (GAO), Commercial Aviation, *Legacy Airlines Must Further Reduce Costs to Restore Profitability*, GAO-04-836, August 2004.

ASMs. In contrast, **Jordan (1982)**<sup>15</sup> in his government report on Canadian airline performance defines labor productivity in several different ways. He uses RTMs per employee and operating revenues per employee and also breaks down employees by category (pilots, maintenance, servicing, management...) in order to compute their respective productivities. In this case outputs are defined as RTMs and operating revenues, and inputs are defined as number of employees in each of those categories. Although both studies claim to analyze labor productivity, their definitions diverge significantly and they are essentially looking at different types of labor productivities. When wanting to analyze productivities, it is thus essential to clearly define the inputs and outputs used, and to be aware of the advantages and shortcomings of these choices.

Looking at quantitative studies, the situation is somewhat similar. However, as studies typically involve creating aggregate indices of inputs and outputs, there have been attempts to standardize what should constitute each of them. In **Oum and Yu (1998)**<sup>12</sup> and also in many other quantitative studies it is common to find that inputs and outputs are broken down into five categories each.

*Outputs:*

- Scheduled passenger service: measured in revenue-passenger kilometers, RPKs
- Scheduled freight service: measured in revenue-ton kilometers RTKs
- Mail service: measured in RTKs
- Non-scheduled passenger and freight services: measured in RTKs
- Incidental services: which include non-airline businesses (such as catering, ground handling, reservations services for other airlines, technology sales, consulting, hotel agreements etc.). Oum and Yu estimate that this category can account for up to 30% of total operating revenues for some airlines with an average of 8% for the airlines included in their sample set.

*Inputs:*

- Labor input: measured by total number of employees
- Fuel input: measured by gallons of fuel consumed
- Flight equipment: measured by computing a fleet quantity index. This index is constructed by computing two separate variables: First, using the multilateral index

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<sup>15</sup> William A. Jordan, *Performance of Regulated Canadian Airlines in Domestic and Transborder Operations*, Consumer and Corporate Affairs Report, Canada, (1982)

procedure established by **Caves, Christensen and Diewert (CCD, 1982)**<sup>16</sup> an aircraft price index based on 14 types of aircraft is established (the CCD method is detailed in section 2.2.4). Then, annual cost for each aircraft type is estimated by using lease rates and the total annual aircraft cost is calculated by summing across all aircraft types. Finally, the fleet quantity index is obtained by deflating total annualized costs by the aircraft price index.

- Real stock of ground properties and equipment (GPE): estimated using the perpetual inventory method (PIM) proposed by **Christensen and Jorgenson (1969)** which accounts for interest, depreciation, corporate income, property taxes and capital gains/losses.
- Materials: Oum and Yu define this as a catch-all cost category containing expenses that do not fit in any of the other four categories. These are costs such as airport fees, passenger meals, consultants, non-labor repair and maintenance, stationery etc. This category is computed by subtracting labor, fuel, flight equipment rentals, and depreciation and amortization from total operating expenses.

This set of outputs and inputs is common in the literature, especially in the papers using the Total Factor Productivity (TFP) method. However it is also not difficult to find other quantitative studies on productivity that do not follow this breakdown. For example, **Ceha and Ohta (2000)**<sup>17</sup> define three inputs and one output in their study of their productivity change model. Their output is expressed in terms of ton-kilometers performed (RTKs). Their inputs include ASKs, cargo-ton kilometers (cargo RTKs) and aircraft hours. A description of why these specific variables are chosen is quite limited and the authors justify their choices by stating that “Sets of inputs and outputs...” have been chosen “...after some experimentation”. They continue by stating that the first two inputs are important because they provide “meaningful managerial information about the capacity of the airline”, and the third is meaningful for “estimation of the direct operating costs”.

To summarize, despite some efforts at standardizing inputs and outputs for the airline industry, there are many different studies that have different definitions of inputs and outputs. Herein lays one of the main difficulties of productivity analysis and perhaps one of the

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<sup>16</sup> Caves, D. W., L. R. Christensen, and W. E. Diewert, *Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers*, Economic Journal, 92, 73–86, 1982.

<sup>17</sup> Rakhmat Ceha, Hiroshi Ohta, *Productivity change model in the airline industry: A parametric approach*, European Journal of Operational Research 121 (2000) 641-655, November 1998

fundamental reasons why a single and integrated guide to airline productivity analysis does not exist. As the choice of inputs and outputs remains subjective, so does the interpretation of productivity measures.

#### *Distinction between output and capacity*

In the previous section, the notion of output plays a central role in productivity analysis. However, output is also in some cases referred to as capacity. **Holloway (2003)**<sup>18</sup> explains the distinction that should exist between the two. Whereas output is measured as currently produced ASMs, capacity represents the maximum output that can potentially be achieved given a fleet composition. In this sense, capacity is thus always equal to or greater than output. In most cases, an airline will seek to get output as close to capacity as possible. Despite this distinction, these two words are used interchangeably in this thesis but also throughout the airline industry and both refer to the first definition i.e. current output produced.

#### **2.2.2. Cost Analysis**

Costs represent an important variable in many management decisions and controlling costs has now become one of the main concerns of airline companies. Although there are many studies focusing on the relative breakdown of costs in the airline business, very few have actually concentrated on linking them to productivity. The reason this is important is that both of these measures play a role in assessing the efficiency of an airline's operations. Reviewing the literature on costs, we retained two different sources which combined, we believe provide a complete approach to understanding airline costs.

#### *Cost definitions and breakdowns*

The first step is to gain an understanding of the different cost components in the airline business. In his book on airline economics, Holloway (2003)<sup>18</sup> covers the topic of costs from a descriptive perspective. He gives an overview of the various types of breakdowns that have been established to assess costs in the airline business. The first breakdown is given in terms of fixed costs (leases, rentals, land, buildings, aircraft, ground equipment) versus variable costs (costs of providing ASMs). In his second section on costs, the author provides the current standard in cost classification in the airline industry. Total costs are separated into non-operating costs (interest

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<sup>18</sup> Stephen Holloway, *Straight and Level: Practical Airline Economics*, Ashgate, 2003.

expenses, affiliate losses...) and operating costs. Operating costs are broken down into indirect costs (ticketing, sales, passenger servicing, overhead...) and direct aircraft operating costs which include fixed items (maintenance, aircraft ownership...) and variable items (fuel, oil, other flight-hour driven costs...). The author also describes alternative approaches to cost classification including the separation of costs by function (or in other words by departments), by product, by route and other common ways of cutting up costs including a description on the cost breakdown found in the Form 41 filings that airlines have to report to the US government. In summary we believe this provides a complete overview of the current standard in cost categorization in the US airline industry.

#### *Focus on labor costs*

The second source that is relevant to our thesis is **Doganis (2006)**<sup>19</sup> who concentrates on the importance of labor costs. Doganis argues that labor costs along with fuel costs should be the two most important cost categories to analyze because combined they usually account for about 50% of an airline's total costs (respectively 30% for labor and 20% for fuel although these numbers can be reversed given the volatility of fuel prices). Furthermore, he provides two reasons justifying why emphasis should be placed on labor costs. The first is that given the recent crisis in the airline industry, labor costs have become increasingly controllable by airline managers and the second is that because the "unit price of labor varies significantly between airlines [...] labor cost is a major factor in differentiating costs between competing airlines".

The author also argues that the impact of labor costs on the overall cost structure of an airline is dependent on the interplay of two groups of factors. The first group relates to the cost of labor relative to the total costs, and the second group relates to the productivity of the labor used. In his own words, "labor costs depend on the unit cost of labor as an input and the amount of that labor that is required to produce a unit of output", thus effectively linking costs to productivity as we also believe they should be.

#### *The unit cost of labor*

The unit cost of labor is defined by Doganis as total labor costs divided by ASMs. Among the factors that influence this variable are prevailing wage rates and social charges. In particular, pilot wage rates are examined because they account for a disproportionate amount of labor expenses given their small relative size in terms of the airline's total workforce (expressed in number of employees). He finds that cockpit crews can account for 20-30% of total labor costs

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<sup>19</sup> Rigas Doganis, *The Airline Business, Second Edition*, Routledge, 2006.



whereas they usually represent much less than 10% of total staff members. In addition to wages and social charges, the author also identifies two further factors which affect the level of labor costs in an airline's overall cost structure. The first is the relative importance of the non-labor costs. If an airline's particular non-labor cost item is significantly low compared to its peers, this will push the relative importance of its labor costs up. The second factor is that of the airline's home currency volatility which is important when comparing cross-border airlines. We find this breakdown of costs into labor vs. non-labor to be particularly interesting and with some adjustments that will be explained in the following Chapter, we used a similar method to establish our cost comparisons between airlines.

### **2.2.3. Productivity Analysis**

#### *Labor productivity*

Labor costs depend on the level of wages and social charges mentioned previously, but also on the number of employees. According to Doganis, labor productivity is traditionally expressed in terms of ATKs per employee and by looking at this measure he finds that LCCs did not have significantly higher productivity than the better legacy carriers in 2002 for his sample set. In the literature there are also alternative approaches to looking at labor productivity. These included a study by Jordan (1982)<sup>15</sup> looking at revenue passenger-miles (RPMs), revenue ton-miles (RTMs) and operating revenues per employee.

#### *Factors that influence costs and productivity*

The above-mentioned authors also lead detailed discussions on the shortcomings of their methods explaining that labor productivity is a complex issue depending on the interplay of several groups of factors which can or cannot be influenced by management decisions. When comparing productivities across different airlines we typically would want to remove the effects of non-controllable inputs because of the bias they can lead to.

Doganis groups the factors that cannot be influenced by management in two categories.

- Institutional factors: Labor productivity depends on such factors as the number of working days in a week and number of hours worked per day, the length of the annual

holidays, maximum duty periods for flying staff, the hiring and firing laws relating to full time personnel etc. Doganis argues that these factors can severely impede management's ability to improve the productivity of their staff.

- Operational factors: Among these are included the average size of the aircraft flown and the average stage length. Regarding aircraft size, the author explains that there are significant economies of scale when operating larger aircraft because some of the labor inputs such as pilots and ground handling staff typically increase much less than the increase in outputs from moving to a larger aircraft.

Jordan (1982) also pointed some of the shortcomings associated to using the variables he picked out for assessing labor productivity (RPKs, RTKs and operating results per employee).

- The first is a similar argument to the one provided by Doganis involving operational factors. Jordan states that in some cases, the results come from fundamental differences in each airline's operational structure which can distort the comparison. For example, an airline with mostly large capacity aircraft will tend to produce more output per employee than an airline with smaller aircraft. Comparing two such airlines will thus give us an indication on which of the two strategies (large vs. small aircraft fleet) might be more efficient, however it will not allow us to understand which of the two carriers has been more efficient in producing output.
- The second shortcoming is as we argued earlier, that there is no clear and satisfactory definition of airline output measures. For example using RPMs does not include revenues generated from cargo and so does not give the complete picture in terms of total generated output. The alternative for RPMs is to use RTMs (revenue ton-miles) but this requires converting passenger-miles into ton-miles. This conversion is done by assuming an average weight for each passenger (10 passengers per ton) and baggage. This method excludes weight from passenger-related items such as seats and lavatories, and does not distinguish between different types of cargo operations. It is unnatural to assume that a ton of passengers carried and a ton of cargo carried should have the same weight of importance in the calculation of output.

We would also argue the following: An alternative way to measure output is to look at capacity output by replacing RPKs with ASKs or ASMs. By doing this, we are shifting our focus from the question of “how many passengers do I carry per employee?” to “how many seats are produced per employee?”. In our view this is a more fundamental indicator of airline output. Whereas RPKs depend on factors such as the airline’s marketing strategies and its effectiveness to fill the seats with passengers (which would be a measure of marketing productivity and not labor productivity), ASMs are clearly the more primary form of airline output measure when it comes to labor productivity because they do not depend on such factors.

In addition to the above explanations, Holloway (2003)<sup>18</sup> also includes two other factors that can influence productivity:

- The nature of the product offered: A full-service flight requires longer turnaround times than a limited no-frills service.
- Network structure: Depending on whether the airline is organized in a hub-and-spoke network or if it is flying point-to-point, its output will vary dramatically. As a rule of thumb, the point-to-point structure tends to achieve greater output levels than the hub-and-spoke model.

#### **2.2.4. Quantitative Approaches to Productivity Analysis**

The use of the generic input-output model described earlier leads to a method of comparing productivities called the factor productivity methods. These were initially developed in the field of economics to establish a way to evaluate productivities across different industries, and it has thus been the goal of many academics to extend it to the air travel industry. The most successful attempts have utilized the Partial Factor Productivity and Total Factor Productivity models described below.

##### *Partial Factor Productivity Models*

As mentioned previously, productivity is measured as the ratio of output to input, however airlines use a combination of inputs (assets, labor, aircraft...) to produce a combination of outputs (ASMs, RPMs...). Therefore, although the definition of productivity is conceptually simple, it can be difficult to measure because it requires establishing methods to aggregate its different components.

Partial measures of productivity are thus commonly used to compare differences in performance between airlines by isolating each input and computing its efficiency by linking it to its output (examples are given below). The advantage of these partial measures is that they are easier to compute and remain analytically tractable.

This is certainly the case when compared to some more advanced models that we will describe in the next section. However the PFP method developed by Oum and Yu still requires the computation of an aggregate output index. Essentially what this method involves is to isolate a particular input to focus on (such as labor costs for example), and take the ratio of the total aggregate output index to this input.

The output index is computed using the Translog Multilateral Index procedure proposed by Caves, Christensen and Diewert-CCD (1982)<sup>16</sup>. The resulting index is a weighted average which uses cost shares of the capital categories as weights for the aggregation. This method of aggregation is very common and the full mathematical formula is given below. Considering  $i$  observations and  $k$  categories of aggregation:

$$\ln \frac{P_i}{P_j} = \sum_i \frac{W_{ki} + \bar{W}_k}{2} \ln \frac{P_{ki}}{P_k} - \sum_j \frac{W_{kj} + \bar{W}_k}{2} \ln \frac{P_{kj}}{P_k}$$

where  $P_i$  is the price index for the  $i$ -th observation,  $P_{ki}$  is the price for category  $k$  of the  $i$ -th observation, the  $W_{ki}$  are weights, a bar over a variable indicates the arithmetic mean and a tilde indicates the geometric mean.

Oum and Yu<sup>12</sup> also argue that these partial results need to be interpreted with caution because of two main reasons: The first is that by definition a single input does not hold all of the information about the airline's total productivity and the second is that measures of these partial indicators are affected by variables that are beyond managerial control such as average stage length and composition of outputs. The effects of such uncontrollable factors must be removed in order to establish measures allowing for a meaningful comparison of productivities across different airlines. Two of these factors that were identified are similar to the ones mentioned by Jordan (2003) and Doganis (2006). These are:

- Average Stage Length: This variable is highly dependant on the airline's network structure (Hub-and-spoke vs. point-to-point) and on other factors such as geographical

location of its main airports, the structure of its routes (international vs. domestic flying) and even government regulations. Since unit costs decline with stage length, longer stage lengths tend to lead to higher productivities.

- Composition or airline outputs: This variable refers to the composition of the airline's revenue streams. In the US market, most airlines have concentrated on the passenger business which in relative terms is more significant than cargo and mail. Yet differences in the breakdown between passenger, cargo and other businesses (such as non-core activities) can influence airline productivities. For example, cargo servicing typically requires less labor than passenger servicing (but also generates less revenue). When comparing different airlines, if cargo is excluded, this could lead to a bias when computing revenues-generated per employee in favor of the airline with the higher cargo-service component.

In their study, Oum and Yu<sup>12</sup> define four PFP variables. These are:

- Labor efficiency: Which is defined by computing the aggregate output index described earlier and taking its ratio to the number of employees. Using this method, they find that for example Northwest has been consistently on top in terms of labor efficiency, followed by Continental and United (for the 1986-1993 sample period).
- Fuel efficiency: Which is defined by the ratio of the aggregate output index to the total number of gallons of fuel consumed. They find that United and Canadian had the highest fuel efficiency figures.
- Aircraft efficiency: Which is defined by the ratio of the aggregate output index to the aggregate fleet quantity index. They name Continental as the most aircraft efficient airline based on the above definition.
- Materials efficiency: Which is defined as the ratio of the aggregate output index to the materials quantity index. This measure shows that American had the highest materials efficiency among the sample set.

The authors then continue by arguing that each input efficiency measure tells a “different story” regarding an airline’s relative performance to its peers and that in order to get a “complete picture” the efficiency of using all inputs should be considered in an integrated manner. This can be done by using the TFP method.

#### *Total Factor Productivity Models*

Caves et al. (1981) focused on levels and growth rates of Total Factor Productivity (TFP) for a set of 11 US Carriers between 1972 and 1977. In the subsequent years, several papers were written investigating and putting to use TFP measures: These include Caves et al. (1987) which showed the effects of US deregulation on airline productivity and Bauer (1990) which linked TFP growth to changes in return of scale, cost efficiency and technology. In the 1990’s several new methods appeared including Good, et al. (1995) who used two different methods to compare eight European and eight US airlines during the 1976-1986 period: Using the stochastic frontier method and the data envelopment analysis (DEA) method which allow to take into account technical efficiency, they found that deregulation played an important role in the increase of productivity and efficiency in the US market.

A detailed example of TFP analysis can be found in **Oum and Yu (1995)**<sup>20</sup> who compare productivity and unit cost for 23 international airlines. As these methods have been well established and are utilized often we give a summary of their approach here. The authors’ goal was to identify factors which influenced unit cost and productivity differences across their data set. The analysis is broken down into the five traditional input/output categories described previously. An aggregate of all five categories for output and input is computed using the CCD method. The TFP index is then defined as the ratio of aggregate output to aggregate input, and is essentially a weighted average of the productivities of all the different inputs.

The TFP index is calculated for each airline allowing for a direct comparison across the industry. Some of the shortcomings of this method are that it does not include the effects of stage length, load factor and other variables that can influence productivity exogenously. Corrections can be attempted to the TFP index by running regressions to extract the effects of these variables.

Although these methods are well-established and widely utilized in the academic literature, it is our understanding that their use in the industry remains limited. The reasons

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<sup>20</sup> Tae Hoon Oum and Chunyan Yu, *A productivity comparison of the world’s major airlines*, Journal of Air Transport Management Vol 2, No 3/4, pp. 181-195 1995

commonly raised are the difficulty to gather quality data with enough detail to construct the TFP index. Furthermore, to overcome this lack of data, several restrictive assumptions need to be made which raises an issue of tractability and can render the results less applicable. An example of such assumptions can be found in Oum and Yu's description of their output/input categories. In both cases, one category is defined as a "catch-all" index which involves constructing an index of data that could not fit in any other category.

In the scope of this thesis, we will not be following the TFP construction method for the reasons mentioned above but also because we are more interested in breaking down productivity to its different subcomponents rather than just constructing an aggregate index. Furthermore, the view as to what constitutes relevant factor outputs and inputs can vary and is subjective and our view diverges among studies.

#### *Alternative Methods*

Alternative and more advanced methods in calculating aggregate factor productivity can be found in Sickles (1985)<sup>21</sup> which use a more theoretical econometric approach and Oum and Yu (1998)<sup>22</sup> which use the American Productivity Center (APC) model. Although these models can have advantages in certain cases, they are significantly more complex to understand and implement and their advantages are not necessarily relevant for our thesis. The most important advantage they provide is perhaps the ability to include the effects of technology and to be able to describe its role in shaping productivity. Since we will not be focusing on technological innovations in the airline industry in this thesis, these methods will not be studied further here.

#### *Eliminating uncontrollable factors*

The usually way that some of the uncontrollable factors described earlier are isolated and removed from the analysis is by conducting multifactor regressions to identify their importance. These types of regressions are utilized in Oum and Yu<sup>22</sup> to remove the effects of stage length and revenue stream composition and we will be using similar methods which will be described in Chapter 3 to adjust our own results.

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<sup>21</sup> Robin C. Sickles, *A nonlinear multivariate error components analysis of technology and Specific Factor Productivity growth with an application to the U.S. Airlines*, Journal of Econometrics 27 (1985) 61-78, North-Holland

<sup>22</sup> Tae Hoon Oum, Chunyan Yu, *An Analysis of profitability of the world's major airlines*, Journal of Air Transport Management 4 (1998) 229-237

Other ways commonly used to account for these factors include an approach by Jordan (1982) which involves plotting the desired variable (unit cost for example), versus the factor that is supposedly affecting it (such as stage length) for a particular year. Taking the trend line of the plot, this gives us a way to compare airlines based on whether they're below or above the trend line. This method is essentially equivalent to conducting regressions because obtaining the trend line involves going through the regression process. These methods will be further detailed in Chapter 3.

#### *Additional performance categories – financial performance*

This input-output models are all based on the assumptions that productivity only involves looking at the operations of an airline and evaluating how efficient these are. In this sense, only three productivity categories are defined as we explained at the beginning of this Chapter. However some recent papers by **Feng and Wang (2000)**<sup>13</sup> and **Hung and Liu (2005)**<sup>23</sup> argue that financial considerations and balance sheet information (such as debt-to-capital ratio) can also be included in the analysis. Feng and Wang state that financial performance can directly influence the survival of an airline and the absence of financial ratios will lead to biased assessment. A conceptual framework is redeveloped to include finance aspects in addition to the traditional three categories of production, marketing and management efficiencies. A case study is then developed based on Taiwan's five major airlines and the author shows that "performance evaluation for airlines can be more comprehensive, if financial ratios are considered". In particular, he concludes that traditional transportation indicators are more suitable to measure production efficiency than financial ratios and mixed indicators, and the execution efficiency is best measured by financial ratios.

We believe these results provide a good justification for our decision to focus exclusively on production efficiency (i.e. labor and non-labor productivity) not taking into account financial performance, since we are primarily interested in comparing performance around traditional transportation indicators.

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<sup>23</sup> Jung-Hua Hung, Yong-Chin Liu, *An examination of factors influencing airline beta values*, Journal of Air Transport Management 11 (2005) 291-296



# Chapter 3

## Dataset & Methodology

In this Chapter we describe the dataset used and the variables selected for our analysis. We also explain our methodology for constructing aggregate cost and productivity measures, and for grouping carriers into Legacy vs. LCCs. The methodology for analyzing costs and productivity on the detailed fleet-level is also explained.

### 3.1. Dataset and Time Period

#### *Data source*

The main source of data consists of Form 41 filings to the US Department of Transportation (U.S. DOT pursuant to CFR Part 241) and the Securities and Exchange Commission (SEC). We use Form 41 P and B schedules to extract the financial and operating data needed. Figure 2 illustrates some of the schedules that airlines have to file and that we have used to extract our data.

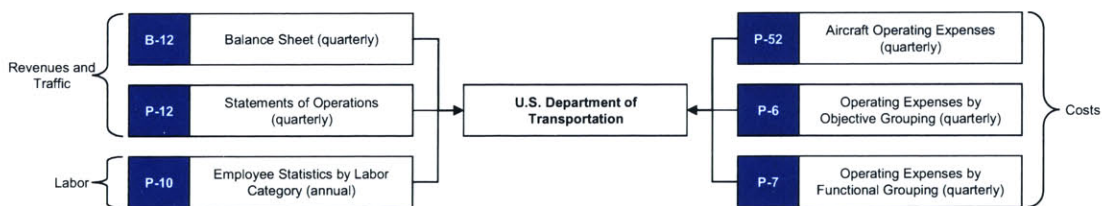


Figure 2 Form 41 P and B schedules

Access to the data was facilitated using the Form 41 CD marketed by Data Base Products<sup>24</sup> (DBP) which contains statements of all US major, national and large regional airlines. The carriers are divided into three groups according to total annual operating revenues: Group I includes airlines not exceeding \$100M; Group II includes airlines with operating revenues ranging between \$100M and \$1,000M and group III consists of airlines with operating revenues higher than \$1,000M. The CD does not include data for group I airlines with operating revenues under \$20M. Furthermore, the amount and quality of available data varies from group to group: Data from group II and group III carriers is more reliable and complete than from group I carriers. In our analysis we have only kept airlines from groups II and III.

### *Time period*

The data available from the Form 41 CD goes back to 1977 however we chose to limit our study to the 1995-2006 period. We find this interval to be particularly relevant as it represents three different periods of the airline industry cycle: The golden 90s from 1995 to 1999; the economic downturn from 2000 to 2005; and the start of what could be a new era and a return to profitability in 2006.

## **3.2. Airline Group Selection**

Throughout this thesis we will be comparing Legacy carriers and Low-Cost carriers, and thus clear definitions must be established for both groups. Although this may seem straightforward, it is a vital step in our analysis and needs to be examined in more detail. Given the ever-changing nature of the airline business it is not always apparent where airlines stand in terms of groupings.

### *Legacy Carriers*

Legacy carriers are commonly defined as long-established and traditional airlines with widespread hub-based networks and international service that allows them to generate a revenue premium. In the literature, these airlines have also been referred to as major carriers (or the majors), network carriers, network legacy carriers (NLCs) or traditional carriers.

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<sup>24</sup> Form 41 Airline Financial Statistics CD 1/1/2007, Data Base Products, Inc.

### *Low-Cost Carriers (LCC)*

In contrast, LCCs are usually considered to be airlines that have smaller point-to-point networks, simpler service, a lower cost-structure and lower fares. Other common terminologies used to refer to LCCs include low-fare carriers or new-age carriers.

It is not difficult to find airlines not satisfying each one of those conditions. For example, Southwest has always been considered a Low-cost carrier and for good reason: They pioneered the “low-cost concept”; but looking at Southwest’s flight network, the picture is much more ambiguous. Their original point-to-point structure has evolved into a complex hybrid point-to-point/multi-hub based system generating traffic and dominating market share in many top US markets. Their domestic network resembles that of a Legacy carrier’s.

There are also airlines that belong to a grey zone somewhere between these two definitions. Alaska Airlines is a good example of this problem as it doesn’t fit well into any of the two categories. Its cost structure is somewhat lower than most Legacy carriers, yet higher than most LCCs and its network structure is somewhere in between both types of carriers. For this reason, we decided to not include Alaska in our analysis of these two distinct categories.

Furthermore, there are certain airlines who simply “declare” themselves to be of one type rather than another. US Airways is a good example of this self-imposed view as it is doing everything in its power to enforce a low-cost culture to both its employees and its clients. In this sense, the airline decided to change its stock ticker from “UAIRQ” to “LCC” reflecting the company’s new business direction after the merger with America West.

As a general rule when setting our own selection for the purpose of this thesis, we tried to classify airlines based on the two definitions above, but we also tried to integrate many different aspects including the company’s history, culture and subjective view when the situation called for it. We selected our sample size to six Legacy carriers and six Low-cost carriers after screening the top 30 Airlines in the US in terms of domestic market share.

The breakdown we kept is given as follows:

<b>Legacy Carriers</b>	<b>LCCs</b>
America West and US Airways (HP + US)	JetBlue (B6)
American Airlines (AA)	Frontier (F9)
Continental (CO)	Airtran (FL)
Delta (DL)	American Trans Air (TZ)
Northwest (NW)	Southwest (WZ)
United Airlines (UA)	Spirit Airlines (NK)

**Table 1 Breakdown of carriers into Legacy and LCC groups**

These 12 carriers account for the majority of the US traffic market-share (as measured by RPMs). For the first seven months of 2006, the above-mentioned Legacy carriers accounted for roughly 70% market share and the LCCs accounted for another 18%<sup>25</sup>. We thus believe that these airlines constitute a large enough sub-sample to accurately represent trends throughout the industry as a whole.

*The US Airways – America West case*

The US-HP merger which went through in 2005 will result in a single airline that will keep the name of US Airways. So far, both airlines have merged service, however their Form 41 data is still filed separately. This case is particularly interesting because it involves the merger between a traditional Legacy carrier (US), and a lower cost carrier (HP) and it can lead to some confusion regarding whether the resulting company should belong to the first or the second group. Looking ahead and for the purpose of our aggregate comparisons, we decided to combine both airlines as one and included them in the Legacy carriers group under the single name US Airways (US).

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<sup>25</sup> Aviation Daily, *US Industry Traffic Market Share*, Eclat Consulting, McGraw-Hill, Friday, August 18, 2006.

### 3.3. Data Extracted

For each of the above-mentioned airlines we extracted from the Form 41 CD a total of 37 variables. Table 2 gives the complete list of these variables along with the schedule from which they originated.

#	Source/Variable	#	Name	#	Name
	<b>P010 - Employment statistics</b>		<b>P052 - Aircraft Op. Expenses</b>		<b>Operating Exp. by Objective Grouping</b>
(1)	Empl Pilots & Copilots	(17)	FO- Pilots and Copilots	(34)	S&W- Total Salaries
(2)	Empl Total Weighted Avg CY Empl	(18)	FO- AC Fuel	(35)	S&B- Total Salaries & Benefits
	<b>P012 - Statement of Operations</b>	(19)	FO- ACOil	(36)	Svcs- Outside Flight Eqpt. Maint.
(3)	Rev- Passenger		<b>P05B - Traffic, Capacity and AC op.</b>	(37)	Svcs- Traffic Commissions - Passenger
(4)	Rev- Total Operating Revenue	(20)	Revenue Aircraft Dpt. Perf.- Non Sch		
(5)	Exp- Flying Operations	(21)	Enplaned Passengers - Sch+NSch Serv.		
(6)	Exp- Maintenance	(22)	RPMs - Sch. + NonSch. Serv. (000's)		
(7)	Exp- Passenger Service	(23)	Rev. Ton Miles- Sch+NSch Serv.(000's)		
(8)	Exp- Aircraft & Traffic Servicing	(24)	Avl. Ton Miles- Sch+NSch Serv.(000's)		
(9)	Exp- Promotion & Sales	(25)	ASMs - Sch. + NonSch. Serv. (000's)		
(10)	Exp- General & Administrative	(26)	Rev. Arcft. Miles- Sch+NSch Serv.		
(11)	Exp- General & Administrative	(27)	Departures Performed - Sch+NSch Serv.		
(12)	Exp- Depreciation & Amortization	(28)	Block Hours		
(13)	Exp- Transport Related	(29)	Total Airborne Hours		
(14)	Exp- Total Operating Expenses	(30)	Aircraft Days - Carrier Equipment		
(15)	Operating Profit or Loss	(31)	Aircraft Days - Carrier Routes		
(16)	Net Income	(32)	Gallons of Fuel		
		(33)	Gallons of Oil		

**Table 2 List of variables extracted from Form 41 CD**

An example of the data extracted at the carrier-level from Form 41 is given below for American Airlines.

Carrier <American Airlines> <AA\*>  
 Equipment <All Equipment Types>

	1995 1	1995 2	1995 3	1995 4	1996 1	1996 2	1996 3	1996 4
Empl Pilots & Copilots	23	8,391	8,391	8,391	8,391	8,369	8,369	8,369
Empl Total Weighted Avg CY Empl	99	83,483	83,483	83,463	83,483	78,902	78,902	78,902
Rev- Passenger	-3,139,256,000	-3,394,151,000	-3,511,052,000	-3,281,449,000	-3,283,597,000	-3,507,715,000	-3,530,536,000	-3,309,996,000
Rev- Total Operating Revenue	-3,680,910,000	-3,976,141,000	-4,095,758,000	-3,857,392,000	-3,639,338,000	-3,884,660,000	-3,900,147,000	-3,711,858,000
Exp- Flying Operations	877,805,000	898,984,000	919,272,000	938,336,000	939,145,000	964,695,000	981,066,000	1,043,852,000
Exp- Maintenance	341,507,000	343,561,000	356,190,000	339,322,000	340,439,000	343,932,000	356,073,000	348,182,000
Exp- Passenger Service G23	416,117,000	425,711,000	444,824,000	449,969,000	414,333,000	441,169,000	440,661,000	432,910,000
Exp- Aircraft & Traffic Servicing G23	674,218,000	701,581,000	727,509,000	758,636,000	672,550,000	646,025,000	640,615,000	652,495,000
Exp- Promotion & Sales G23	635,822,000	682,382,000	679,232,000	661,973,000	613,731,000	603,185,000	565,533,000	581,877,000
Exp- General & Administrative G23	176,890,000	181,955,000	187,816,000	624,968,000	173,318,000	194,086,000	226,336,000	125,187,000
Exp- General & Administrative G1	0	0	0	0	0	0	0	0
Exp- Depreciation & Amortization	287,314,000	287,084,000	284,108,000	280,779,000	230,399,000	224,569,000	236,285,000	256,217,000
Exp- Transport Related	19,803,000	19,067,000	18,116,000	21,730,000	15,380,000	19,572,000	9,837,000	71,504,000
Exp- Total Operating Expenses	3,429,476,000	3,520,325,000	3,616,867,000	4,075,713,000	3,399,295,000	3,437,233,000	3,456,406,000	3,512,224,000
Operating Profit or Loss	-251,434,000	-455,816,000	-478,891,000	218,321,000	-240,043,000	-447,427,000	-443,741,000	-199,634,000
Net Income	-56,506,000	-191,184,000	-212,208,000	252,132,000	-78,221,000	-215,132,000	-207,405,000	-73,061,000
FO- Pilots and Copilots G23	237,716,000	238,362,000	242,014,000	250,933,000	246,326,000	242,926,000	251,138,000	272,160,000
FO- AC Fuel G23	348,004,000	368,994,000	382,958,000	378,394,000	391,894,000	421,403,000	440,141,000	477,205,000
FO- AC Oil G23	708,000	1,068,000	1,252,000	921,000	807,000	797,000	807,000	1,307,000
DE- Pilot and Copilot S&W + Ben. G1	0	0	0	0	0	0	0	0
DE- Aircraft Fuel and Oil G1	0	0	0	0	0	0	0	0
Revenue Aircraft Dpt. Perf. - Non Sch	241	178	170	223	268	205	217	339
Enplaned Passengers - Sch+NSch Serv.	19,371,719	20,255,651	20,727,295	19,212,517	18,811,203	20,210,948	20,817,569	19,547,908
RPM's - Sch. + NonSch. Serv. (000's)	23,793,103	25,971,787	27,770,713	25,218,542	24,586,246	26,630,976	27,808,526	25,592,673
Rev. Ton Miles- Sch+NSch Serv.(000's)	2,874,181	3,134,868	3,282,150	3,055,077	2,961,538	3,186,609	3,271,619	3,087,885
Av. Ton Miles- Sch+NSch Serv.(000's)	5,723,817	5,970,352	6,213,378	5,973,154	5,789,454	5,928,297	6,043,828	5,820,201
ASM's - Sch. + NonSch. Serv. (000's)	37,359,108	38,702,515	40,333,746	38,781,347	37,508,248	38,392,650	39,135,801	37,759,381
Rev. Aircr. Miles- Sch+NSch Serv.	222,617,948	228,591,879	239,209,207	230,287,910	223,494,650	230,479,804	234,594,274	227,552,320
Departures Performed - Sch+NSch Serv.	208,987	205,269	208,274	200,961	193,432	198,427	200,751	195,836
Block Hours	577,036	582,623	599,314	584,969	572,510	586,748	598,519	584,637
Total Airborne Hours	493,898	500,470	515,674	503,767	492,575	503,967	510,005	500,018
Aircraft Days - Carrier Equipment	58,478	58,941	59,852	59,775	58,866	58,894	59,666	59,382
Aircraft Days - Carrier Routes	58,478	58,941	59,852	59,775	58,866	58,894	59,666	59,382
Gallons of Fuel	665,918,163	687,307,018	711,446,570	684,798,026	663,451,972	686,923,501	706,285,198	677,369,055
Gallons of Oil	0	0	0	0	0	0	0	0
S&W- Total Salaries	978,590,000	1,029,127,000	1,020,123,000	1,029,233,000	956,843,000	976,281,000	953,953,000	979,704,000
S&B- Total Salaries & Benefits	1,318,722,000	1,372,219,000	1,366,377,000	1,685,132,000	1,285,494,000	1,302,665,000	1,266,088,000	1,302,074,000
Svcs- Outside Flight Eqpt. Maint.	51,868,000	45,560,000	49,832,000	56,369,000	55,288,000	55,669,000	56,003,000	59,536,000
Svcs- Traffic Commissions - Passenger	303,841,000	302,972,000	320,567,000	294,604,000	293,159,000	299,874,000	300,895,000	274,972,000

Table 3 Example of data extracted from Form 41 CD

These quarterly measures are extracted for each carrier and across our time period (from 1995-2006).

### 3.4. Measures Computed

Using the variables extracted above and following the definitions given in Chapter two, we established the cost and productivity measures listed in the table below.

Variable	Operation	Variable	Operation
<b>CASM</b>		<b>Employee Productivity</b>	
(A) CASM ex. Transport	$[(14)-(13)]/(25)$	(G) Employment	(2)
(B) CASM ex. Transport & Fuel	$[(14)-(13)-(18)]/(25)$	(H) \$ Salary & Benefits / Employee	(35)/(2)
(C) CASM Labor	(35)/(25)	(I) ASM / Employee	(25)/(35)
(D) CASM NonLabor	$[(14)-(13)-(18)-(35)]/(25)$	(J) ASM / \$ Salary & Benefits	(25)/(2)
<b>AC Productivity</b>		(K) Passengers / Employee	(21)/(2)
(E) Block Hours / AC Day	(28)/(31)	(L) Passengers / Employee Dollar	(21)/(35)
(F) ASM / AC Day	(25)/(31)		

Table 4 List of cost and productivity measures used in the analysis

### *Unit Cost (CASM) adjustments*

In order to compare cost efficiency across our sample of airlines, we have concentrated on measures of unit cost. Traditionally, this has also been the popular definition used when comparing cost-efficiency across airlines. However given the fact that we are specifically interested in comparing Legacy carriers to LCCs on an aggregate level, it was necessary to slightly modify this definition to take into account certain fundamental differences between both groups. The idea behind this unit cost adjustment is to eliminate factors that we know can lead to biased results. In the case of unit costs we isolated two factors that we think distort our cost measures:

- Transport related expenses (measure #13 in list of variables): Transport related expenses appear on the P12 operations statement of certain carriers. These expenses are defined as follows: “Expenses related to the generation of Transport Related Revenues – which come from the US Government as direct grants or aids for providing air transportation facilities and all services which grow from and are incidental to the air transportation services performed by the carrier”<sup>26</sup>. In other words, these expenses represent agreements between the airlines and the US government to provide service to remote or regional locations in exchange for government subsidies. However, usually the expenses in this category do not directly reflect operational costs incurred from serving such markets. In fact Legacy carriers who have signed the agreements tend to outsource the activity to regional carriers. In this case the expenses are thus payments made to these regional carriers therefore they should not be used as an indication of the airline’s own operational efficiency and cost performance.

Furthermore, several accounting policies have been implemented over the last decade which have led to large jumps in transport related expenses for certain years. For example, Continental’s transport related expenses surged from \$0.26 billion in 2003 to \$2 billion in 2004 representing a 660% increase. These jumps can greatly distort CASM measures.

Finally these transport agreements typically only concern Legacy carriers as LCCs have usually not been active in this area. This can lead to a positive bias favoring LCCs’ cost-efficiency measurements. Indeed, although the Legacy carriers incur these transport related costs, the ASMs outputted from these activities are not reported as part

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<sup>26</sup> Data Base Products Inc., Form 41 CD instructions manual - 2006

of the airline's operations because of outsourcing. This leads to higher CASMs for the Legacies.

- Fuel expenses (measure #18): Fuel expenses are usually included in unit cost comparisons. Under this fact is the assumption that airlines are subject to the same type of fuel price environment. Although historically this has been the case, the emergence of financial hedging instruments has provided new ways for airlines to take control of their fuel expenses. The most striking example is that of Southwest which had locked in the price of its fuel purchases eliminating a great deal of its exposure to the market. With this increased interest in fuel hedging, airlines are no longer on a level playing field when it comes to fuel costs. We believe that these management-dependent decisions should not be included in our cost comparison and thus removed fuel expenses from our analysis. Indeed, guessing the movement of oil prices is not part of an airline's core operations and is not an indicator of its operational advantage.

After removing transport related and fuel expenses from our total costs, we can break down the remaining costs in two categories: Labor costs and non-labor costs.

- Labor costs: Labor costs include total salaries and benefits paid out to employees. Analyzing this category gives an indication of how productive an airline's workforce is. This is an interesting category because some of the most important changes that have occurred in the past decade have involved labor. Indeed, as airlines go through bankruptcy and implement cost-cutting measures, the labor component is usually the one that is the more directly impacted.

Non-labor costs: This is a catch-all cost category which includes everything that is not part of transport related, fuel or labor costs.

A summary of our approach for adjusting CASM is presented in Figure 3.



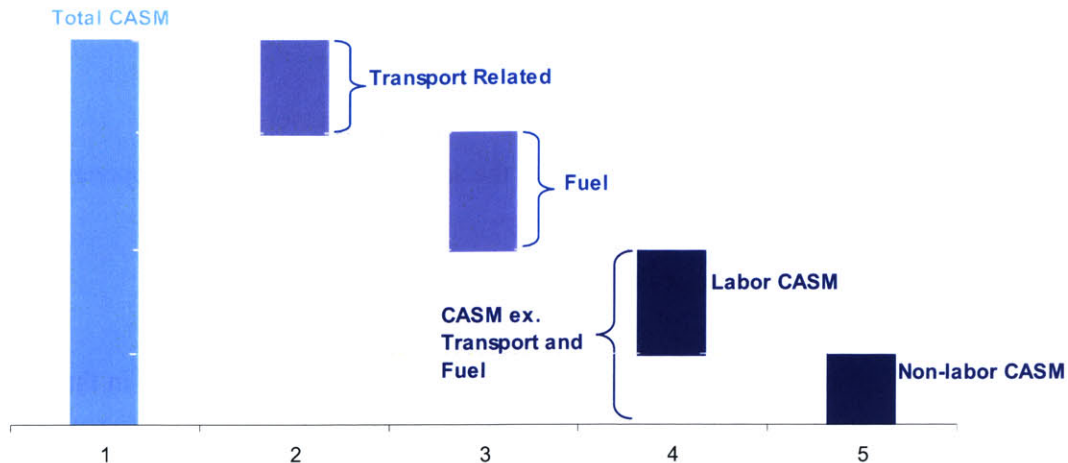


Figure 3 Adjusting Unit Costs (CASM)

### 3.5. Airline Aircraft Group Selection

In addition to grouping airlines into Legacy carriers and LCCs, we are also interested in identifying the effects of aircraft size on the variables we listed above. The fleet composition of an airline is an important driver of cost and productivity and is also related to the type of network structure that the airline has (hub-and-spoke vs. point to point, international vs. domestic service i.e. long-haul vs. short haul). The network structure in turn plays a role on the level of output an airline can achieve. For example the following trends are typically observed in the industry:

- The point-to-point structure tends to achieve greater output levels (in terms of ASMs) than the hub-and-spoke model.
- Long-haul carriers produce more output than short-haul carriers (driven by the fact that these carriers have larger aircraft and longer stage lengths). The same trend is observed in international vs. domestic service carriers.

The increase in output associated with larger aircraft affects cost and productivity measures because these measures depend directly on output achieved. For example, if we break

down CASM into total costs divided by output (ASMs), we see that, all else being, equal switching to larger aircraft implies that:

- Total operating costs increase because, the larger aircraft has higher operating (labor, fuel) and maintenance costs
- ASMs also increase because the aircraft is flying more available seats

The reason this can lead to economies of scale is because as mentioned in the literature review, labor inputs such as pilots and ground handling staff typically increase proportionally less than the increase in outputs (ASMs). This is the case for most productivity measures using ASMs as an indicator of output.

In order to account for these aircraft-size effects, we needed to extract detailed data on a fleet level. For each airline of our sample set, we thus extracted the variables that are reported at the aircraft level. These include the following:

- Traffic measures: Block hours, aircraft days, system ASMs, system RPMs, gallons of fuel, departures performed and aircraft miles.
- Labor measures and costs: Pilot labor expenses, fuel expenses, total operating expenses, non-labor expenses (excluding fuel), total operating expenses (excluding fuel).

The number of variables available at this level of detail is more limited than those extracted in our previous approach. To keep entirely consistent with our analysis at the non-fleet-detail level we would also need to obtain measures of employees and transport related expenses broken down by aircraft type. These, however, are not available because they are not filed at the aircraft level. We are thus unable to compute all of the measures of employee productivity defined previously or to remove the effects of transport related expenses. However we do have access to detailed labor expenses for pilots and maintenance which allows us to compute measures of employee productivity (we will refer to this measure as “labor productivity” at the fleet level).

#### *Method for establishing fleet groups*

The next step in our approach is to find a meaningful breakdown with respect to aircraft size. One approach to dividing aircraft into groups would be to do so according to number of

seats available. Following this idea, we could create a number of intervals containing a subjective amount of seats. For example:

- Aircraft with less than 80 seats could be considered “small-sized”
- Those having between 80 and 200 seats could be considered “medium-sized”
- Those with 200 seats or more could be considered “large-sized”

Although this approach is conceptually sound, it runs into certain difficulties that limit its applicability. The most important is that for each aircraft type, there are a number of different models available, each having a different number of seats. A Southwest Boeing 737 for example will not necessarily have the exact same number of seats as an American Airlines 737. It can be the case that one falls into one category and the other into a different one depending on how the categories are defined. Furthermore, another difficulty associated with this method is that it would require obtaining the exact number of seats for each aircraft sub-type and this information is not mandatory for the airlines to provide and it is not filed in form 41.

An alternative approach is to use a more traditional breakdown in terms of **wide-body** vs. **narrow-body** aircraft. By definition, “A wide-body aircraft is a large airliner with a fuselage diameter of 5 to 6 meters” and in common terms it refers to “an aircraft with twin aisles inside the cabin”<sup>27</sup>. Whereas, “a narrow-body aircraft is an airliner with a fuselage diameter typically of 3 to 4 meters, and airline seat arranged 2 to 6 abreast along a single aisle”<sup>28</sup>. Furthermore in terms of seat capacity: “typical wide-body aircraft can accommodate between 200 and 600 passengers, while the largest narrow-body aircraft currently in widespread service (the Boeing 757-300) carries a maximum of about 250”<sup>28</sup>.

This is more or less equivalent to dividing the fleet in terms of “small aircraft” doing mostly short-haul domestic flying and “large aircraft” doing mostly transcontinental and international flying. This approach is much more practical than the previous one because we can more easily identify which aircraft are wide- and which are narrow-body. This is the breakdown we kept for all of the aircraft reported by our list of 12 airlines which are given below.

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<sup>27</sup> Wikipedia.com, key-word: “wide-body aircraft”, [http://en.wikipedia.org/wiki/Wide-body\\_aircraft](http://en.wikipedia.org/wiki/Wide-body_aircraft)

<sup>28</sup> Wikipedia.com, key-word: “narrow-body aircraft”, [http://en.wikipedia.org/wiki/narrow-body\\_Aircraft](http://en.wikipedia.org/wiki/narrow-body_Aircraft)

**Wide-bodies:**

Airbus A300's: 600, B4/C/F-100/200  
 Airbus A310's: 200, 300  
 Airbus A330  
 Boeing 747's: 100, 200, 300, 400, -F  
 Boeing 767's: 200, 300, 400  
 Boeing 777  
 McDonald Douglas DC-10's: 10, 30  
 McDonald Douglas MD-11  
 Lockheed L-1011's: 1, 100, 200  
 Lockheed Tristar

**Narrow-bodies:**

Airbus A318  
 Airbus A319  
 Airbus A320's: 100, 200  
 Airbus A321  
 Boeing 717-200  
 Boeing 727's: 200, 231  
 Boeing 737's: 100, 200, 300, 400, 500, 700, 800, 900  
 Boeing 757's: 200, 300  
 McDonald Douglas MD's: MD-80 & DC-9-80, MD-87  
 McDonald Douglas D-90-30, D-90-50  
 McDonald Douglas DC-9's: 10, 30, 40, 50

**Table 5 List of Wide-body and Narrow-body aircraft from our sample set**

An example of the data extracted at the fleet-level from Form 41 is given below for the block hours measure for American Airlines:

Carrier <American Airlines> <AA^>  
 Variable: Block Hours

Carrier Type	AC Type	Aircraft	Yr 2000	Yr 2001	Yr 2002	Yr 2003	Yr 2004	Yr 2005
L	-	<Fokker 100> <603>	234,292	218,422	227,319	174,474	44,965	0
L	N	<Boeing B-717-200> <608>	0	0	12,269	0	0	0
L	N	<Boeing B-737-800/900> <614>	130,594	220,822	262,377	252,704	287,344	275,224
L	N	<Boeing B-757-200> <622>	388,813	388,285	550,674	526,988	514,240	528,308
L	W	<Boeing B-767-200/ER> <625>	126,112	111,106	103,689	72,267	59,760	62,086
L	W	<Boeing B-767-300/ER> <626>	231,714	214,806	230,866	229,730	259,281	256,695
L	W	<Boeing 777> <627>	91,070	144,718	174,650	181,641	194,124	201,255
L	N	<McDonald Douglas MD-87> <6>	12,716	6,301	0	0	0	0
L	N	<MD-80 & DC-9-80 All> <655>	1,004,310	920,895	1,188,002	1,111,858	1,165,615	1,135,236
L	N	<Mc. Douglas D-90-30/50> <6>	11,826	2,206	0	0	0	0
L	W	<Arb A-300-600/R/CF/RCF> <6>	114,184	109,920	82,890	86,101	97,590	102,633
L	N	<Boeing B-727-200/231A> <71>	202,007	155,498	15,936	0	0	0
L	W	<Mc. Douglas DC-10-10> <730>	6,074	0	0	0	0	0
L	W	<Mc. Douglas DC-10-30> <732>	14,780	0	0	0	0	0
L	W	<McDonald Douglas MD-11> <7>	31,685	12,925	0	0	0	0
<b>&lt;All Eqp Types&gt;</b>			<b>2,600,177</b>	<b>2,505,904</b>	<b>2,848,672</b>	<b>2,635,763</b>	<b>2,622,919</b>	<b>2,561,437</b>

L="Legacy"  
 N="Narrow Body"  
 W="Wide Body"

**Table 6 Example of data extracted at the fleet level from Form 41 CD****3.6. Aggregation Methods**

In order to use data at the carrier or fleet level to obtain information representing industry trends we need a methodology for aggregation. The approach we have kept is to sum the data using weighted averages. A detailed explanation of how this is done is given below.

*Legacy vs. LCC comparison*

Grouping the data in terms of legacy carriers and LCCs is relatively straightforward. The first step is to convert the quarterly numbers extracted from form 41 to annual numbers. This is done by summing the four quarters for each year. The next step is to tag each airline according to the group it belongs to (Legacy or LCC) and sum the totals for each group obtaining aggregate numbers. The last step is to compute our cost and productivity measures using these aggregate results. This method is equivalent to creating weighted averages. An example is given below for the computation of the “block hours per aircraft day” productivity measure. The average block hours per aircraft day of the legacy carriers is given for year “j” as follows:

$$BHpACday_{Legacies}^{year,j} = \frac{\sum_{i=1}^6 BH_i^j}{\sum_{i=1}^6 ACdays_i^j}$$

Where  $i=1, \dots, 6$  is the list of Legacy carriers from our sample set (AA, CO, DL, US, UA, NW) and “j” represents year “j” of our time period ( $j=1995, \dots, 2006$ ). This formula is equivalent to a weighted average on ACdays of each individual airline for each year “j” as follows:

$$\begin{aligned} BHpACday_{Legacies} &= \frac{\sum_{i=1}^6 BH_i}{\sum_{i=1}^6 ACdays_i} = \frac{\sum_{i=1}^6 \frac{BH_i}{ACdays_i} ACdays_i}{\sum_{i=1}^6 ACdays_i} \\ &= \sum_{i=1}^6 (BHpACday_i) \frac{ACdays_i}{\sum_{i=1}^6 ACdays_i} \\ &= \sum_{i=1}^6 (BHpACday_i) \cdot w_i \end{aligned}$$

Where  $w_i = \frac{ACdays_i}{\sum_{i=1}^6 ACdays_i}$  is the weight of the output variable for airline “i” (in this case

aircraft days).

The same computations are repeated for the LCC group of carriers in order to obtain the “LCC” average. The same method is also used to compute the rest of the productivity measures listed in Table 4.

*Wide-body vs. Narrow body comparison*

A similar method is applied here to aggregate numbers from the fleet level into wide-body and narrow-body categories with the difference that we need to sum across two categories (for example wide-body and legacy carriers). An example is given below for obtaining the block hours per aircraft day measure for wide-body aircraft in the legacy carriers group.

$$BHpACDay_{Legacy}^{Wide-body} = \frac{\sum_{i=1}^6 \sum_{j=1}^{N_i} BH_{i,j}}{\sum_{i=1}^6 \sum_{j=1}^{N_i} ACDayS_{i,j}}$$

Where  $i=1, \dots, 6$  is the list of Legacy carriers from our sample set (AA, CO, DL, US, UA, NW) and  $j=1, \dots, N_i$  is the list of all wide-body aircraft tagged for each carrier  $i$ .

Similarly, we obtain the “block hours per aircraft day” measure for narrow-bodies by summing across the list of narrow-body aircraft and we can show as previously that this is equivalent to computing weighted averages of each carrier’s individual BHpACDay measure. We compute the measures for both Legacy carriers and LCCs, however we did not compute wide-body LCC measures because these carriers typically do not have wide-body aircraft.

A conceptual summary of all the aggregation computations we conducted is given below in section 3.7.

### 3.7. Summary of Aggregation Methodology

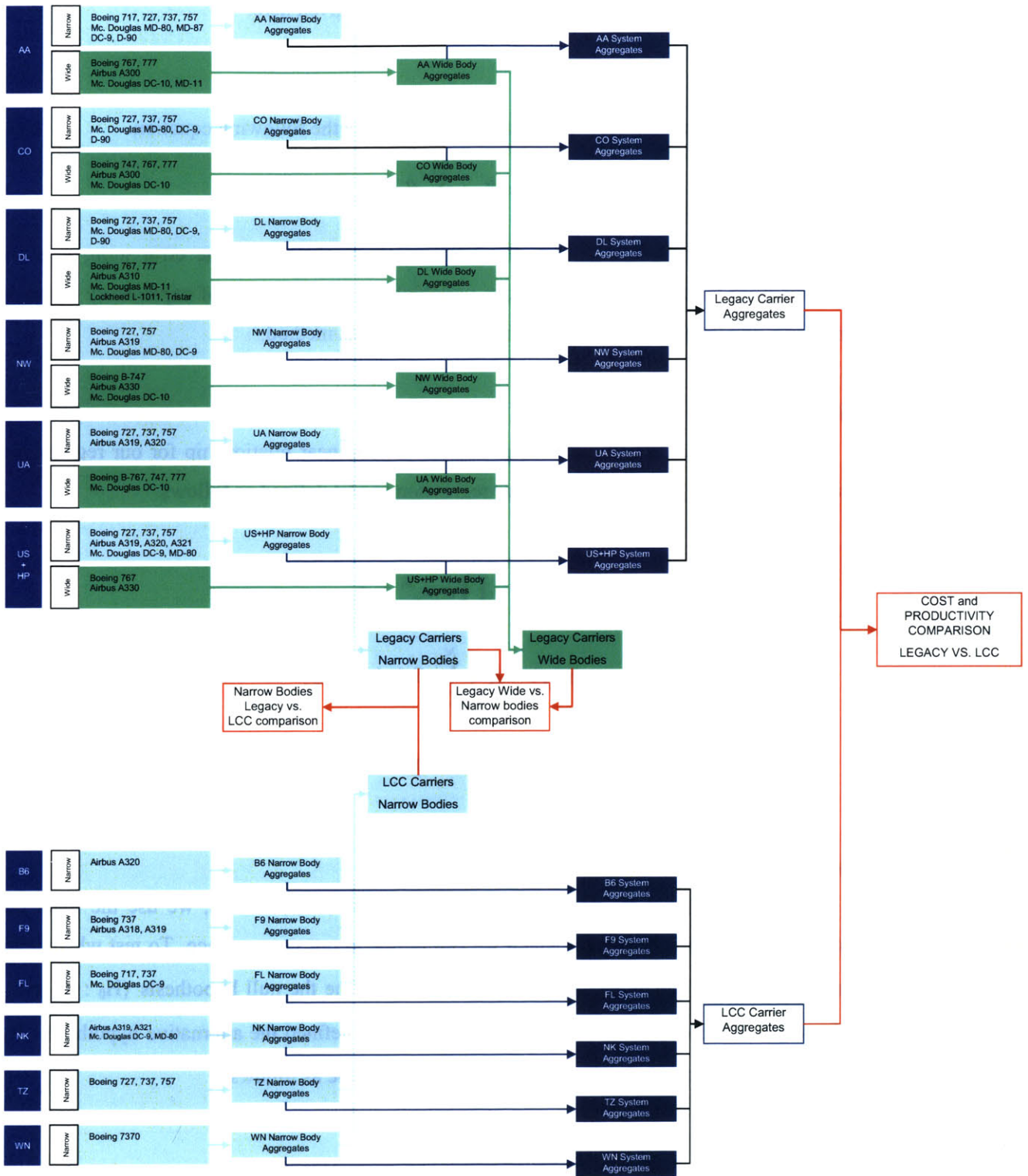


Figure 4 Conceptual graph of aggregation methodology

### 3.8. Regression Analysis

We will be using in certain cases regressions to fit curves or to seek relationships between different variables. A summary of our approach is given here.

#### *Linear model*

We use a standard linear regression model given by the following equation

$$y = \beta_0 + \sum_{i=1}^{N_x} \beta_i x_i + \varepsilon$$

Where the  $x_i$  are explanatory (or exogenous) variables,  $\varepsilon$  is the error term,  $y$  is the variable we want to explain (or endogenous variable),  $N_x$  is the number of explanatory variables we are using, and the  $\beta_i$  are estimated using the least squares method.

#### *Log-Linear model*

In certain cases it is more adequate to use a non-linear relationship for our regressions. For such cases we use a standard log-linear regression model defined as follows:

$$y = \prod_{i=0}^{N_x} \alpha_i x_i^{\beta_i} + \varepsilon_1$$

$$\ln(y) = K + \sum_{i=0}^{N_x} \beta_i \ln(x_i) + \varepsilon_2$$

Where  $K = \sum_{i=0}^{N_x} \ln(\alpha_i)$ ,  $\alpha_i$  relates to the intercept and  $\beta_i$  relates to the slope.

#### *Testing for statistical significance*

To test the statistical significance of our regression coefficients, we use the t-stat test statistic at the  $\alpha$  significance level which we can define at our convenience. To test whether for example the slope of our regression is significant we define the null hypothesis  $\{H_0 : \beta_1 = 0\}$  that the slope of the regression is equal to zero. We also defined the alternative hypothesis  $\{H_a : \beta_1 \neq 0\}$  which is two-sided. We calculate the critical t-value as follows:



$$t = \frac{\beta_1 - 0}{\frac{s}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2}}}$$

Where  $s^2 = \frac{1}{n-2} \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_i)^2$  and  $\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$

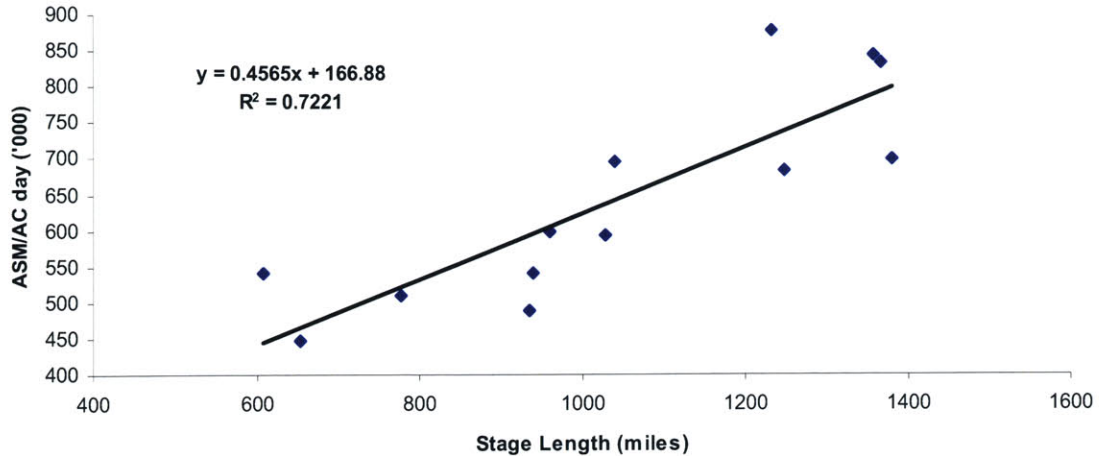
$H_0$  is rejected if  $|t| > t_{\alpha/2, n-2}$  and we obtain the value of  $t_{\alpha/2, n-2}$  by choosing our confidence level (usually taken at  $1-\alpha = 95\%$ ) and looking up the t-value from tabulated data. We can also use a one-sided test (either  $\beta_1 > 0$  or  $\beta_1 < 0$ ) if it is justifiable a priori, which only requires a slight modification in the definition of our critical t-value.

### 3.9. Stage Length Adjustment

#### *Example using linear model*

In the literature review, several methods were described that address the issue of stage length adjusting cost and productivity measures. The rationale behind this is that stage length is a central parameter influencing these measures. Empirically, it is observed that as stage length increases, unit cost decreases and productivity, defined in the broad sense, increases. To account for this correlation, a simplifying assumption is often used on the nature of this relationship. We assume a linear relationship between the measure of interest and stage length and we ignore the other parameters that might be affecting it. This is equivalent to conducting a one-factor linear regression. To explain the methodology we will use, we take an example of adjusting aircraft utilization in 2005 as measured by ASMs per aircraft day.

We first plot ASM/ACday for each airline versus its stage length (for year 2005) and obtain the following graph:



A regression is conducted to obtain a linear approximation for our sample data. The linear regression results are seen on the graph (slope = 0.4565, intercept = 166.88)

We proceed to compute several statistical measures for our dataset that figure in the table below: In particular we obtain the average stage length (ASL = 1041 miles) and the average utilization (642 ASMs/AC day) of our sample.

Adjusted ASMs per aircraft day example - 2005

Carrier	SL	ASMpACd	[ASMpACd]	abs error	rel. error	# of stdev	adjusted ASMpAC day	Adjusted rankings	Stats
WN	608	541	444.4	96.7	17.9%	1.3	757	1 WN	ASL 1041
FL	655	446	465.7	-19.8	-4.4%	-0.3	613	2 TZ	AU 642
US	777	511	521.7	-11.0	-2.2%	-0.1	628	3 DL	stdev SL 264
NK	934	489	593.4	-104.0	-21.2%	-1.4	506	4 B6	stdev U 142
F9	939	540	595.7	-55.6	-10.3%	-0.7	576	5 UA	stdev error 75
NW	961	599	605.4	-6.5	-1.1%	-0.1	635	6 NW	SL: stage length
HP	1028	595	636.1	-41.2	-6.9%	-0.6	597	7 US	ASL: average stage length
DL	1039	695	641.1	54.1	7.8%	0.7	692	8 FL	U: utilization
TZ	1233	876	729.8	145.9	16.7%	2.0	749	9 HP	AU: average utilization
AA	1248	682	736.7	-55.2	-8.1%	-0.7	590	10 AA	stdev: standard deviation
B6	1357	842	786.5	55.4	6.6%	0.7	684	11 F9	Delta_x: SL - ASL
UA	1368	831	791.2	39.9	4.8%	0.5	673	12 CO	Delta_y: Slope * (Delta_x)
CO	1381	699	797.4	-98.5	-14.1%	-1.3	551	13 NK	

We adjust the results for each airline by looking at how much its ASMs/ACday differ from the results expected from the regression. In the case for WN for example we see that its ASM/ACday are 541 and the regression model gives 444. This means that WN's utilization is 17.9% above the expected result given by the model. To be able to compare these results across all airlines, we set a common stage length at which we bring all airlines to. This stage length is chosen to be the industry average. We then adjust each airline's results by their spread from the trend line. For example the calculation for WN is done as follows:

$\{\text{Adjusted Utilization}_{\text{WN}}\} = \{\text{Utilization expected for a Stage Length equal to the Industry average}\} * \{1+17.9\%\}$

The new rankings are then sorted and reported in the table of the previous page. Using this method, we can see that if all airlines had a stage length equal to that of the sample average, WN would be ahead of the pack in 2005 with a utilization of 756,600 ASM's / AC day, followed by TZ, DL, B6... This method thus effectively removes the differences in stage length amongst airlines.



## Chapter 4

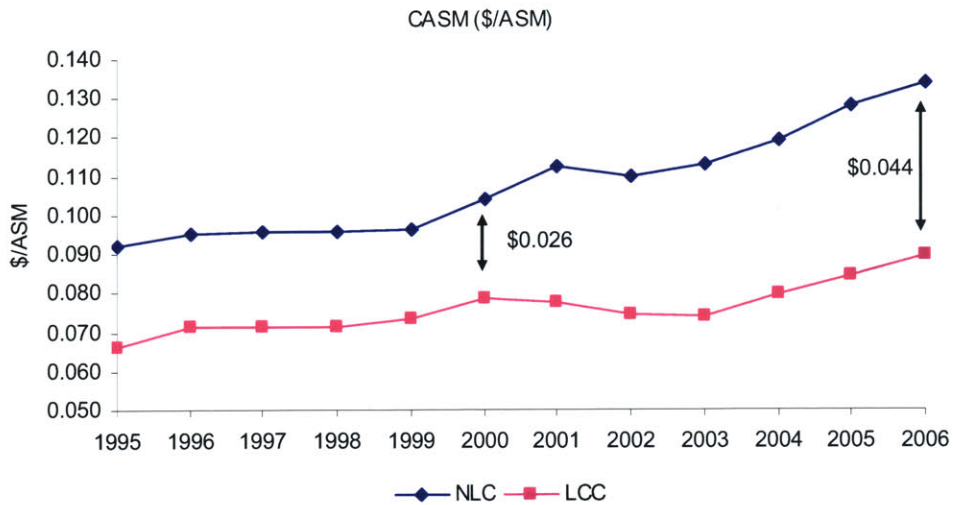
# Unit Cost Analysis

In this Chapter we present the results of our cost analysis organized in increasing levels of detail. The first part examines industry trends comparing aggregate unit costs of Legacy carriers and LCCs. The second part presents trends for individual airlines from both groups to see which carriers have been the most successful at reducing their unit costs. The third part shows more detailed results comparing costs at the aircraft level. In this last section we compare costs between wide-body and narrow-body aircraft from both groups of carriers. We conclude this Chapter by summarizing the results and by conducting regressions to test our findings.

### **4.1. Aggregate Industry Cost Comparison: NLC vs. LCC**

Our goal in this section is to look at aggregate unit cost trends for Legacies and LCCs from 1995 to 2006. In the last five years of this period, the Legacy carriers have been forced to seek greater profitability and cost efficiency in order to survive one of the worst financial crises of their history. At the same time LCCs have managed to capture an increasing amount of the US domestic market share using an alternative low-cost business model. We thus focused on examining the difference in unit costs that exist between these two groups and how these differences have evolved over time in an effort to identify potential cost convergence in the industry.

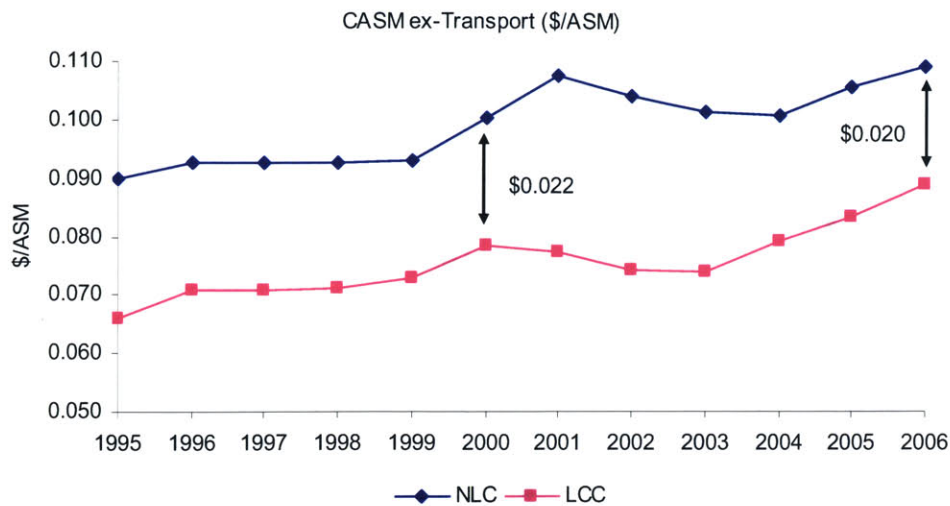
Our aggregate analysis concentrates on unit costs (combined using the methods described in Chapter 3) starting from the total costs and looking at the major cost components which include non-transport related costs, non-fuel costs, labor and non-labor costs. This breakdown allows us to identify which areas have undergone the most changes.



**Figure 5 Aggregate comparison: Total CASM 1995-2006**

As shown in Figure 5, total CASM has increased significantly from 1995 to 2006 for both Legacy and LCC carriers. There are two interesting periods to note regarding the difference in CASM between these two carrier groups: From 1995 to 2000 the difference in CASM remained almost constant at around 2.6 cents per ASM. From 2000 to 2006 Legacy CASM started increasing faster than LCC CASM, bringing the difference from 2.6 cents per ASM in 2000 to 4.4 cents per ASM in 2006. During this time period, Legacy carriers experienced a 30% increase in total CASM while LCCs went through only a 15% increase. These results suggest that both groups are diverging significantly with respect to total unit costs.

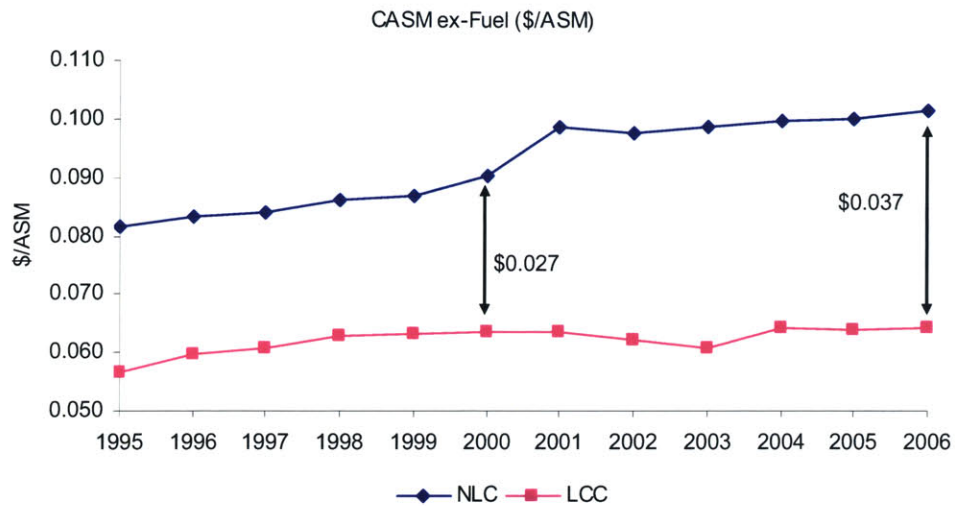
The increase in total CASM for both groups can be driven by a variety of factors including increasing fuel costs and transport-related expenses. The impact of each of these as well as the role of labor vs. non-labor components are analyzed in the graphs that follow.



**Figure 6 Aggregate comparison: Ex-transport related CASM 1995-2006**

Removing transport-related expenses from Legacy carriers gives us a more clear view on the difference in CASM between both groups in Figure 6. The results are quite different from the total CASM comparison: From 1995 to 2000 the difference in CASM remains almost constant as was previously the case. From 2000 to 2006 the difference in CASM fluctuated around a mean value of 2 cents per ASM and ended slightly lower in 2006 at 2.0 cents per ASM (vs. 2.2 cents per ASM in 2000). These results suggest that both groups are slightly converging with respect to ex-transport related CASM.

By removing transport-related expenses from Legacy carrier CASM we see that the trends in unit costs between both groups are very similar and that both curves are highly correlated. The correlation coefficient between Legacy and LCC ex-transport CASM from 1995 to 2006 is 0.84 and from 2003 to 2006 is even higher at 0.91. These high correlation numbers indicate that both groups might be subject to the same type of underlying forces that are driving CASM upward.

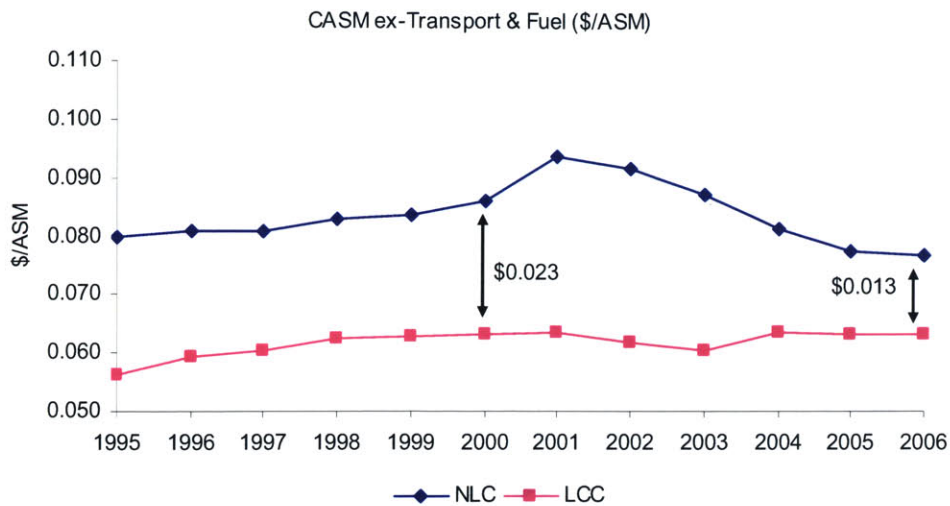


**Figure 7 Aggregate comparison: Ex-fuel CASM 1995-2006**

By removing fuel expenses from total CASM we see that LCC carriers have managed to keep their CASM almost constant from 2000 to 2006 while the Legacies have experienced an increase from 9 cents to 10 cents per ASM. Regarding the difference between both carrier groups we can break down the trends in two separate time periods: From 1995 to 2000 the difference in CASM remains almost constant at 2.7 cents per ASM. From 2000 to 2006 the difference in CASM significantly increased from 2.7 cents to 3.7 cents per ASM (almost a 40% increase). The main cause for this divergence is the increase in Legacy CASM from 2000 to 2006 and most of the contribution comes from increased Legacy CASM from 2000 to 2001. When taking into account CASM ex-fuel we find that difference between both carrier groups has diverged.

Removing fuel-expenses from total CASM indicates that the increase in LCC CASM seen earlier can be mainly attributed to an increase in fuel prices. On the other hand Legacy ex-fuel CASM has still increased indicating that fuel alone cannot fully explain the increase seen in total CASM for this group.

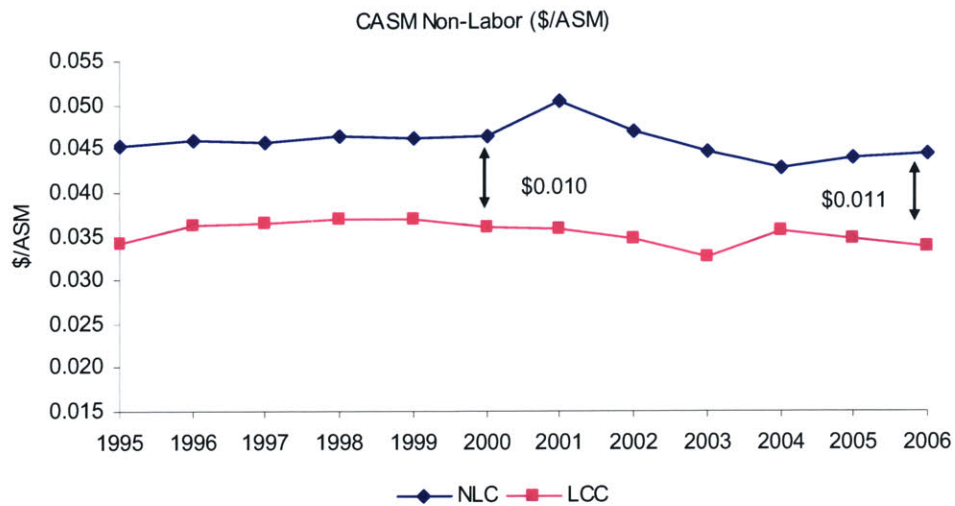




**Figure 8 Aggregate comparison: CASM<sub>exTF</sub> (ex transport-related and fuel) 1995-2006**

As mentioned in the literature review, by removing both fuel and transport-related expenses we obtain a measure of CASM that in our view provides a better cost comparison between both groups. The results for this modified CASM (CASM<sub>exTF</sub>) shown in Figure 8 represent a very different picture than previously. Legacy CASM<sub>exTF</sub> has slightly decreased from 1995 to 2006 and has slightly increased for LCCs: The major changes have taken place between 2001 and 2006, a period during which Legacy CASM<sub>exTF</sub> dropped 17% from 9.4 cents to 7.8 cents per ASM, while LCC CASM<sub>exTF</sub> remained flat at around 6.3 cents per ASM. As a result the difference between both carrier groups went from 2.3 cents to 1.3 cents per ASM from 2000 to 2006, a 43% decrease. When removing fuel and transport-related expenses, both carrier groups have seen their CASM<sub>exTF</sub> converge significantly from 2000 to 2006.

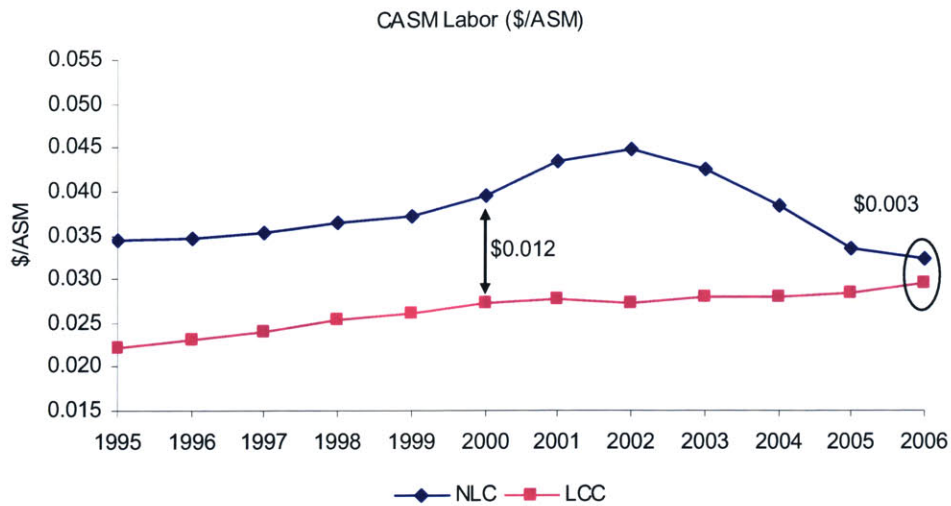
The results suggest that fuel and transport-related expenses have been predominant in driving up unit costs for Legacy carriers since 2000 and that fuel has been the main cause of increased unit costs for LCCs. There is thus strong evidence of convergence between both carrier groups when looking at CASM<sub>exTF</sub>. In order to identify the underlying forces of this trend we break-down this cost category into its labor and non-labor components.



**Figure 9 Aggregate comparison: Non-labor CASM<sub>exTF</sub> 1995-2006**

In Figure 9 we can see that non-labor CASM<sub>exTF</sub> has remained virtually flat when comparing 1995 to 2006 for both groups. The gap in non-labor CASM between both groups remains stable from 1995 to 2000 at which time it was at 1 cent per ASM. From 2000 to 2001 the gap widens slightly and then follows a trend of convergence until 2004. From 2004 onward, non-labor CASM<sub>exTF</sub> seems to be slightly diverging as LCCs' non-labor CASM<sub>exTF</sub> is decreasing and Legacy non-labor CASM<sub>exTF</sub> is increasing.

The non-labor CASM<sub>exTF</sub> category we are analyzing here is a catch-all category that includes any costs other than labor, fuel and transport-related expenses. In this sense it is a reflection of a company's internal cost structure resulting from a variety of factor such as network structure, fleet type and distribution channels to name a few. In this sense it is difficult to identify which factors are responsible for the variations in non-labor CASM<sub>exTF</sub>. However given the fact that excluding some variations between 2000 and 2005, the gap between both groups has remained stable, we expect to see the convergence in CASM<sub>exTF</sub> mentioned previously to be explained by a convergence in the labor component.



**Figure 10 Aggregate comparison: Labor CASM<sub>exTF</sub> 1995-2006**

As can be seen in Figure 10, Legacy labor CASM<sub>exTF</sub> has been very volatile; it followed an upward trend starting at 3.5 cents per ASM in 1995 and reached a peak in 2002 at 4.5 cents per ASM. Since 2002, it has been reduced considerably to 3.3 cents per ASM. On the other hand, LCC labor CASM<sub>exTF</sub> has been steadily increasing since 1995 (going from 2.2 cents in 1995 to 3 cents per ASM in 2006). These changes have led to a significant reduction of the difference in labor unit costs between both carrier groups since 2000. The gap was at 1.2 cents per ASM in 2000 and was cut to just 0.3 cents per ASM in 2006. This is evidence of a strong convergence occurring in the labor cost category between Legacies and LCCs in the past 6 years.

The large decrease in labor CASM<sub>exTF</sub> for Legacy carriers is a direct result of the cost-cutting strategies that have been put in place during the 2000-2005 crisis period and that will be described in the following sub-sections of this Chapter. The bankruptcies and threats of bankruptcies have played an important role in allowing Legacy carriers to cut their work force and renegotiate lower wages from their unions. On the other hand, LCC carriers have had to deal with two issues that have kept their labor costs growing: The first is increased seniority and the second is aging aircraft.

The aggregate results thus show that Legacy carriers have been so effective in cutting their costs that they are currently entirely competitive on the labor front with their LCC rivals. In other words, the LCC advantage can no longer be simply attributed to lower labor costs.



Figure 11 and Figure 12 below show a breakdown of the cost categories as a percentage of the total unit cost from 1995 to 2006.

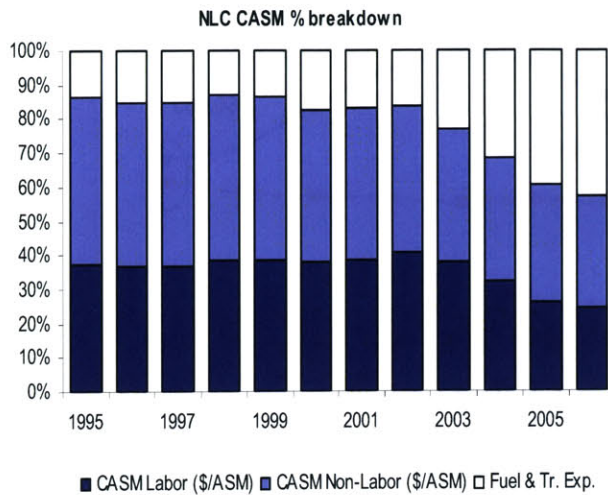


Figure 11 Aggregate comparison: NLC CASM % breakdown

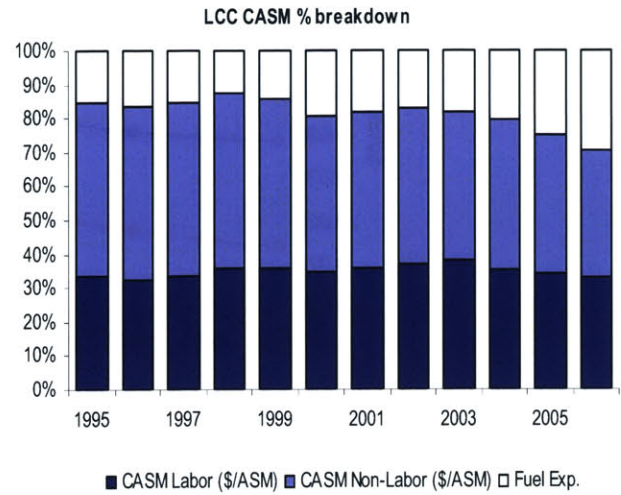


Figure 12 Aggregate comparison: LCC CASM % breakdown

As we argued previously, Figure 11 shows that NLC carriers have gone through a fundamental transformation of their cost structures. The part of fuel and transport related expenses has grown from 13% of unit costs in 1995 to over 40% of unit costs in 2006. This gain as well as the labor cost-cutting strategies have reduced labor unit costs to less than 30% of the total in 2006. The non-labor cost category has also been reduced from 45% in 1995 to 30% in 2006. These results provide further evidence that fuel and transport-related expenses have been the main drivers behind the increase in total unit costs seen in Figure 5.

The results for LCC carriers in Figure 12 reflect the same sensitivity to fuel prices. The fuel component of total CASM has gone up from 15% in 1995 to around 30% in 2006. Labor costs however have fluctuated throughout the period but remained centered on a value of 30% of total unit costs. The non-labor component of unit-cost has thus undergone a reduction going from 50% of the total in 1995 to 35% in 2006.

### *Summary of aggregate unit cost comparison*

The key findings from our aggregate analysis are summarized below:

- Both groups of carriers have experienced an increase in total CASM since 1995 (a 45% increase for Legacy carriers and a 35% increase for LCCs).
  - At the aggregate level, the increase in CASM for Legacy carriers can be explained mainly by increased fuel and transport-related expenses.
  - The increase in CASM for LCCs can be explained mainly by increased fuel expenses.
  
- When taking away these two components (fuel and transport-related expenses) we observe strong convergence between the  $CASM_{exTF}$  of both groups.
  - On the Legacy side, this convergence is due to a hefty reduction in labor unit costs which have been the focus of the cost-cutting strategies put in place since the beginning of the crisis period in 2000.
  - On the LCC side, this convergence has been likely driven by increased staff seniority and aging fleet.
  - In 2006 labor costs between both groups only differed by 0.3 cents per ASM

As a conclusion, the LCC labor-cost advantage which has been often cited as one of the main profitability advantages of LCC carriers in the literature has virtually disappeared in 2006. The next section explores in more detail how each airline from our sample group has contributed to these results.

## 4.2. Individual Airline Cost Comparison

In this section we look at the unit costs of each airline from our sample set in order to assess their individual contribution to the aggregate results. We analyze total CASM, and  $CASM_{exTF}$ . We also break-down  $CASM_{exTF}$  into its labor and non-labor components. The graphs have been organized by separating the Legacy carriers that have been into bankruptcy from the ones that have not in an effort to compare which ones have been more active in cutting costs. Table 7 gives the list of bankruptcies and their exit dates for all Legacy carriers in our sample set.

period:	Entered Chap11	Exited Chap11	Duration
1995-2006			
AA	-	-	-
CO	-	-	-
UA	December-02	February-06	4 years
US1*	August-02	March-03	1.5 years
US2 -> USHP**	September-04	September-05	1 year
DL	September-05	April-07	1.5 years
NW	September-05	May-07	1.5 years

\*Refers to US's first bankruptcy

\*\*Refers to US's second bankruptcy and merger with HP

**Table 7 Bankruptcies between 1995 and 2006**

Furthermore when looking at individual trends we need to keep in mind the relative weight of each airline with respect to the aggregate industry results. Since we are looking at costs divided by ASMs, we need to compute the appropriate ASM-weighted figures to assess the relative contribution each airline has in the total of its group. An ASM weight matrix is given in Table 8 for each year of the time period. The last column of the table includes a time-averaged weight ( $w_i$  for each carrier  $i$ ) that is a good approximation of an airline's impact on the industry. For example Southwest's average ASM weight during the period is 0.61 (or 61%) meaning that the CASM trends seen in the LCC results are largely influenced by Southwest's numbers. On the other hand, Spirit airlines has an average weight of 4% which means that if we were to remove it from our sample set, the LCC results would barely change. These weights must be kept in mind when analyzing individual airlines and linking their results to the industry trends.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	average Weight $w_i$
AA	0.23	0.23	0.22	0.22	0.21	0.21	0.21	0.24	0.25	0.25	0.25	0.25	0.23
CO	0.08	0.08	0.09	0.1	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.13	0.11
DL	0.2	0.2	0.2	0.2	0.19	0.19	0.19	0.18	0.18	0.18	0.19	0.18	0.19
NW	0.13	0.14	0.14	0.13	0.13	0.14	0.13	0.13	0.13	0.13	0.13	0.12	0.13
UA	0.24	0.24	0.24	0.24	0.24	0.23	0.23	0.21	0.2	0.21	0.2	0.2	0.22
USHP	0.12	0.12	0.12	0.11	0.11	0.12	0.13	0.12	0.12	0.12	0.12	0.11	0.12
B6						0.02	0.04	0.07	0.11	0.13	0.16	0.17	0.08
F9	0.01	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.05
FL			0.02	0.07	0.07	0.06	0.06	0.07	0.08	0.08	0.1	0.12	0.07
NK	0.01	0.02	0.02	0.02	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.03	0.04
TZ	0.25	0.23	0.2	0.2	0.18	0.17	0.16	0.15	0.16	0.14	0.09	0.05	0.15
WN	0.72	0.73	0.73	0.68	0.67	0.66	0.65	0.6	0.56	0.54	0.56	0.56	0.61

Table 8 ASM weights Matrix

#### 4.2.1 Total CASM Increase

Total CASM has increased on average around 45% from 1995 to 2006 for NLC carriers. Concentrating more precisely on the 2001-2006 period in Figure 13 we see that all major carriers experienced a significant increase ranging from 5% at AA to 38% at DL (with a group average of 22% and a standard deviation of 11.5%). The results for AA are surprising as it has not gone through bankruptcy and yet it is the most successful Legacy from our sample set in terms of containing its total unit cost increases.

Likewise from 1995 to 2006, LCCs experienced a 35% average increase in CASM. From 2001 to 2006, we can see that FL has been the most successful at containing its unit costs which increased by 5%, while NK has increased the most with 32%. With an average increase of 18% and a std. deviation of 9% unit costs are more contained than for the Legacies. Figure 14 and Figure 16 give the detail of CASM for each airline and Figure 15 shows CASM rankings in 2006.

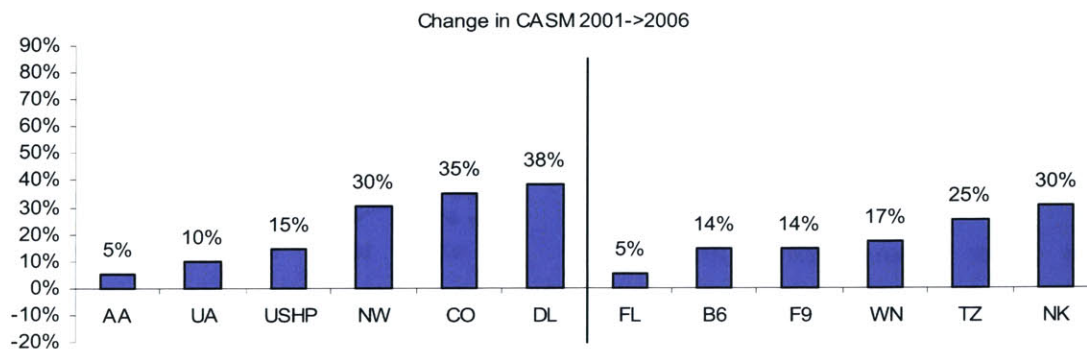
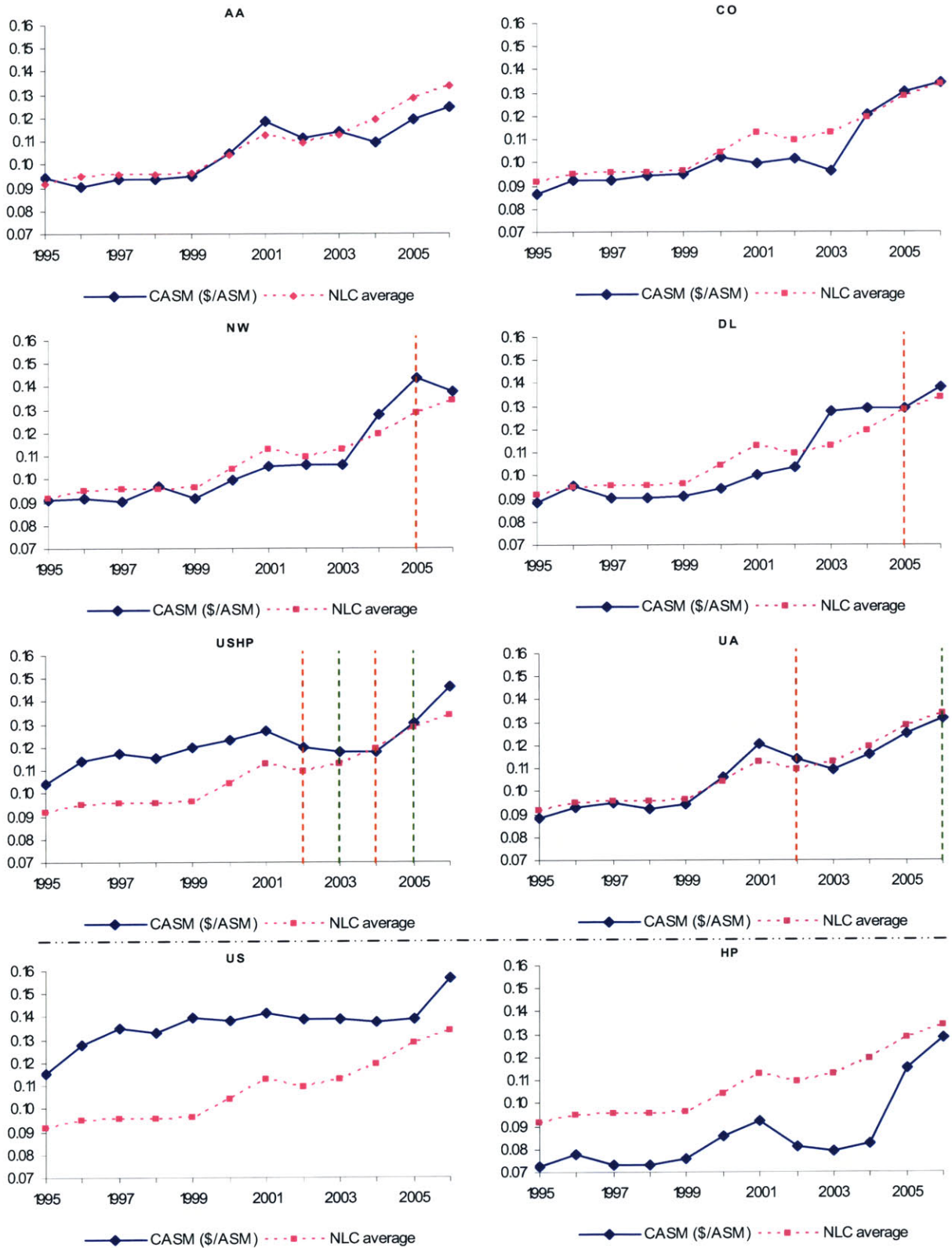


Figure 13 Change in total CASM 2001-2006



**Figure 14 By-carrier analysis: NLC Total CASM**

*Bankruptcies are signaled by vertical lines. Red = year of entry. Green = year of exit.*



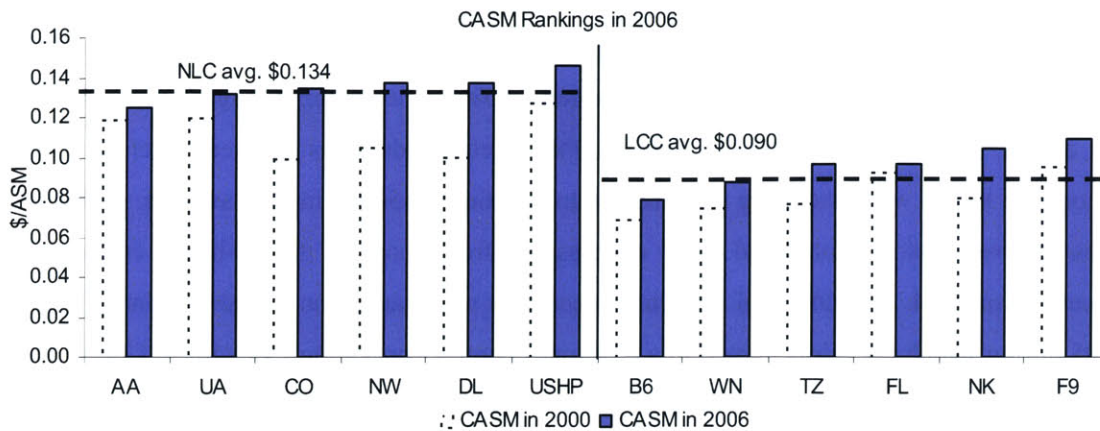


Figure 15 CASM Rankings in 2006

#### 4.2.2. Legacy Carriers Total CASM

Looking at Figure 14 and Figure 15 we can see how total CASM has changed from 1995 to 2006 for each carrier. A case-by-case study of the results is given below.

*American* ( $w_{AA}=23\%$ ) and *Continental* ( $w_{CO}= 11\%$ )

Despite being the only two airlines that have not gone through Chapter 11 in the recent period, AA and CO have been surprisingly effective at keeping their total CASM relatively low. In Figure 15 we see that AA is leading all Legacy carriers in 2006 with a total CASM of \$0.125/ASM while CO is third with a CASM of \$0.135/ASM.

Looking at the more detailed graphs in Figure 14 we see that AA's turn-around started in 2003 when its CASM went below the industry average for the first time. Around this period two noteworthy events played a role in this reduction: On the labor front, AA pilots in 2003 made significant concessions amounting to \$660M annually in an effort to avoid bankruptcy. In fact, AA reported that it managed to obtain cost savings of \$1.8B in total labor concessions in 2003. On the non-labor front, a little earlier in April of 2002 AA finished retiring its aging Boeing 727 fleet which had reached a total of 182 planes at its peak.

Continental's situation is slightly different as its best cost period took place between 2000 and 2003. During this time, CO had a CASM substantially lower than that of the industry. A major reason for this was its strategic position in the international market as it was amongst the first airlines to expand into international routes, particularly towards Asia. It is also worth mentioning that CO had undergone two bankruptcies in the past (in 1983 and 1990) which had

helped it shed costs by cutting jobs and pay. In 2003 the situation started to change. The Iraq war threats reduced demand for international travel and CO was heavily hit having to reduce capacity in March 2003. A day after this act, it announced a 25% cut in senior management, a 15% cut in the officer group, 1200 furloughs and \$500M in cost reductions. A year later in 2004, it announced that it was struggling and needed an additional \$500M in cost savings. Utilizing the threat of bankruptcy it obtained these concessions from most of its US-based employees by December of 2004. An additional wave of concessions was reached on the labor front in March of 2005 during which the pilots agreed to a 45-month contract providing CO with \$213M in annual cost savings. The latest wave occurred in January 2006 as it finalized concessions with its flight attendants. Despite these streams of concessions, CO was not able to control its costs as efficiently as AA but still remains in good standing when compared to the rest of the industry. On the fleet side, CO retired its aging MD-80 aircraft in March of 2005 which reduced its fleet to just three types of aircraft (the Boeing 777, 767/757 and the 737). This also helped it keep its costs under control.

*Northwest ( $w_{NW}=13\%$ ) and Delta ( $w_{DL}=19\%$ )*

Northwest and Delta filed for bankruptcy in September 2005 and so it is still too early to tell what the full effects will be on their unit costs. In 2006 we see that both carriers have very similar total CASM with NW at \$0.137 and DL at \$0.138/ASM. This is slightly above the industry average of \$0.134/ASM.

Like all the other major carriers, NW's labor force gave up several concessions after 9/11. The most recent before the bankruptcy was a \$250M cost savings obtained from its pilots. When it went into Chapter 11, NW indicated that it needed an estimated \$1.4B in yearly cost reductions and while it is not clear just how much of that amount has been achieved, looking at NW's CASM in Figure 13, it seems that it is getting back on track in 2006. Indeed the airline managed to reduce its CASM by around 4% from 2005.

On the flip side Delta has seen its CASM increase by 7% from 2005 to 2006. Similarly to NW, it had managed to obtain many labor concessions in 2004 and notably it received \$1Bn in pilot concessions. Other efforts it put in place to cut costs included a restructuring effort announced in early 2004 involving a scale back in its Dallas hub, an expansion of its Atlanta operations, the introduction of its "Simplifares" programs designed to simplify its fare structure and further expansion towards international routes in Europe and Latin America. On the non-labor side, Delta simplified its fleet by retiring old aircraft which had lower cost efficiency. It replaced its Lockheed L-1011 with Boeing 767's, its 727's with 737's in 2003, and got rid of its

MD-11's by 2004. Despite all these efforts DL entered bankruptcy in 2005, planning to cut around 20% of its employees and targeting around \$3Bn per year in cost reductions by 2007.

*United Airlines ( $w_{UA} = 22\%$ )*

United's case is interesting to look at individually because it went into bankruptcy in 2002 - relatively early compared to the other airlines - and emerged after a long period around 4 years later in 2006. During its bankruptcy it focused on cutting costs and service so as to emerge as a smaller and more efficient airline. It reduced its fleet by around 20% from pre-9/11 levels and cut domestic flights by 14% in favor of international routes. On the labor side, it negotiated new contracts in 2003 which secured labor cost savings of \$2.5Bn per year for six years. Furthermore in 2005 it terminated employee pensions entirely – this act constituted the largest corporate pension default in US history. The second round of labor cost reductions occurred in July 2005 during which it obtained an additional \$700M in cost savings. Looking at United's CASM we see that all these measures have helped it maintain lower-than-average unit costs from 2003 to 2006. In fact in 2006 United and American which account for almost 45% of total Legacy ASMs in 2006, were the only two airlines with below-average CASM.

*US Airways – USHP ( $w_{USHP}=12\%$ )*

As a combination of a Legacy carrier and an LCC, USHP reflects trends from both of these groups. Individually US' CASM has been much higher than that of the Legacy industry average while HP's has been significantly lower as expected. When looking at the combined result (USHP) in Figure 14, we see an airline emerge whose CASM follows the types of trends typically seen for the Legacy carriers. Utilizing two bankruptcies and a merger in the last 5 years, USHP managed to dramatically reduce labor costs and decrease its total CASM from 2001 to 2004 while most other carriers experienced a significant increase during the same period. These cost savings resulted from the major concessions it obtained from its employees and the unloading of its pilot pension plan to the federal government in 2003 and 2004. As a result, USHP's most successful year was in 2004 during which its CASM went below the industry average for the first time (at 0.118 \$/ASM). It also had good results in 2005 keeping its increase in CASM on par with the rest of the industry. However in 2006 the airline's CASM climbed up to 0.146 \$/ASM, the highest level and worst performance of the Legacy group for that year.

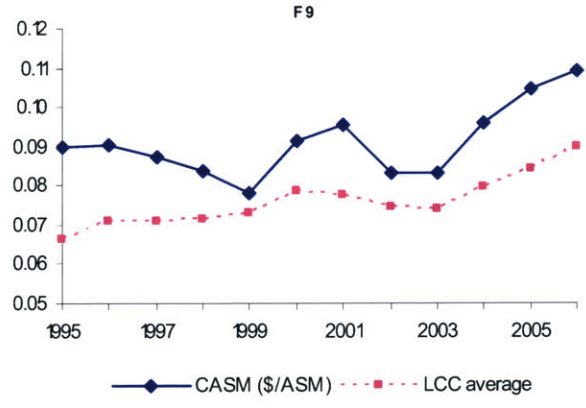
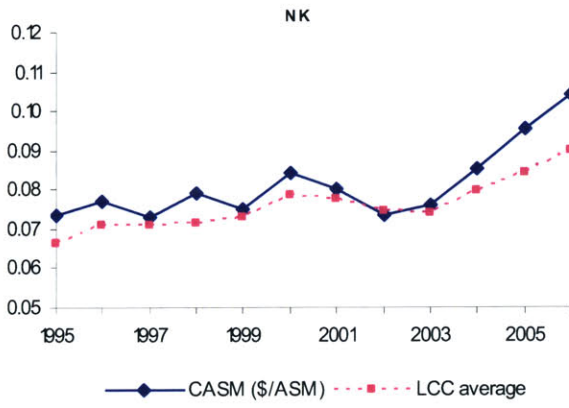
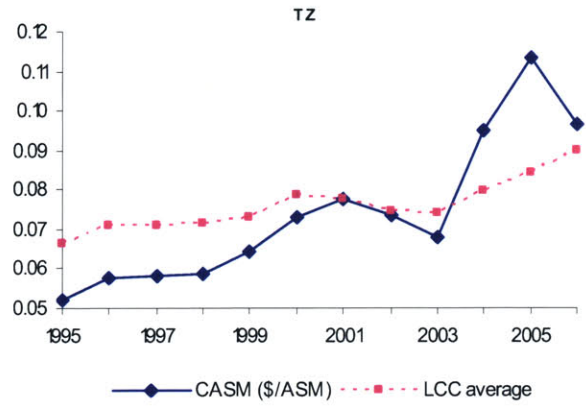
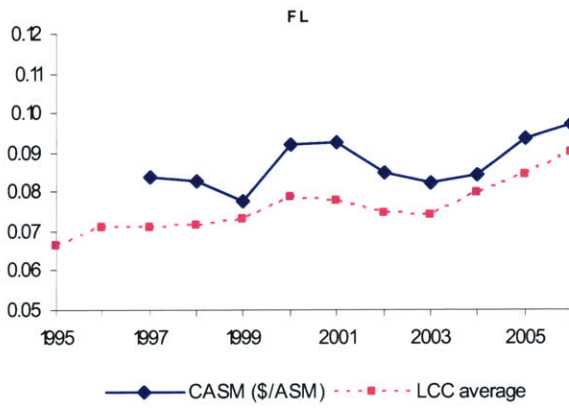
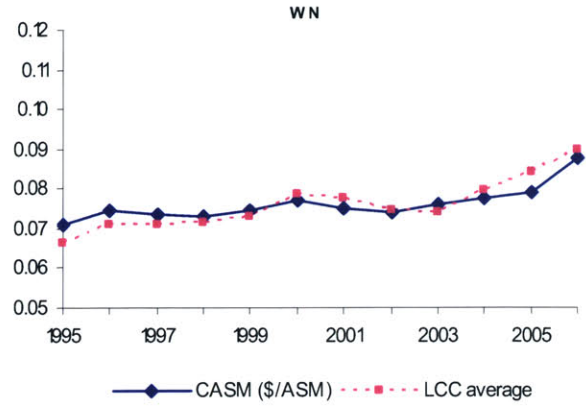
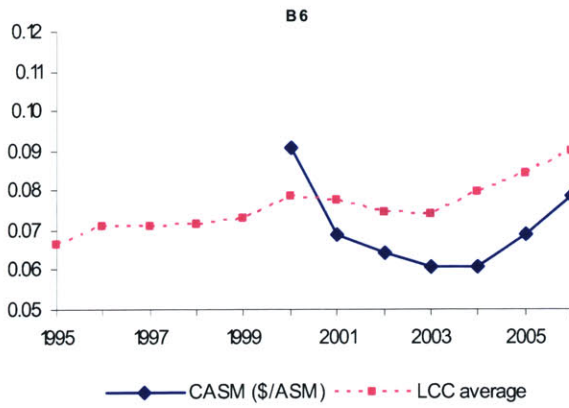


Figure 16 By-carrier analysis: LCC Total CASM

### 4.2.3. LCC Carriers Total CASM

Figure 16 contains the total CASM results for the LCC carriers and a case-by-case study highlighting the main findings is done below.

#### *Jet Blue ( $w_{B6} = 8\%$ )*

Except for its first year in service, B6 has been very successful at keeping its CASM significantly below the LCC average (which is at \$0.09/ASM). From 2000 to 2004 it managed to reduce its CASM by over 30% achieving the highest decrease of any LCC. However this was reversed in the following two years as all carriers were hit by rising fuel prices. Although not losing all the cost-efficiency it had gained from the previous period, the airline did experience a 30% increase from 2004 to 2006. Despite this setback B6 remains the lowest of all its peers in 2006 at \$0.079/ASM.

#### *Southwest ( $w_{WN} = 61\%$ )*

Given WN's large average weight of 61%, it is not surprising to see its CASM wrapped closely around the LCC average trend line, while remaining mostly below it. The most interesting fact that stands out in the graph is that WN's CASM has not been very volatile throughout the entire time period. Its standard deviation of just 5.7% is lower than the industry average of 8%. This steady behavior observed for CASM is a direct result of the company's hedging strategy with respect to fuel. Having hedged-out a large amount of its fuel exposure throughout 2005, it is not surprising to see its CASM remain stable. However from 2005 to 2006 it experienced an increase of around 11%, much larger than the previous years. Interestingly enough its average hedged fuel price was also around 50% higher from 2005 to 2006. For the upcoming years, the company's annual report states that it has been just as active with its hedging strategy – for example it is 95% hedged at \$50/barrel for 2007.

#### *AirTran ( $w_{FL} = 7\%$ ) and Frontier ( $w_{F9} = 5\%$ )*

Although FL and F9 are very different airlines when it comes to fleet types and networks, they do exhibit very similar trends in their CASM. Both carriers have underperformed compared to the LCC average. The worst period came just after 9/11 as both experienced significant increases. The two carriers then recovered from 2002 to 2003 however were again set back by rising fuel prices after 2003. In 2006 F9 had a CASM of \$0.109/ASM, the highest of all LCCs,

while FL was in better shape at \$0.097/ASM. Despite these relatively high numbers compared to other LCCs, both remain substantially lower than the Legacy carriers' average of \$0.134/ASM.

*Spirit ( $w_{NK} = 4\%$ )*

NK exhibits similar trends to FL and F9, but with a much more significant increase in CASM from 2003 to 2006 of almost 37%. For comparison during the same period, average LCC CASM increased at a rate of 20%. This accelerated growth resulted in NK having the second highest CASM of all LCCs in 2006 at \$0.104/ASM.

*America Trans Air ( $w_{TZ} = 15\%$ )*

TZ has historically performed well keeping its CASM lower than the industry average through 2003. However everything turned around beyond that point. From 2003 to 2004 its CASM surged from \$0.068/ASM to \$0.095/ASM representing a 40% increase. The airline filed for Chapter 11 in the end of 2004 and started dramatically reducing its routes and downsizing its fleet. By 2005 it had returned over 30 of its Boeing aircraft including twenty 737-800's and eight 757-300's. From 2004 to 2006 it completed 3 rounds of flight cuts significantly reducing its service. Its ASMs went from 20.7M in 2004 to 13.2M in 2005 to 8.1M in 2006 - a 60% decrease. These events explain the peaks and volatility seen in TZ's graph between 2003 and 2006. In 2006 the airline emerged from bankruptcy after a buy-out made it into a private company. These measures allowed it to reduce its CASM by 15% from 2005 to 2006 reaching \$0.097/ASM.

*NLC vs. LCC Summary*

On the Legacy side we saw that the group suffered an average CASM increase of 22% from 2001 to 2006. It is thus clear that the substantial reductions in capacity, traffic and expenses were not enough to offset the rapidly rising transport-related and fuel expenses. The LCCs, while not as heavily affected as their Legacy rivals, were not able to contain their CASM from rising during the last 5-year period either. As a group, they experienced an 18% average increase with a standard deviation of 9%. This shows just dramatic the impact of fuel prices have been on total unit costs for both sides.

#### 4.2.4. CASMexTF

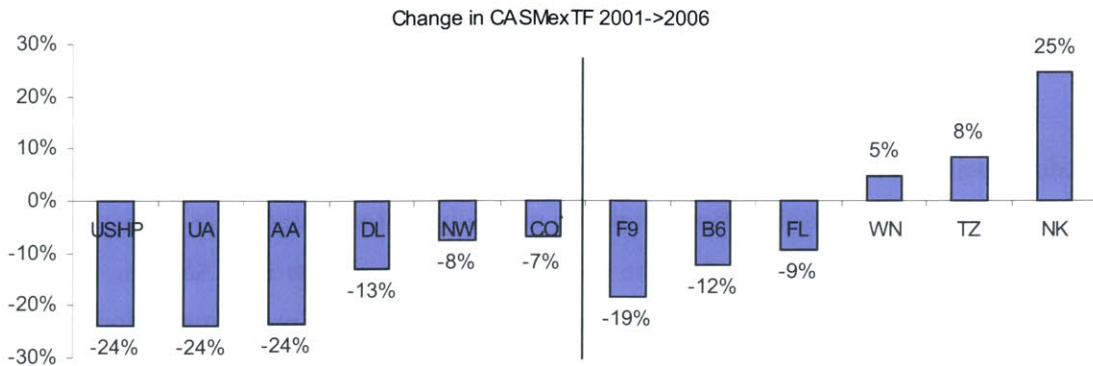


Figure 17 Change in CASMexTF 2001->2006

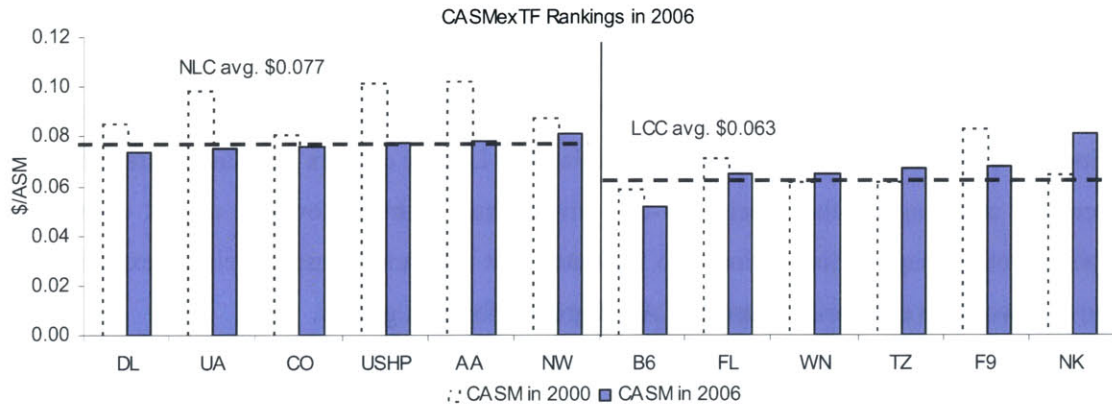


Figure 18 CASMexTF Rankings in 2006

#### Legacy carriers

Consistent with our results from the aggregate cost comparison, by removing fuel and transport-related expenses we see that all Legacy carriers have managed to significantly reduce their unit costs in the last 5-year period (Figure 17). The biggest decreases can be seen for USHP, UA and AA at 24% while CO achieved the lowest decrease at 7%. On average, the Legacy group experienced a reduction of 16% with an 8% standard deviation. This is in clear contrast to the results previously seen for total CASM and by-it we deduce that fuel and transport related expenses have been entirely responsible for the NLC increase in  $CASM_{exTF}$ . In terms of unit cost rankings in 2006 (Figure 18), DL leads the pack with a  $CASM_{exTF}$  of \$0.074 while NW is the

carrier with the highest  $CASM_{exTF}$  at 0.081. As a group in 2006, the Legacies had an average  $CASM_{exTF}$  of \$0.077/ASM with only a 3% standard deviation from the mean.

#### *LCC carriers*

The LCC carriers had split results over the same period. While B6, F9 and FL managed to reduce their unit costs, WN, TZ and NK experienced an increase. TZ increased by 8% and this is directly linked to the difficulties the airline was going through during its bankruptcy. NK's results were substantially worse than the rest of the LCCs as it saw its  $CASM_{exTF}$  increase by 25%. This is somewhat surprising considering that the airline's self-proclaimed priority is to cut costs as much as possible. In fact in March 2007 they announced that their objective was to become the first ultra-low cost airline in the United States, modeling their business plan after the European LCC Ryanair.

#### *Summary*

From the results above it is clear that the focus of almost every carrier in the past 5-year period has been to cut costs as much as possible. The Legacy carriers have in general been more successful at doing so than their low-cost rivals thus pointing towards a cost convergence between both groups. This section also indicates that fuel and transport-related expenses have been the two main categories spurring  $CASM$  growth for both groups.

The next step after this analysis is to break-down  $CASM_{exTF}$  into its labor and non-labor components in order to identify where the cost-cutting effort has been the most effective.



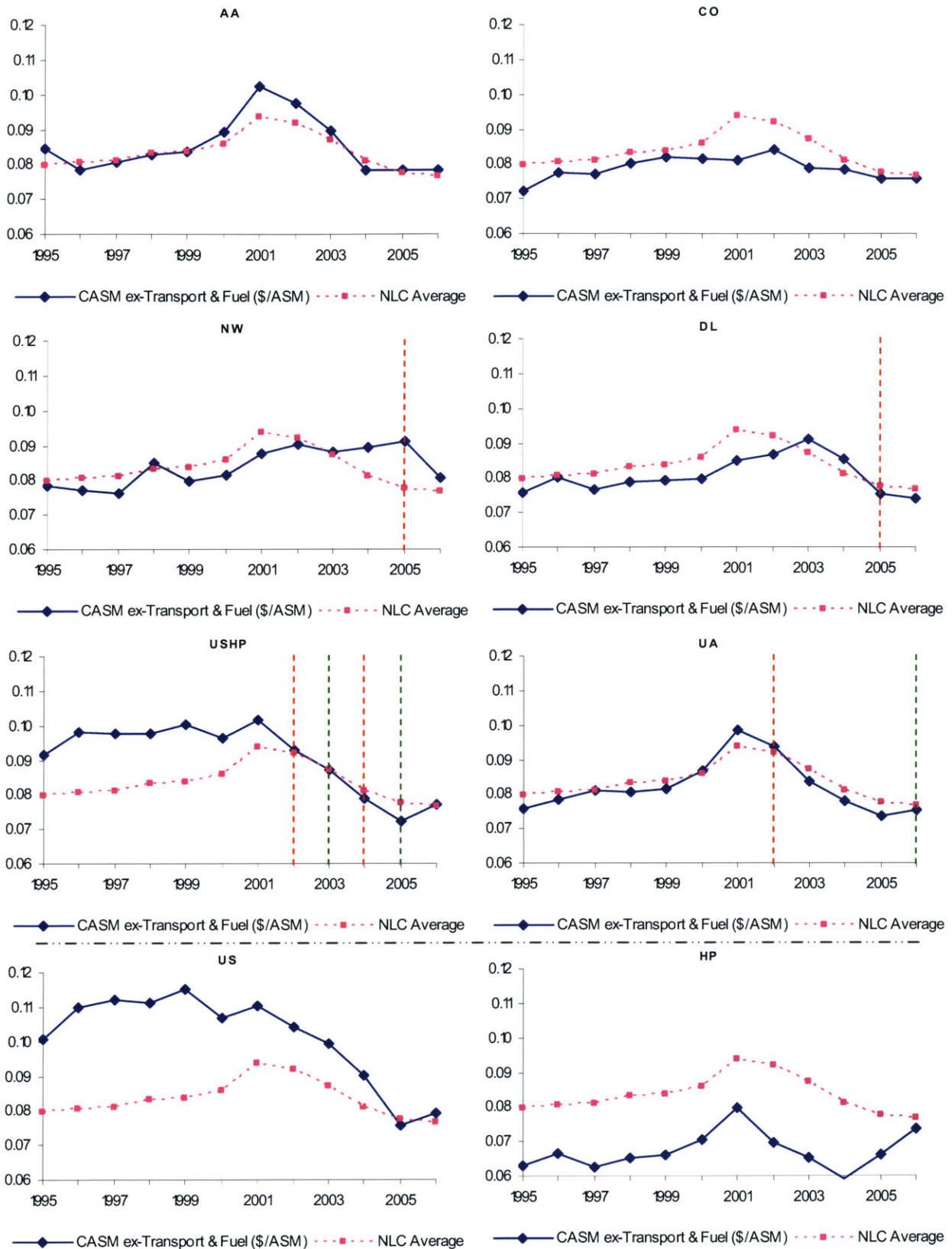


Figure 19 By-carrier analysis: NLC CASM<sub>exTF</sub>

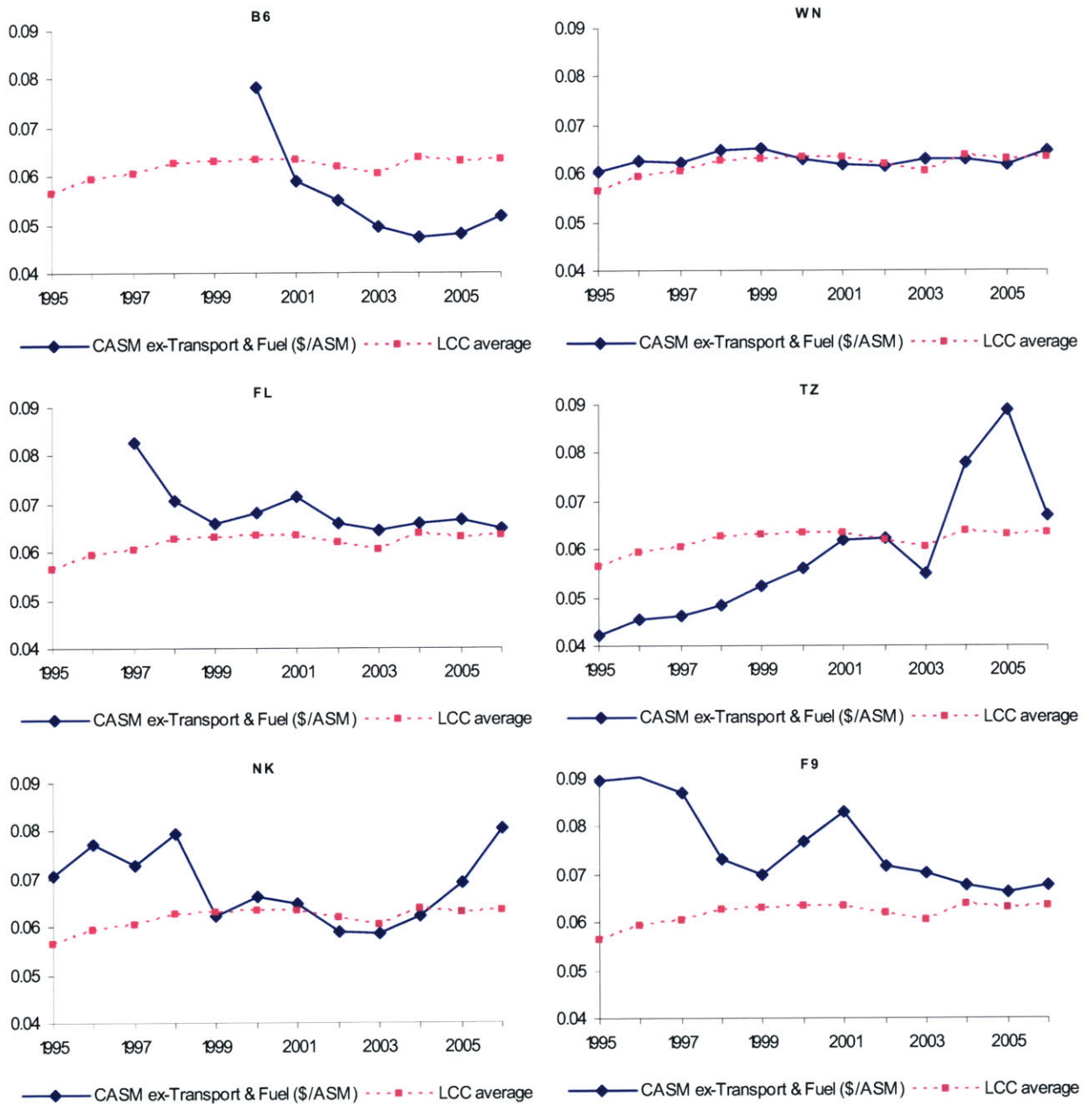


Figure 20 By-carrier analysis: LCC CASMexTF

#### 4.2.5. Labor and Non-Labor Component of CASMexTF

##### *Labor component*

The results presented in Figure 21, Figure 22, Figure 25 and Figure 26 show a high contrast in labor unit cost trends between Legacy and LCC carriers.

The Legacy carriers utilized bankruptcies and all the cost-cutting methods mentioned in section 4.2.1, to successfully reduce their labor costs from 2001 to 2005. As expected, the most successful airlines were the ones that had gone through bankruptcy during that period. Among them, USHP led the group with a decrease of 39% while AA and CO – the only two airlines that have not gone through Chapter 11 – still managed an 18% and 11% decrease respectively. On average the group reduced its labor CASM by 25%. In terms of labor CASM rankings in 2006, USHP led the group with a CASM of just under \$0.029/ASM while AA was the only carrier with above-average CASM at \$0.037/ASM.

The LCC situation is quite different. Besides FL and B6 who managed to reduce their labor CASM, the rest of the LCCs experienced significant increases ranging from 4% at F9 to 26% at TZ. The LCC rankings for 2006 have B6 in front with the lowest labor costs of all LCCs at \$0.021/ASM and the highest of the group belongs to WN at \$0.034/ASM. WN, who also weighs for more than half of the LCC ASMs, has had to deal with an aging fleet but more importantly with the fact that their pilots and staff are becoming more senior. WN's labor CASM in Figure 26 shows just how steadily its labor CASM has been increasing over the past 5 years with no signs of slowing down.

These results reflect the underlying forces of cost-convergence discussed in the aggregate analysis. We can see that the convergence in the case of labor costs can be summarized as follows:

- All NLC carriers have dramatically reduced their labor costs by renegotiating their contracts through bankruptcy or threats of bankruptcy during the last 5 years.
- Most LCC carriers, and mainly WN, have had to deal with increased labor costs due to their employees becoming more senior and an aging fleet.
- As a result in 2006, Legacy carriers had an average labor CASM of \$0.032/ASM while LCCs had an average of \$0.029/ASM. The difference between both groups has been reduced to just 0.3 cents per ASM.

Contrary to historic results, the LCC labor advantage is thus disappearing.

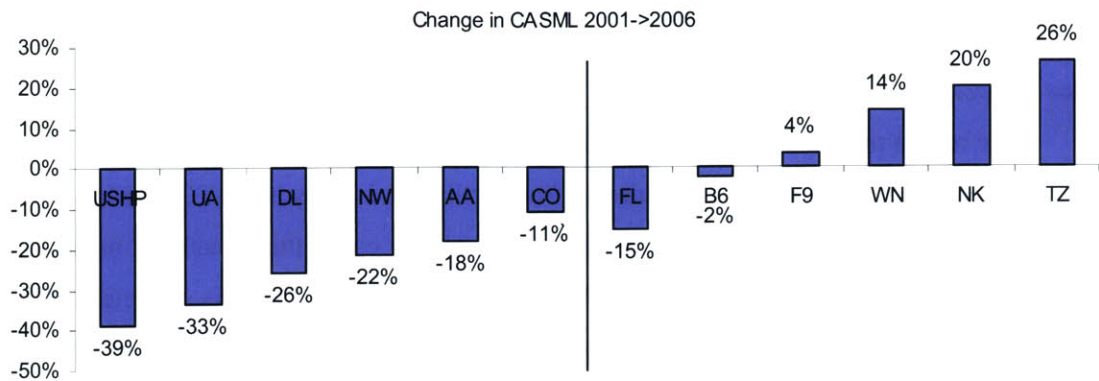


Figure 21 Change in Labor CASM 2001->2006

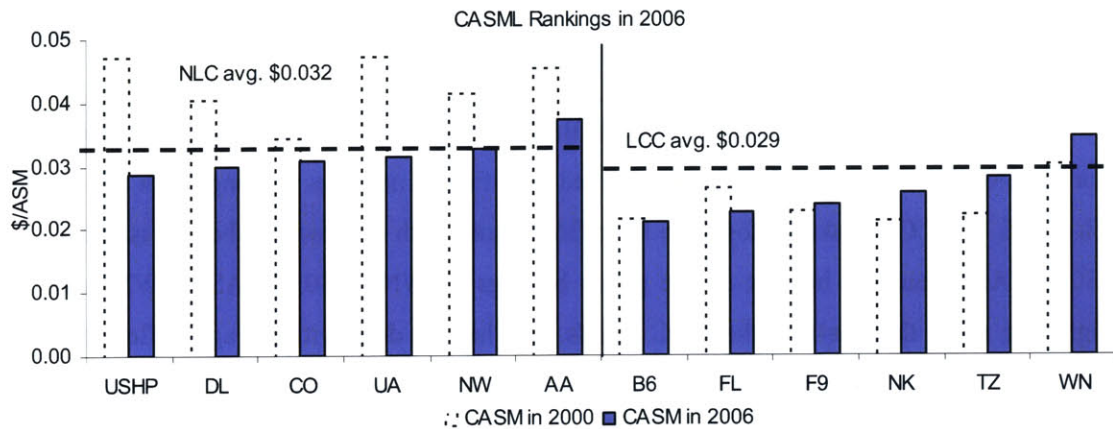


Figure 22 Labor CASM Rankings in 2006

*Non-Labor component*

The results for non-labor CASM are presented in Figure 23, Figure 24, Figure 25 and Figure 26. A first glance at these results shows that both groups of carriers have for the most part managed to reduce their non-labor CASM between 2001 and 2006.

The Legacy group has managed to reduce these costs by an average of 9%. AA has made the most improvements achieving a 28% reduction while NW was the only Legacy carrier to see an increase (of 5%). The single most important factor that contributed to these improvements is likely to be the development of the airlines' more advanced information technology systems and the emergence of internet-based operations. In absolute terms, the Legacy group had average non-labor costs of \$0.044\$/ASM in 2006 with AA leading the group at \$0.040 and NW trailing the most at \$0.048/ASM.

During the same period LCCs also managed to reduce their non-labor costs by an average of 5%. F9 was the most successful achieving a 27% reduction while NK was disproportionately inefficient enduring a 27% increase. In 2006, the LCCs had an average non-labor CASM of \$0.034/ASM which is still a clear advantage of 1 cent/ASM when compared to their Legacy rivals. However, similarly to the results for labor CASM, the difference here is also converging. In fact in the case of NK, it had the highest non-labor CASM of all the airlines, surpassing even the Legacy carriers. On the other hand the most successful airline at keeping its non-labor CASM low is WN. The airline's results stand out from its peers as it is the only one to have labor costs at a higher level than non-labor costs in 2006. We can see that during the 2001-2006 period, although WN was struggling with increasing labor costs as we saw in the previous section, it did a tremendous job in reducing its non-labor costs. As a result the airline's CASM<sub>exTF</sub> has remained almost constant.

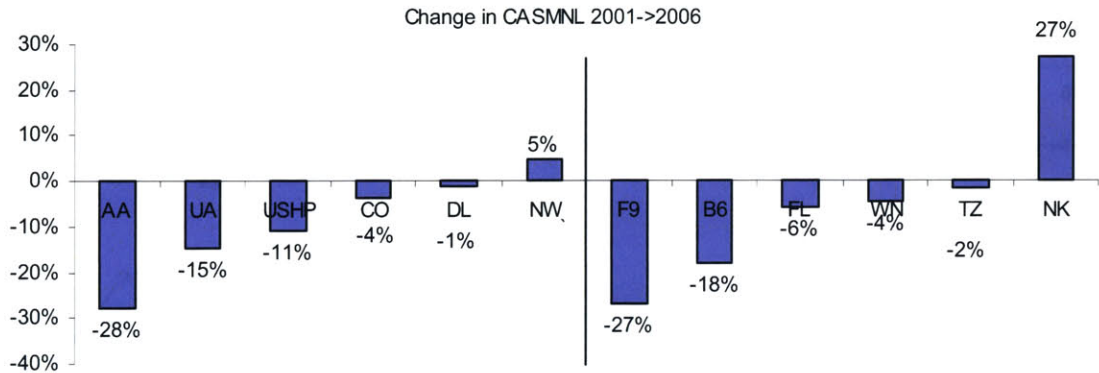


Figure 23 Change in non-Labor CASM 2001->2006

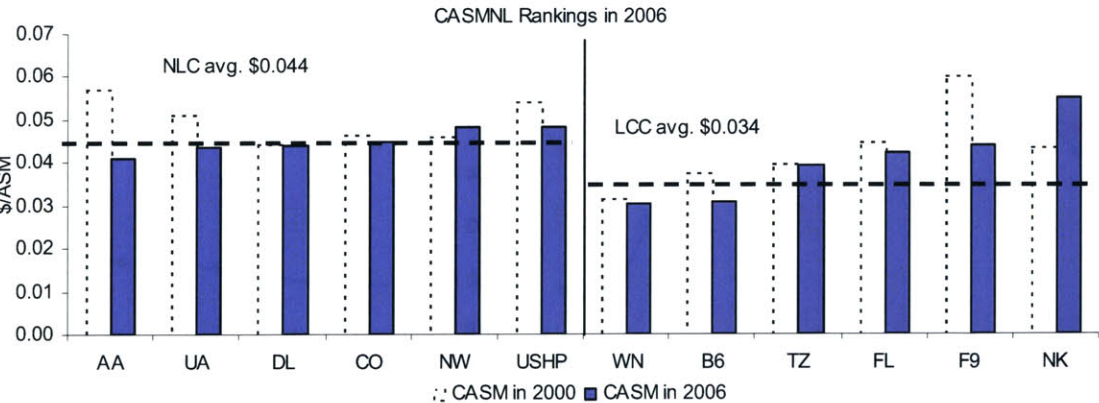


Figure 24 Non-Labor CASM Rankings in 2006



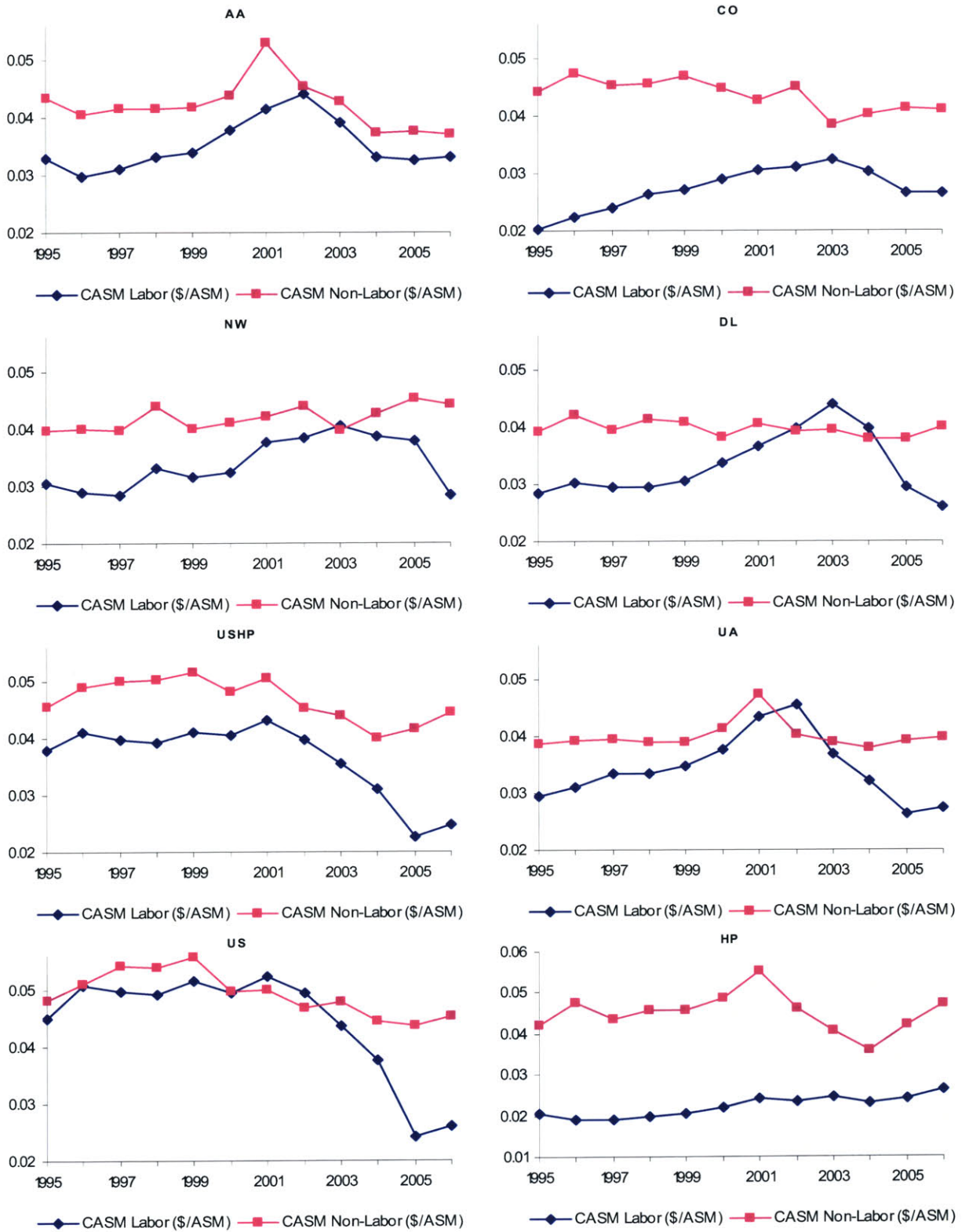


Figure 25 By-carrier analysis: NLC labor & non-labor CASM

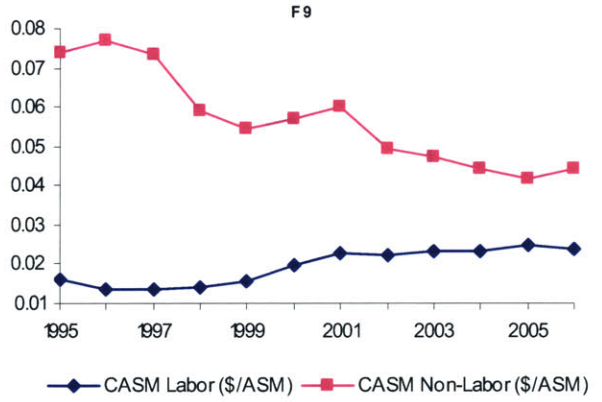
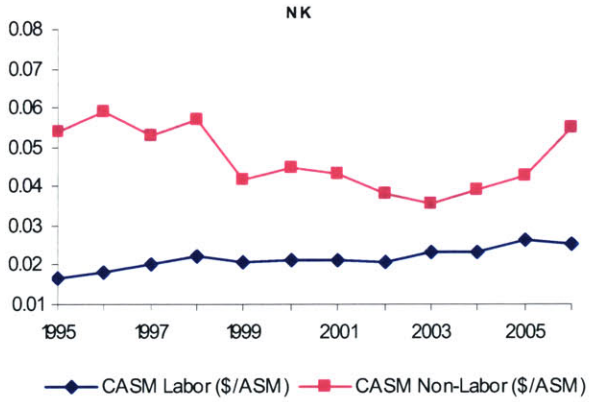
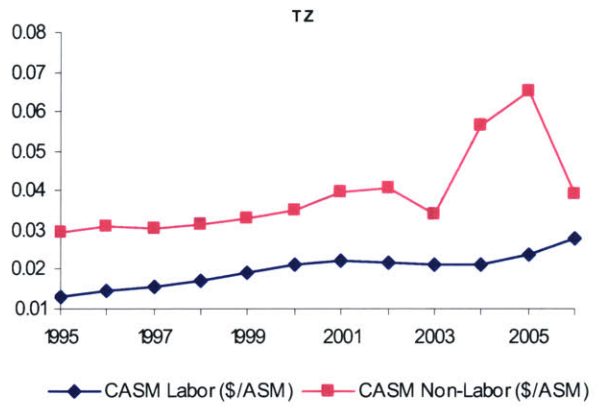
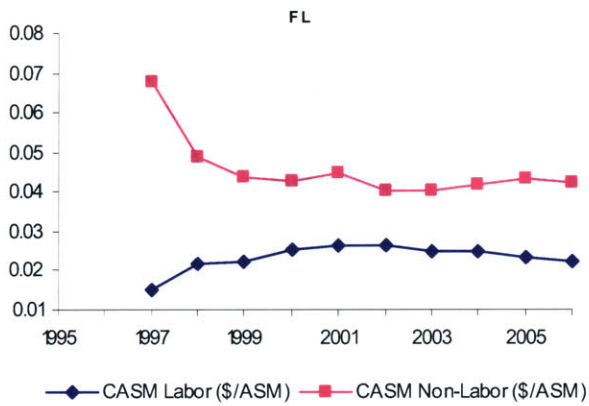
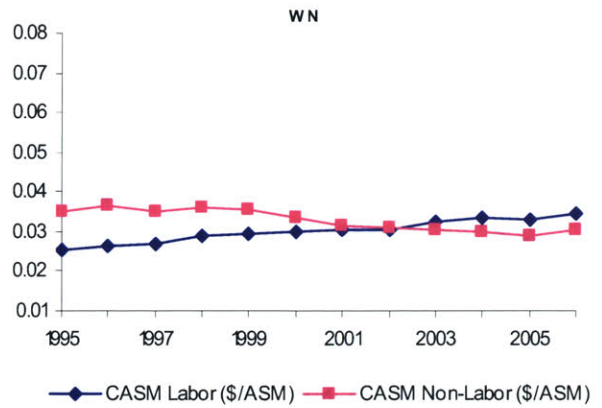
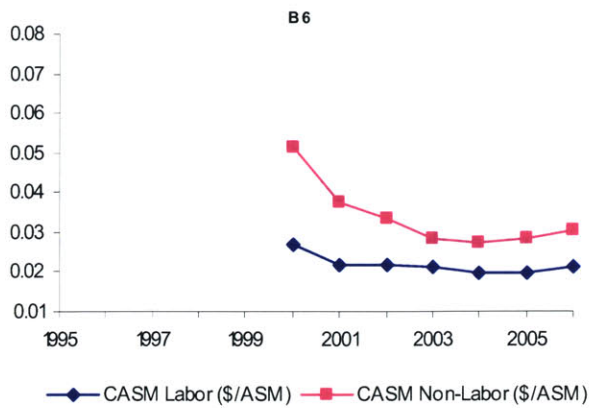


Figure 26 By-carrier analysis: LCC labor & non-labor CASM

#### 4.2.6. Summary of Cost-Performance Results

Table 9 summarizes our findings by establishing rankings (numbers in **bold**) and unit cost values (numbers in *italic*) based on the cost performances analyzed in this Chapter. The columns report rankings by cost category and the rows report an airline's performance across each category. For example looking at the first row we see that AA was first among all Legacy carriers in CASM and CASMNL and it was also first at reducing these two categories from 2001 to 2006. If we concentrate on the first column we see that AA was first in total CASM, UA was second, then CO, NW, DL and finally USHP.

	Standings in 2006 ( <b>Rank</b> and <i>\$/ASM</i> )				Biggest improvements 2001->2006			
	<b>CASM</b>	<b>CASMexTF</b>	<b>CASML</b>	<b>CASMNL</b>	<b>CASM</b>	<b>CASMexTF</b>	<b>CASML</b>	<b>CASMNL</b>
<b>AA</b>	<b>1</b> <i>0.125</i>	<b>5</b> <i>0.078</i>	<b>6</b> <i>0.037</i>	<b>1</b> <i>0.041</i>	<b>1</b> 4.9%	<b>3</b> -23.6%	<b>5</b> -18.3%	<b>1</b> -27.8%
<b>CO</b>	<b>3</b> <i>0.135</i>	<b>3</b> <i>0.076</i>	<b>3</b> <i>0.031</i>	<b>4</b> <i>0.045</i>	<b>5</b> 35.1%	<b>6</b> -6.7%	<b>6</b> -11.1%	<b>4</b> -3.5%
<b>DL</b>	<b>5</b> <i>0.138</i>	<b>1</b> <i>0.074</i>	<b>2</b> <i>0.030</i>	<b>3</b> <i>0.044</i>	<b>6</b> 38.0%	<b>4</b> -13.1%	<b>3</b> -25.9%	<b>5</b> -1.3%
<b>NW</b>	<b>4</b> <i>0.137</i>	<b>6</b> <i>0.081</i>	<b>5</b> <i>0.032</i>	<b>5</b> <i>0.048</i>	<b>4</b> 30.3%	<b>5</b> -7.8%	<b>4</b> -21.8%	<b>6</b> 4.9%
<b>UA</b>	<b>2</b> <i>0.132</i>	<b>2</b> <i>0.075</i>	<b>4</b> <i>0.031</i>	<b>2</b> <i>0.044</i>	<b>2</b> 9.7%	<b>2</b> -23.8%	<b>2</b> -33.4%	<b>2</b> -14.8%
<b>USHP</b>	<b>6</b> <i>0.146</i>	<b>4</b> <i>0.077</i>	<b>1</b> <i>0.029</i>	<b>6</b> <i>0.048</i>	<b>3</b> 14.5%	<b>1</b> -24.0%	<b>1</b> -39.1%	<b>3</b> -10.9%
<b>B6</b>	<b>1</b> <i>0.079</i>	<b>1</b> <i>0.052</i>	<b>1</b> <i>0.021</i>	<b>2</b> <i>0.031</i>	<b>2</b> 14.2%	<b>2</b> -12.3%	<b>2</b> -2.1%	<b>2</b> -18.3%
<b>F9</b>	<b>6</b> <i>0.109</i>	<b>5</b> <i>0.068</i>	<b>3</b> <i>0.024</i>	<b>5</b> <i>0.044</i>	<b>3</b> 14.4%	<b>1</b> -18.5%	<b>3</b> 3.5%	<b>1</b> -26.9%
<b>FL</b>	<b>4</b> <i>0.097</i>	<b>2</b> <i>0.065</i>	<b>2</b> <i>0.022</i>	<b>4</b> <i>0.042</i>	<b>1</b> 4.9%	<b>3</b> -9.4%	<b>1</b> -15.2%	<b>3</b> -5.9%
<b>NK</b>	<b>5</b> <i>0.104</i>	<b>6</b> <i>0.081</i>	<b>4</b> <i>0.026</i>	<b>6</b> <i>0.055</i>	<b>6</b> 30.3%	<b>6</b> 24.7%	<b>5</b> 20.1%	<b>6</b> 26.9%
<b>TZ</b>	<b>3</b> <i>0.097</i>	<b>4</b> <i>0.067</i>	<b>5</b> <i>0.028</i>	<b>3</b> <i>0.039</i>	<b>5</b> 24.9%	<b>5</b> 8.3%	<b>6</b> 26.0%	<b>5</b> -1.7%
<b>WN</b>	<b>2</b> <i>0.088</i>	<b>3</b> <i>0.065</i>	<b>6</b> <i>0.034</i>	<b>1</b> <i>0.030</i>	<b>4</b> 16.9%	<b>4</b> 4.6%	<b>4</b> 14.1%	<b>4</b> -4.5%

Table 9 Non-Stage-Length adjusted Cost Performance Rankings in 2006



### 4.3. Stage Length Adjusted Unit Costs

#### 4.3.1. Unit Costs vs. Stage Length (2000 -> 2006)

As explained in the literature review and methodology Chapters, stage length has historically played an important role in the airlines' strategic decision-making process. Theoretical expectations and empirical results suggest that increasing stage length lowers unit costs. The Figures in the next two pages (Figure 27, Figure 28, Figure 29 and Figure 30) show just how active all airlines have been in pursuing this idea. We plot unit costs vs. stage length in 2000 and 2006 and to illustrate the change between these two years we draw a vector originating in the year 2000 and ending in 2006. In all these Figures, it is clear that all airlines have been very active in increasing their stage length from 2000 to 2006.

##### *Total CASM (Figure 27)*

Contrary to expectations, the increase in stage length did not lead to a decrease in total CASM, with the exception of B6. Furthermore we can see a clear difference between Legacy carriers (blue arrows) being well above and with a higher stage length than the LCCs (pink arrows).

##### *CASM<sub>exTF</sub> (Figure 28)*

The trends in CASM<sub>exTF</sub> are almost uniform across the industry. With the exception of TZ and NK, all airlines have managed to decrease their CASM<sub>exTF</sub> while increasing stage length. This is in line with the theoretical expectations and empirical results.

##### *Labor CASM (Figure 29) and non-labor CASM (Figure 30)*

While the Legacy carriers' labor cost-cutting initiatives are clearly reflected by the downward pointing vectors, LCCs have had mixed results. Among the LCCs, only B6 and FL have managed to decrease their labor CASM. The trends for non-labor CASM are also mixed with the most successful cases being USHP for the Legacies, and B6 for the LCCs. In general we would expect labor CASM to increase with stage length. The reason is that usually higher stage length increases ASMs faster than the requirement in labor to achieve this change, which pushes productivity upward. We can see that this is clearly the case in Figure 29. On the other hand there are many more factors that are included in non-labor CASM and the effect is not expected to be as direct. Figure 30 shows this trend as we obtain a mixed set of results.

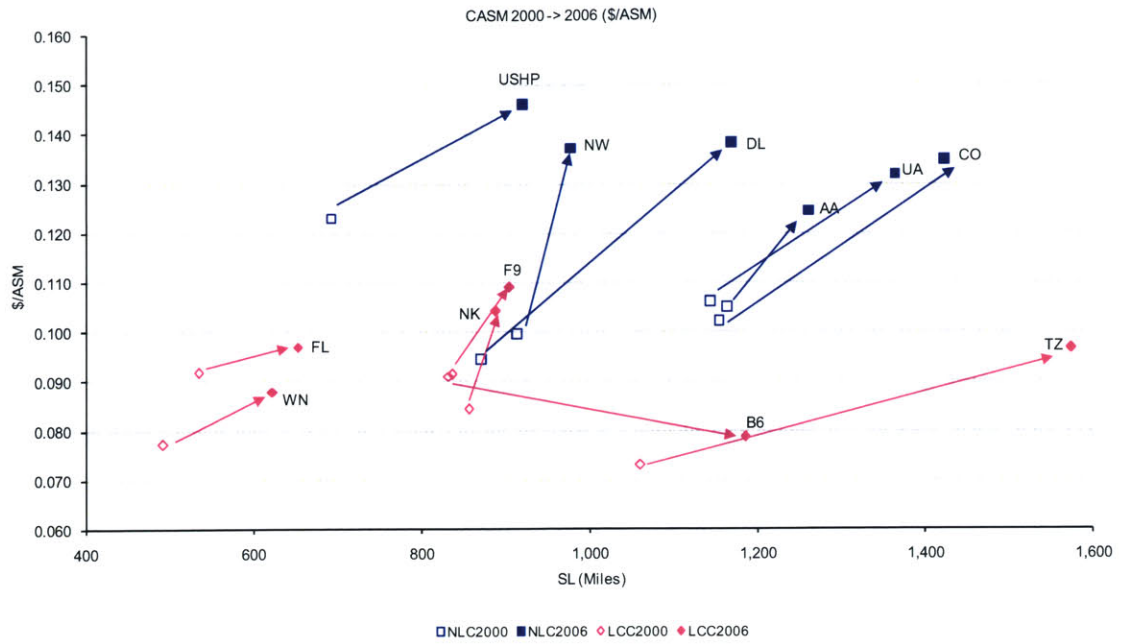


Figure 27 Total CASM vs. Stage Length

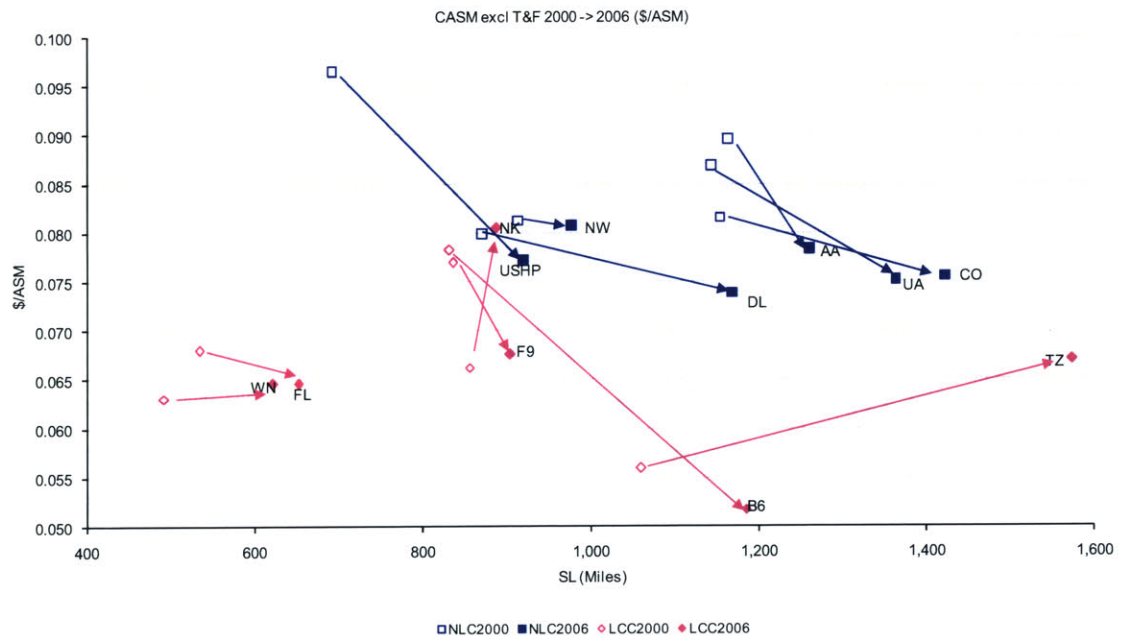


Figure 28 CASM<sub>excl T&F</sub> vs. Stage Length

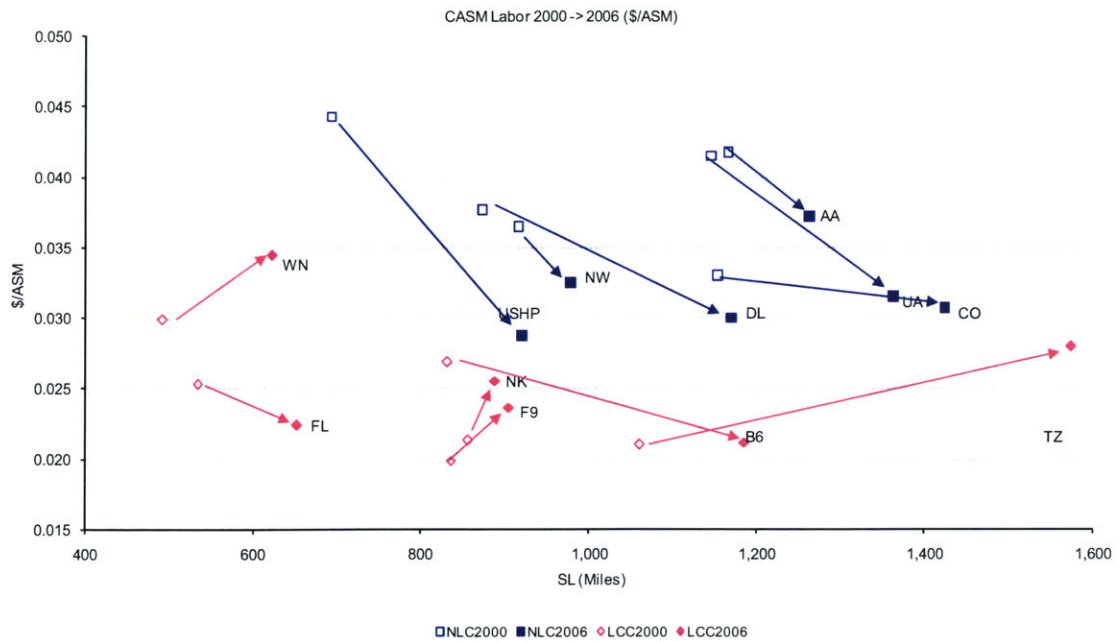


Figure 29 Labor CASM vs. Stage Length

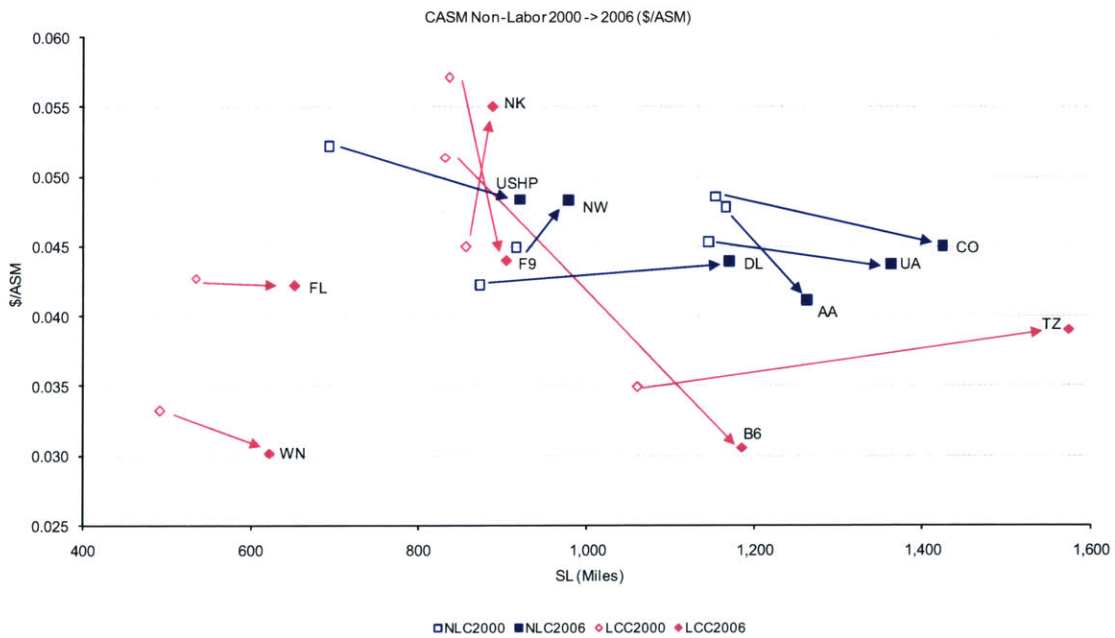


Figure 30 Non-labor CASM vs. Stage Length

### 4.3.2. Stage Length Regressions

In this section we conduct linear and log-linear regressions of unit costs against stage length to identify its importance in the 2006 results.

Regression	Group	STDEVY	STDEVX	Slope	stdError	stdErSlope	t-stat	Intercept	correl	R <sup>2</sup>
CASM vs. SL	NLC	0.007	203.9	-0.000024	0.006	0.00001	-1.83	0.163	-0.67	0.46
	LCC	0.011	358.9	-0.000004	0.012	0.00002	-0.25	0.099	-0.12	0.02
CASM <sub>e</sub> T vs. SL	NLC	0.005	203.9	-0.000014	0.004	0.00001	-1.50	0.126	-0.60	0.36
	LCC	0.009	358.9	-0.000003	0.010	0.00001	-0.21	0.096	-0.11	0.01
CASM <sub>e</sub> F vs. SL	NLC	0.008	203.9	-0.000015	0.008	0.00002	-0.92	0.121	-0.42	0.18
	LCC	0.010	358.9	-0.000005	0.011	0.00001	-0.39	0.073	-0.19	0.04
CASM <sub>e</sub> TF vs. SL	NLC	0.002	203.9	-0.000006	0.002	0.00001	-1.23	0.084	-0.52	0.27
	LCC	0.009	358.9	-0.000004	0.010	0.00001	-0.35	0.070	-0.17	0.03
CASML vs. SL	NLC	0.003	203.9	0.000004	0.003	0.00001	0.54	0.027	0.26	0.07
	LCC	0.005	358.9	-0.000002	0.005	0.00001	-0.34	0.028	-0.17	0.03
CASML vs. SL	NLC	0.003	203.9	-0.000010	0.002	0.00000	-2.12	0.057	-0.73	0.53
	LCC	0.009	358.9	-0.000002	0.010	0.00001	-0.17	0.042	-0.08	0.01

Table 10 Linear regression: Unit Costs vs. Stage Length 2006

Regression	Group	STDEVY	STDEVX	Slope	stdError	stdErSlope	t-stat	Intercept	correl	R <sup>2</sup>
CASM vs. SL	NLC	0.053	0.177	-0.204	0.043	0.108	-1.89	-0.562	-0.69	0.47
	LCC	0.119	0.354	-0.035	0.132	0.167	-0.21	-2.118	-0.10	0.01
CASM <sub>e</sub> T vs. SL	NLC	0.044	0.177	-0.146	0.039	0.099	-1.47	-1.181	-0.59	0.35
	LCC	0.103	0.354	-0.033	0.115	0.145	-0.23	-2.147	-0.11	0.01
CASM <sub>e</sub> F vs. SL	NLC	0.073	0.177	-0.178	0.073	0.185	-0.96	-1.018	-0.43	0.19
	LCC	0.156	0.354	-0.075	0.172	0.218	-0.35	-2.186	-0.17	0.03
CASM <sub>e</sub> TF vs. SL	NLC	0.032	0.177	-0.094	0.030	0.076	-1.23	-1.904	-0.53	0.28
	LCC	0.141	0.354	-0.073	0.155	0.197	-0.37	-2.225	-0.18	0.03
CASML vs. SL	NLC	0.089	0.177	0.152	0.095	0.240	0.63	-4.524	0.30	0.09
	LCC	0.177	0.354	-0.112	0.192	0.243	-0.46	-2.901	-0.22	0.05
CASML vs. SL	NLC	0.063	0.177	-0.263	0.047	0.118	-2.23	-1.241	-0.74	0.55
	LCC	0.229	0.354	-0.004	0.256	0.324	-0.01	-3.209	-0.01	0.00

Table 11 Log-linear regression: Unit Costs vs. Stage Length 2006

The regression results in Table 10 and Table 11 indicate that stage length does not play a statistically significant role in the CASM distribution in 2006. Although all slopes except for NLC CASML (labor CASM) have a negative sign, only NLC total CASM and NLC non-labor

CASM are significant (at the 90% confidence level). These results are illustrated in Figure 31 and Figure 32.

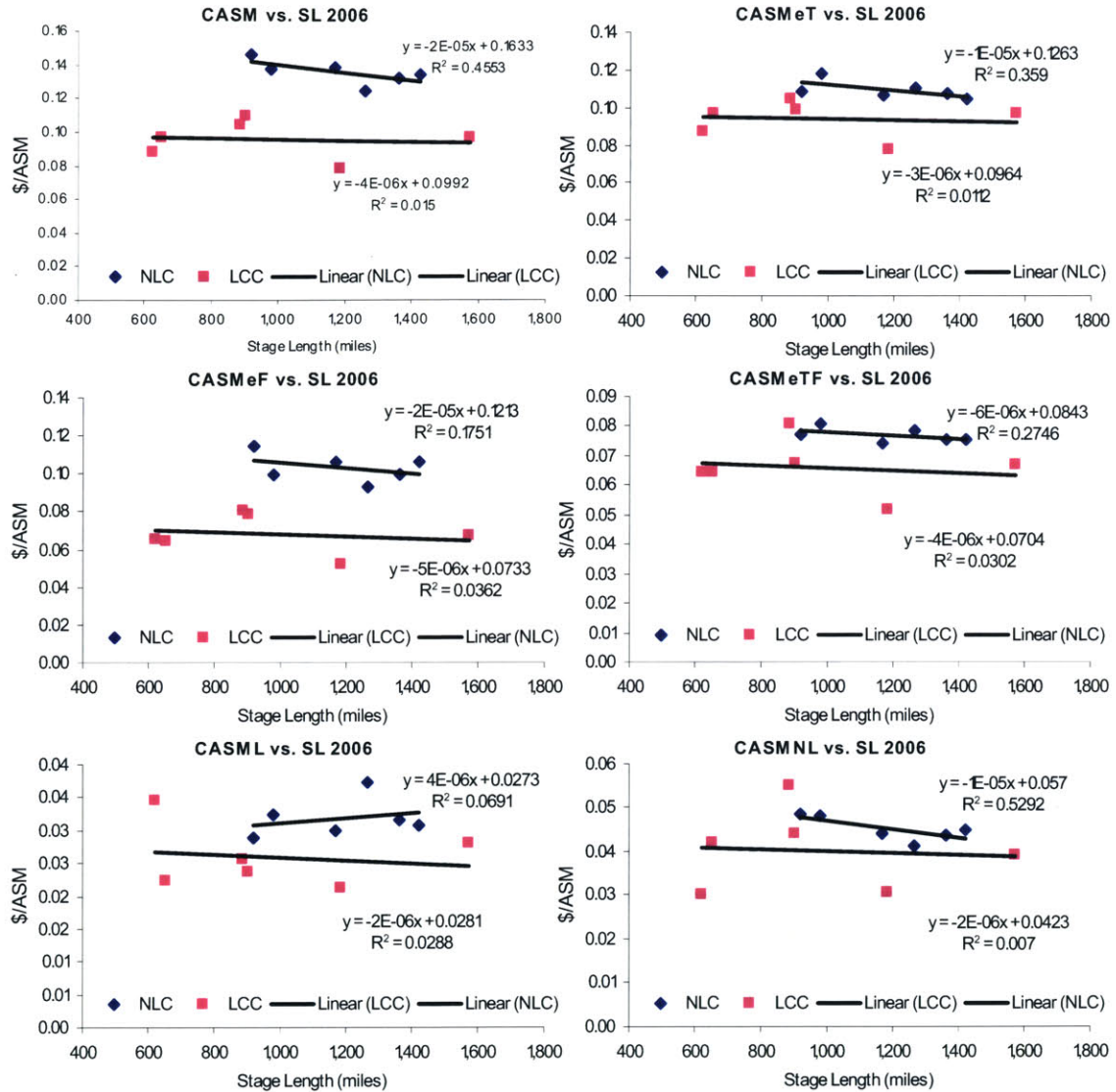
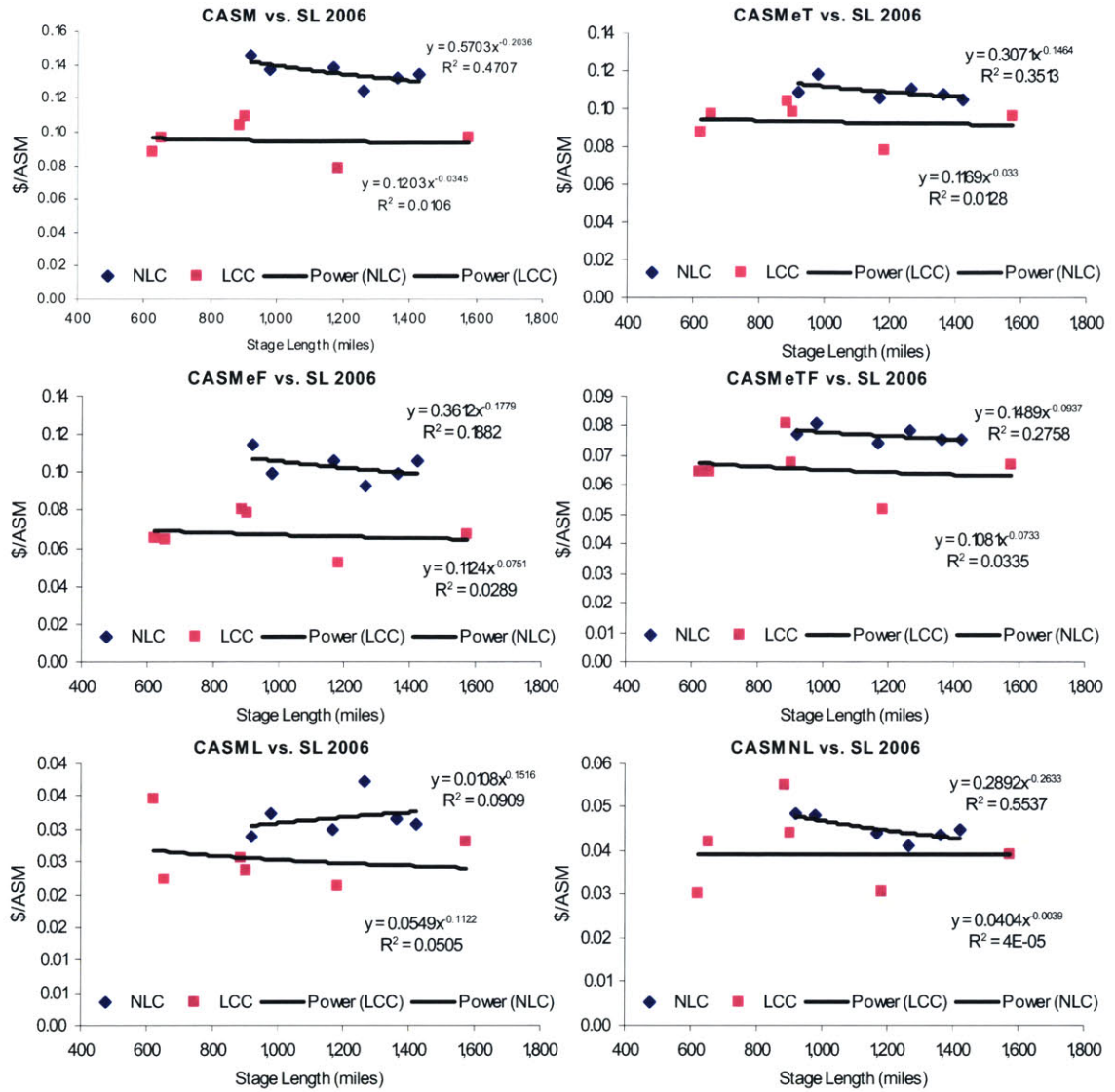


Figure 31 Linear regression: Unit Costs vs. Stage Length 2006





**Figure 32 Log-linear regression: Unit Costs vs. Stage Length 2006**

The results from Figure 31 and Figure 32 show that stage length has not played an important role in driving CASM in 2006. This result goes against empirical evidence suggesting that there has been a fundamental shift in the underlying drivers of unit costs in 2006. Given the analysis from the previous sections we know that fuel and transport-related expenses have been a big part of this change.

### 4.3.3. Stage Length Adjusted results

We utilize the results from the log-linear regression and the method explained in 3.7. to report stage length adjusted results in Table 12 and Table 13 (shaded in grey). However throughout this section we must keep in mind that some of our regressions were not statistically significant, effectively placing a limit on the interpretation we can give to the results.

CASM					CASMeT					CASMeTF				
Regr.:	coeff	intr			Regr.:	coeff	intr			Regr.:	coeff	intr		
	-0.2	0.6				-0.1	0.3				-0.1	0.1		
	Raw	Trend	diff	Adj.		Raw	Trend	diff	Adj.		Raw	Trend	diff	Adj.
AA	0.12	0.13	-6.5%	0.1262	AA	0.12	0.11	15.4%	0.1257	DL	0.07	0.08	-3.7%	0.0739
NW	0.14	0.14	-2.1%	0.1321	NW	0.14	0.11	22.5%	0.1335	USHP	0.08	0.08	-1.8%	0.0753
UA	0.13	0.13	0.6%	0.1358	UA	0.13	0.11	23.6%	0.1347	UA	0.08	0.08	-0.7%	0.0762
DL	0.14	0.14	2.0%	0.1376	DL	0.14	0.11	26.4%	0.1377	CO	0.08	0.08	0.3%	0.0770
USHP	0.15	0.14	2.8%	0.1386	CO	0.13	0.11	26.9%	0.1382	AA	0.08	0.08	2.7%	0.0788
CO	0.13	0.13	3.5%	0.1397	USHP	0.15	0.11	29.1%	0.1407	NW	0.08	0.08	3.4%	0.0793

CASML					CASMNL				
Regr.:	coeff	intr			Regr.:	coeff	intr		
	0.2	0.01				-0.3	0.3		
	Raw	Trend	diff	Adj.		Raw	Trend	diff	Adj.
CO	0.03	0.03	-5.9%	0.0298	AA	0.04	0.04	-6.8%	0.0418
USHP	0.03	0.03	-5.9%	0.0298	DL	0.04	0.05	-2.4%	0.0438
DL	0.03	0.03	-5.1%	0.0301	USHP	0.05	0.05	1.0%	0.0453
UA	0.03	0.03	-2.8%	0.0308	UA	0.04	0.04	1.1%	0.0453
NW	0.03	0.03	5.5%	0.0335	NW	0.05	0.05	2.3%	0.0459
AA	0.04	0.03	16.1%	0.0368	CO	0.04	0.04	5.2%	0.0472

Table 12 Stage length adjusted NLC Unit-Costs (log-linear regression method)

CASM					CASMeT					CASMeTF				
Regr.:	coeff	intr			Regr.:	coeff	intr			Regr.:	coeff	intr		
	-0.03	0.12				-0.03	0.12				-0.07	0.11		
	Raw	Trend	diff	Adj.		Raw	Trend	diff	Adj.		Raw	Trend	diff	Adj.
B6	0.08	0.09	-16.6%	0.0791	B6	0.08	0.09	-15.6%	0.0786	B6	0.05	0.06	-19.5%	0.0526
WN	0.09	0.10	-8.8%	0.0865	WN	0.09	0.09	-7.2%	0.0864	WN	0.06	0.07	-4.1%	0.0626
FL	0.10	0.10	0.9%	0.0957	FL	0.10	0.09	2.8%	0.0958	FL	0.06	0.07	-3.8%	0.0628
TZ	0.10	0.09	3.6%	0.0982	TZ	0.10	0.09	5.4%	0.0982	F9	0.07	0.07	3.1%	0.0673
NK	0.10	0.10	9.6%	0.1039	F9	0.10	0.09	5.5%	0.0982	TZ	0.07	0.06	6.4%	0.0695
F9	0.11	0.10	14.7%	0.1088	NK	0.10	0.09	11.6%	0.1040	NK	0.08	0.07	22.7%	0.0801

CASML					CASMNL				
Regr.:	coeff	intr			Regr.:	coeff	intr		
	-0.11	0.05				0.00	0.04		
	Raw	Trend	diff	Adj.		Raw	Trend	diff	Adj.
FL	0.02	0.03	-15.5%	0.0215	WN	0.03	0.04	-23.3%	0.0302
B6	0.02	0.02	-14.7%	0.0217	B6	0.03	0.04	-22.1%	0.0306
F9	0.02	0.03	-7.5%	0.0235	TZ	0.04	0.04	-0.4%	0.0392
NK	0.03	0.03	-0.3%	0.0253	FL	0.04	0.04	7.2%	0.0422
TZ	0.03	0.02	16.3%	0.0295	F9	0.04	0.04	11.8%	0.0440
WN	0.03	0.03	29.2%	0.0328	NK	0.06	0.04	40.0%	0.0550

Table 13 Stage length adjusted LCC Unit-Costs (log-linear regression method)

We then compare these numbers to the rankings summary presented in section 4.2.6. and obtain the results in Table 14.

		Adjusted (in black) and non-adjusted (in grey) rankings in 2006				
		CASM	CASMeT	CASMeTF	CASML	CASMLNL
AA		1	1	5	6	1
CO		6	6	4	1	6
DL		4	4	1	3	2
NW		2	2	6	5	5
UA		3	3	3	4	4
USHP		5	5	2	2	3
B6		1	1	1	2	2
F9		5	5	4	3	5
FL		3	3	3	1	4
NK		6	6	6	4	6
TZ		4	4	5	5	3
WN		2	2	2	6	1

Table 14 Stage length adjusted and non-adjusted unit cost rankings in 2006

We can see that there are certain differences between the adjusted and non-adjusted results. In particular, CO and FL jump to first place in the labor CASM category. Looking at composite scores we find that overall AA and DL are the most cost-efficient Legacy carriers while NW is the one with the most difficulties. This result is quite different from the non-adjusted numbers which had UA in first place. On the LCC side, adjusted rankings have B6 leading the pack while WN came in second replacing FL. While these results are more inline with what we could have expected (especially on the LCC side), we have to keep in mind that the lack of enough statistical significance for some of our results make further interpretations difficult.



#### **4.4. Detailed Fleet-Level Cost Comparison**

This section represents the last step in the increasing level of detail of our analysis for this Chapter. In this section we examine the impact of fleet type on unit costs. More precisely we break down each unit cost category into a wide body (large aircraft) and a narrow body (smaller aircraft) component. As explained in Chapters 2 and 3, this analysis is motivated by the fact aircraft size plays a crucial role in determining an airline's unit costs (both on the labor and the non-labor component). Our goal here is to quantify this role and to examine to what extent flying larger aircraft leads to lower unit costs, as is the case theoretically. We analyze total CASM, CASM excluding fuel ( $CASM_{exF}$ ), labor CASM and non-labor CASM. The unit cost category of CASM excluding transport-related expenses is incompatible with our analysis here because these types of expenses cannot be reported at the aircraft level. Furthermore, since LCCs do not generally use wide-body aircraft we only report their narrow-body results. As in previous sections, the analysis is first done on an aggregate level and then on a carrier-by-carrier basis.

##### **4.4.1. Aggregate Analysis: Legacy vs. LCC Comparison of Narrow-Body Fleets**

In Figure 33 we compare Legacy and LCC unit costs for narrow-body aircraft. The graphs thus show how cost efficient each group has been at flying their small aircraft mainly in the domestic markets (as narrow-bodies are typically used for domestic flying).

Total CASM has increased in several stages since 1995 and both groups experienced a significant increase during the period: Legacies had a 60% increase while LCCs had a 70% increase. The most important result here is that Legacy carriers' CASM has been on average around 0.5 cents per ASM higher than the LCCs. This would mean that typically a Legacy carrier cannot compete with LCCs on the cost-side in domestic markets where narrow-body aircraft are used. It is also interesting to notice how highly correlated both curves are with a correlation coefficient of 94.2% suggesting that their CASM is subject to the same kind of underlying forces. The explanation of this cost-differential can be further understood by looking at the other 3 unit cost categories.

Removing fuel expenses from total CASM we have an entirely different story: Legacy carriers exhibit a strong decrease in unit costs starting from 2002 while LCCs continued a steady but slow increase throughout the period. The cost gap between both groups went from 1.3 cents in

2001 to 0.9 cents in 2006, resulting in a clear convergence. Fuel has thus impacted both groups very differently in the sense that Legacy carriers have had to pay much higher consequences. This result can be explained by the fact that Legacy carriers tend to fly older narrow-body airplanes which are less fuel efficient but also because of Southwest's hedging strategies which make it almost immune to oil price fluctuations.

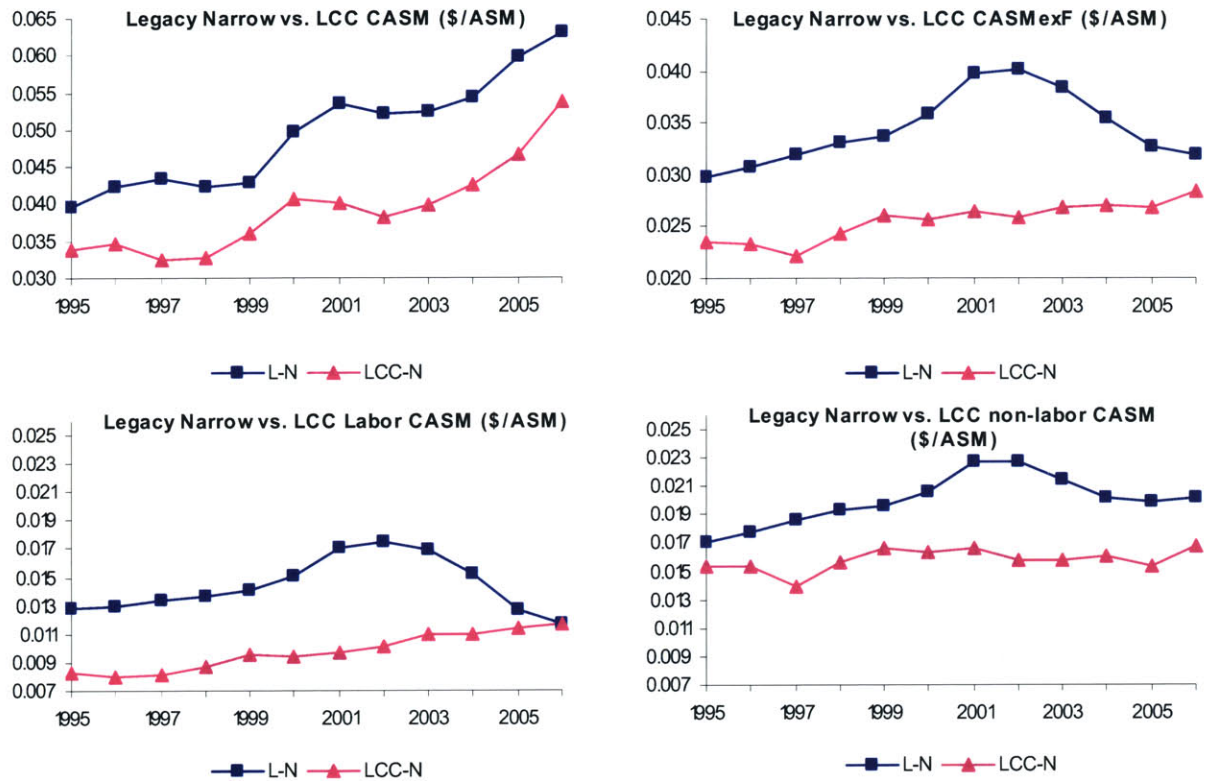


Figure 33 Aggregate fleet analysis: Legacy vs. LCC comparison

The Labor category in this section differs from the definitions we had in our non-fleet based analysis in that it only includes pilot and maintenance costs. Furthermore it does not include outsourced maintenance costs which have been increasing lately and so may distort the results. Despite this different definition, we see exactly the same trends emerge as in our previous analysis: Labor unit costs have dramatically converged between both groups and the labor gap has completely disappeared in 2006.

The results from non-Labor CASM show that LCCs have managed to retain a cost advantage in this category. The gap between both groups has varied throughout the period and

has slightly converged from its highest level at 0.8 cents/ASM in 2002 to 0.3 cents/ASM in 2006. So although LCCs still are more cost efficient in the non-labor category, they are losing ground.

The results from our Legacy vs. LCC narrow-body comparison show that LCCs have managed to retain a unit cost advantage however in the same time this advantage is shrinking. It is clear in our results that labor CASM and fuel expenses have again been the main drivers of convergence between both groups. We also find that non-labor CASM has recently started to converge possibly reflecting the changes in fleets i.e. the LCCs' aging aircraft and the acquisition of new aircraft from the Legacy carriers.

#### **4.4.2. Aggregate analysis: Legacy wide- vs. Narrow-Body Comparison**

In Figure 34 we compare Legacy carrier unit costs between wide-body and narrow-body aircraft. The results show that the wide-body fleet has on average a lower unit cost than the narrow body fleet across all cost categories. The two curves are also highly correlated (with correlation values above 70% for non-labor costs and above 90% for the other categories). These results are in line with our expectations and to some extent justify the carriers' decision to shift to international markets where wide-body aircraft cost advantages can be utilized.

Looking at individual unit cost categories, we see the same type of trends emerge as in the previous analysis. Total CASM has significantly gone up over the period, driven by fuel prices and the largest cost savings have been achieved in the labor category. The non-labor category started decreasing after 2002 reflecting once again the retiring of older aircraft (both wide and narrow-body) and the introduction of newer aircraft. In terms of cost differences between both fleet types, they range between 3 cents/ASM to 10 cents/ASM depending on the year. It is interesting to note that the largest difference in total CASM occurred in 2001 with wide-bodies being 1 cent/ASM lower than narrow-bodies and that this difference was gradually reduced to 0.3 cents/ASM by 2006. During the same period, the difference in ex-fuel CASM and non-labor CASM remained stable while labor costs were reduced more significantly in the narrow-body category. Although this could mean that domestic markets were more the focus of cost-cutting strategies it is also certainly due to increased outsourcing of maintenance costs since 2002.

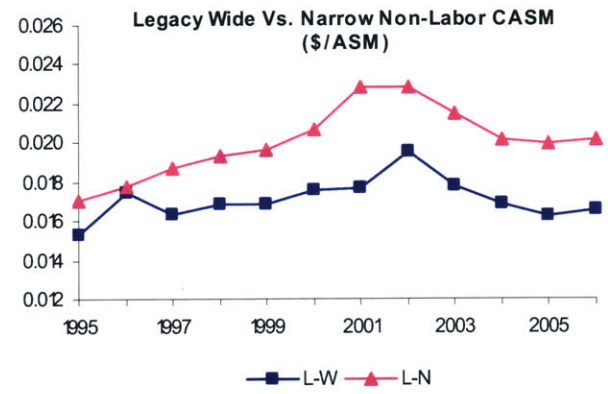
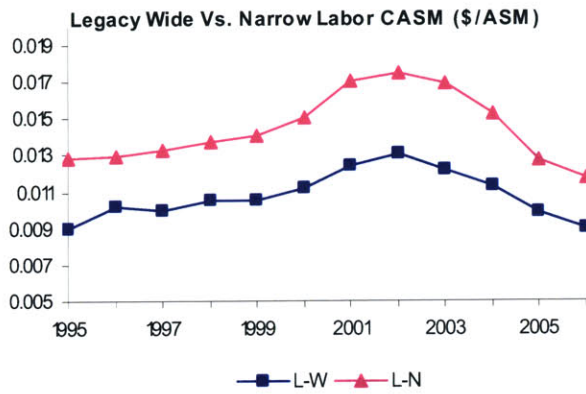
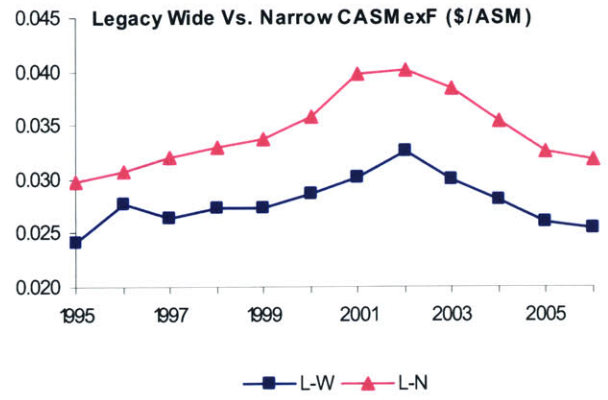
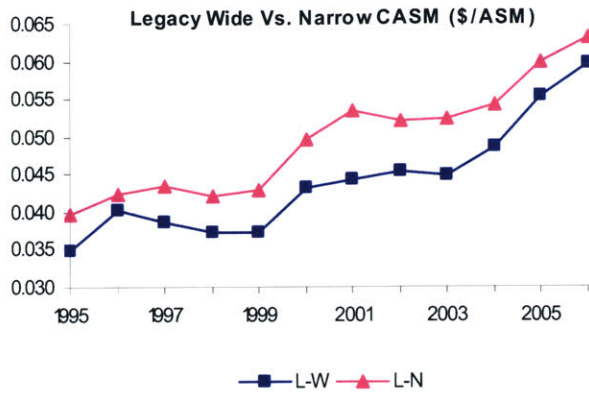


Figure 34 Aggregate fleet analysis: Legacy wide-body vs. narrow-body analysis

#### **4.4.3. By-carrier analysis: Comparison Across Time**

Looking at Legacy carriers in Figure 35 and Figure 36 we observe that their narrow-body aircraft tend to have higher unit costs than their wide-bodies. This result is thus as expected. There are several individual cases that are interesting to discuss.

The first is that of AA and NW. AA's wide and narrow-body unit costs are highly correlated to each other and are also very close in absolute value. This is also the case for NW with the difference that its narrow-body unit costs are below that of its wide-bodies. NW is the only Legacy carrier that exhibits this irregularity.

Continuing with our discussion we can see that UA also exhibits similar trends to AA. While its narrow-body costs were much higher than its wide-bodies historically, it has started to converge in the past 4 years. This period coincides with UA's bankruptcy during which it cut a large amount of its fleet shifting towards international routes. We can see the positive impact this had on its narrow-body unit costs.

The next two cases are DL and USHP. Both of these airlines have narrow-body costs that are significantly higher than their wide-body ones. This gap has remained stable over the past few years as both categories are growing at the same speed.

The last case is that of CO which stands out from its peers because it had a significant decrease in wide-body unit costs from 2000 to 2003. Being the first airline to shift its focus heavily towards international markets, we can see how effective these measures were at reducing CO's wide-body costs early before fuel prices surged and competition increased internationally.

When removing fuel-related expenses from CASM (Figure 37 and Figure 38), all Legacy carriers have narrow-body unit costs that are above wide-body unit costs in 2006. The trends observed here remain similar to the total CASM category and it is therefore not very interesting to analyze each carrier independently.

Looking at labor CASM in Figure 39 and Figure 40, we see that 4 of the 6 carriers exhibit very similar trends: These are AA, NW, DL and UA. For all of these carriers, the narrow body unit costs are above wide-body unit costs and both curves are highly correlated. The interesting

story is that of CO which has an unusually large gap between its narrow-body and large-body labor costs. Indeed, CO has the lowest labor wide-body costs of all carriers. Again, this shows us the impact of CO's strategy to fly internationally on the labor component of its wide-body fleet. Significant unit cost-gains are observable compared to the other carriers. Furthermore, USHP also stands out because it managed to dramatically decrease its wide-body unit costs over the last 4 years. Similarly DL and UA saw their wide-body labor unit costs decline also. These wide-body labor cost declines in the past few years are the result of the industry's shift towards international markets.

Similar to the labor unit costs, the non-labor trends in Figure 41 and Figure 42 have been driven by the shift to international flying. Of the group, USHP seems to be the most successful at keeping its wide-body non-labor costs down. An interesting fact is that the group as a whole doesn't seem to be reducing its non-labor wide-body CASM as much as its labor part. For the most part, non-labor CASM has remained stable during the last 4 years with the exception of CO which again was the first to shift into serious international flying.

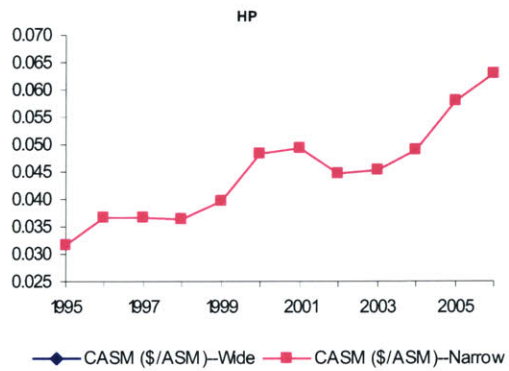
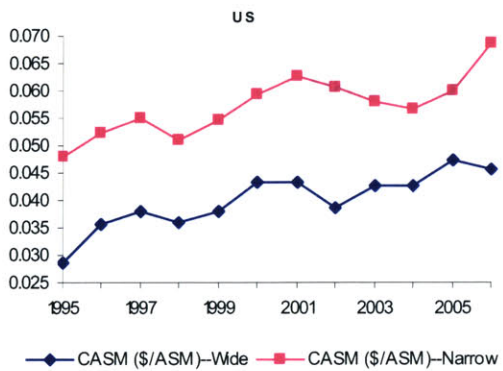
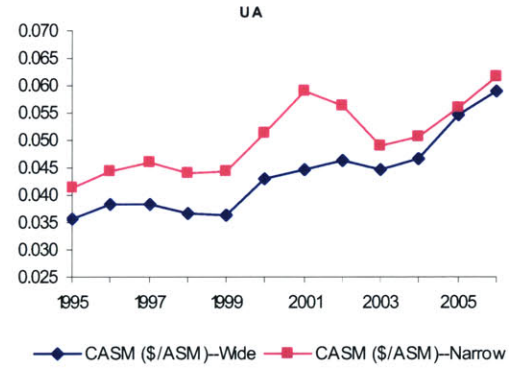
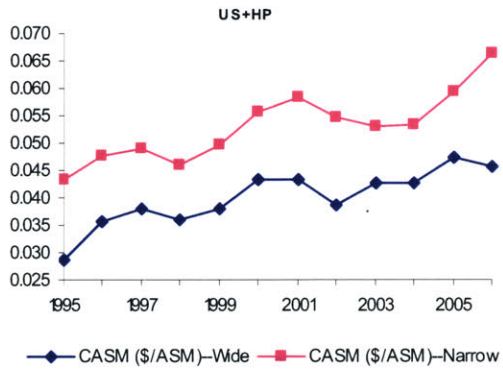
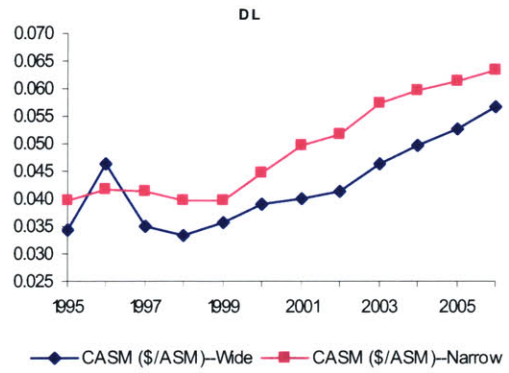
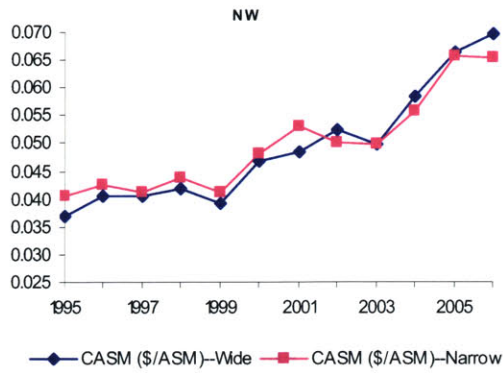
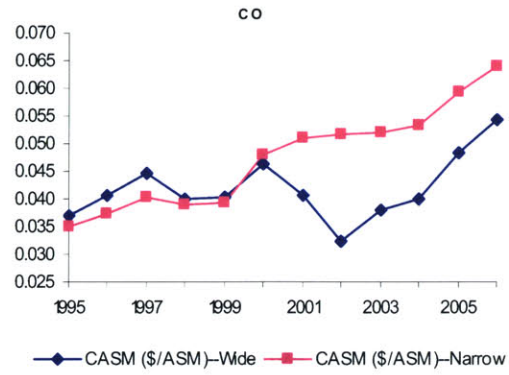
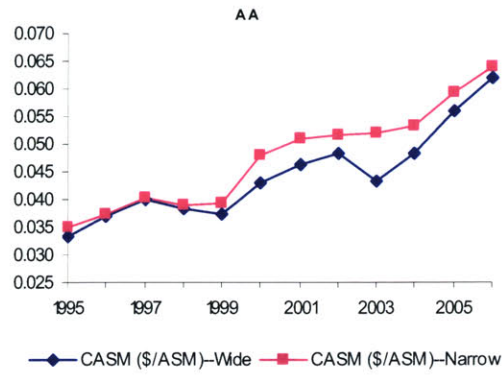


Figure 35 Fleet detail Analysis: NLC total CASM

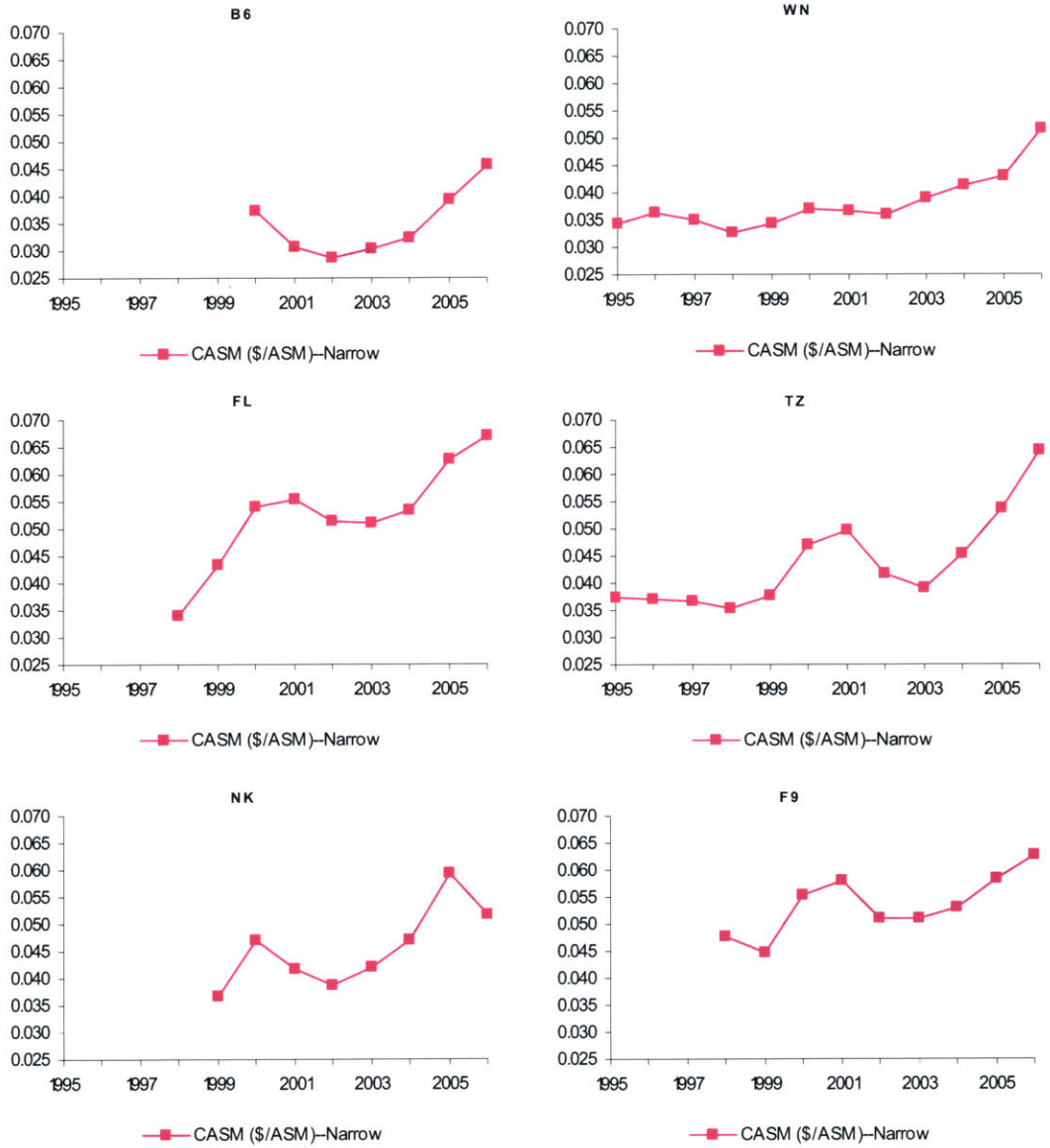


Figure 36 Fleet detail Analysis: LCC total CASM



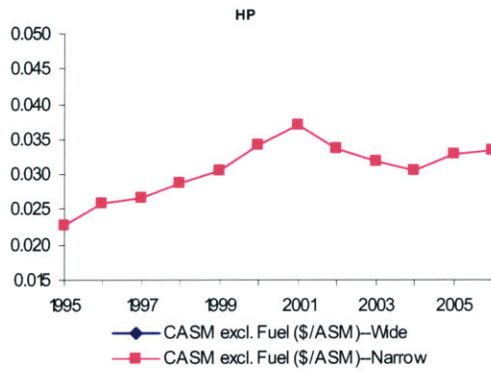
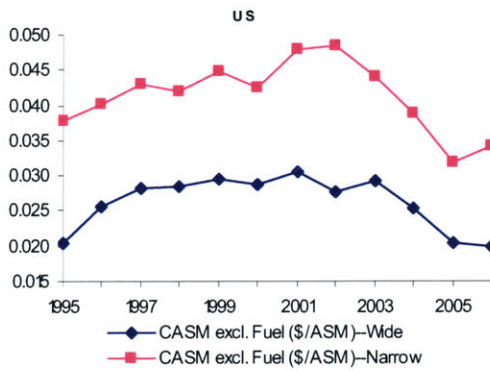
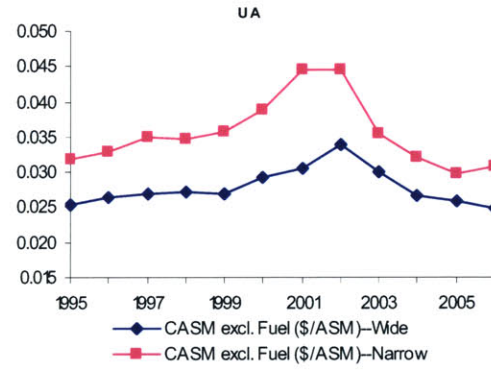
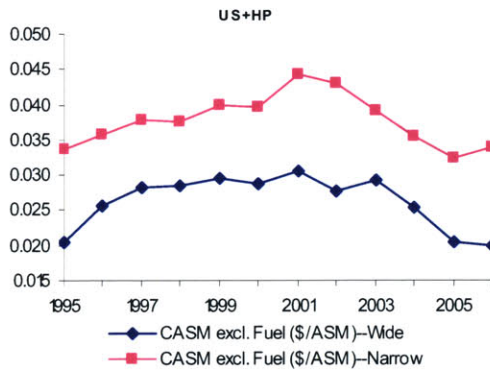
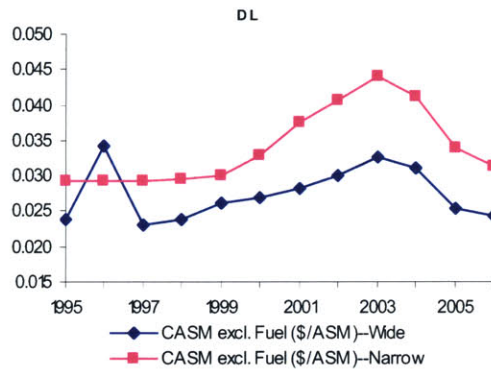
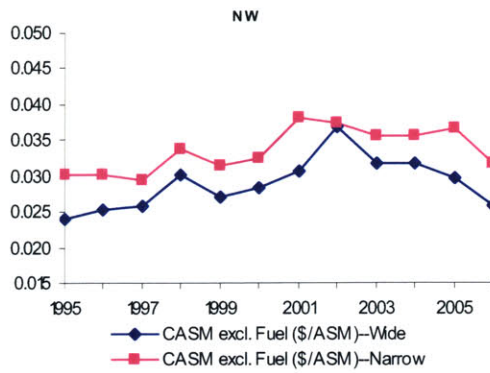
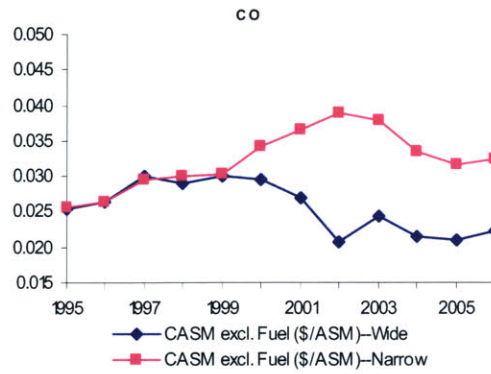
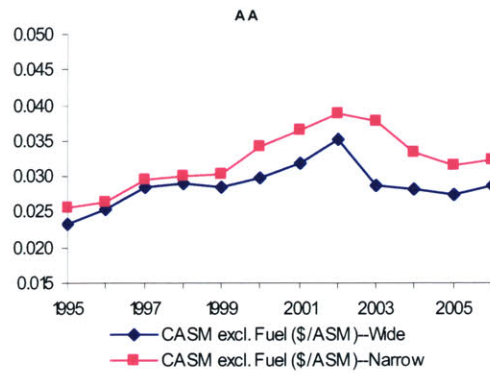


Figure 37 Fleet detail Analysis: NLC CASM excl. Fuel

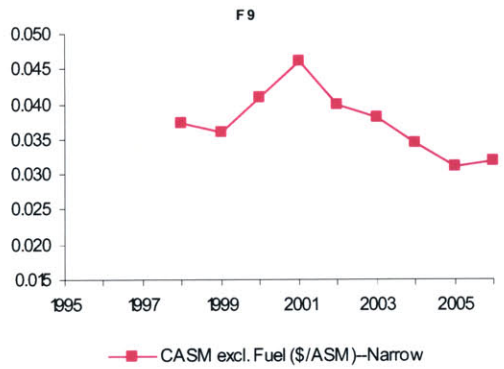
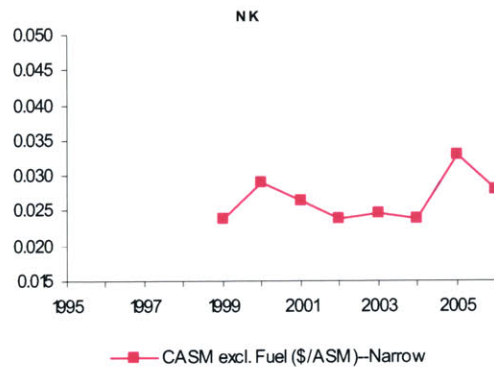
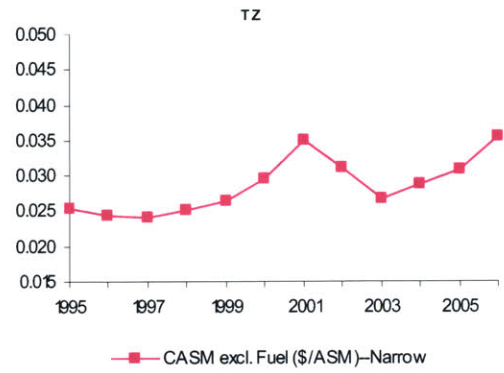
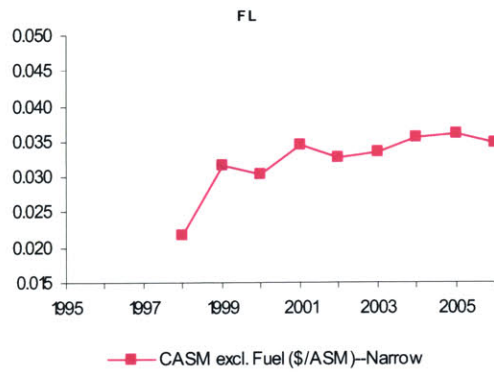
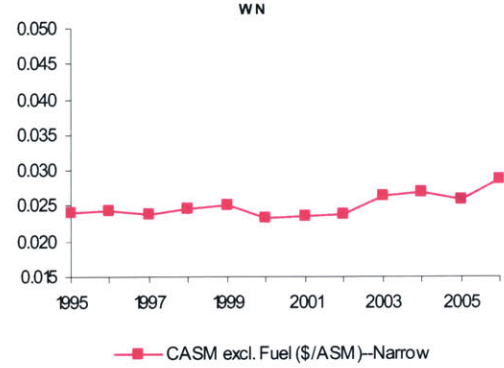
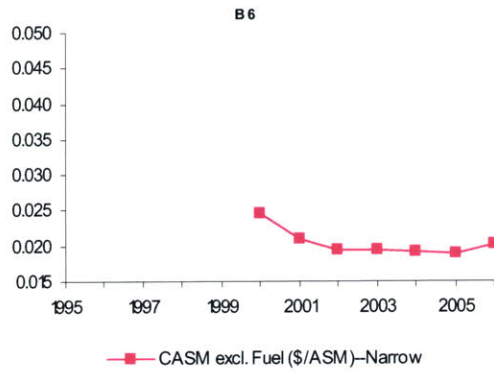


Figure 38 Fleet detail Analysis: LCC CASM excl. Fuel

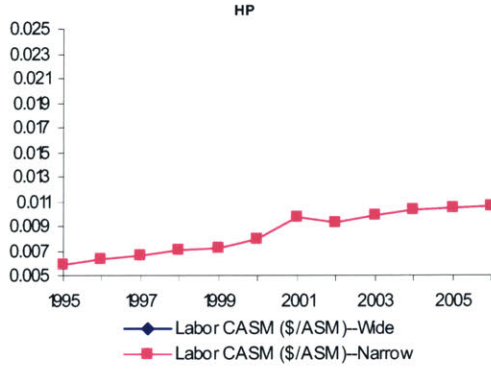
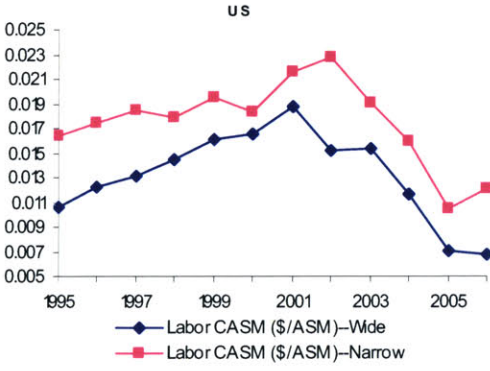
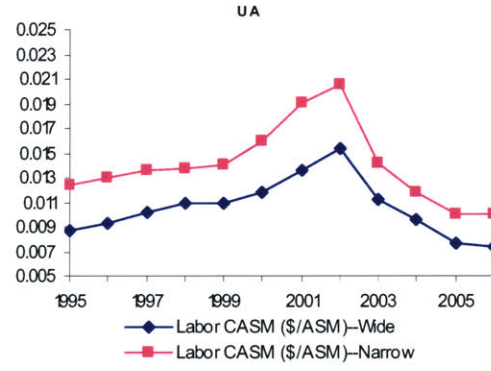
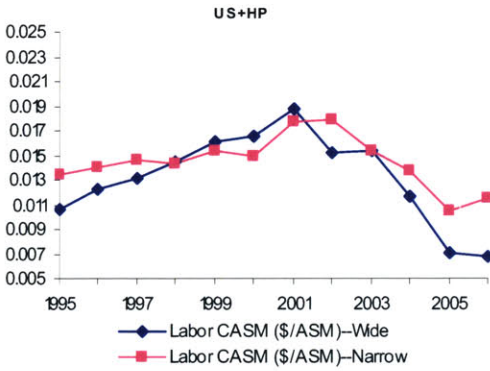
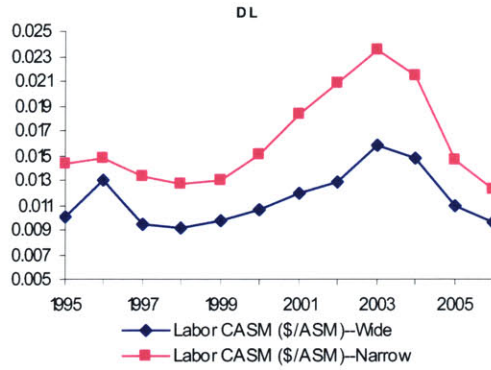
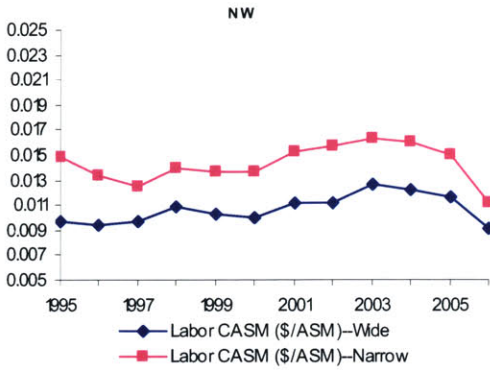
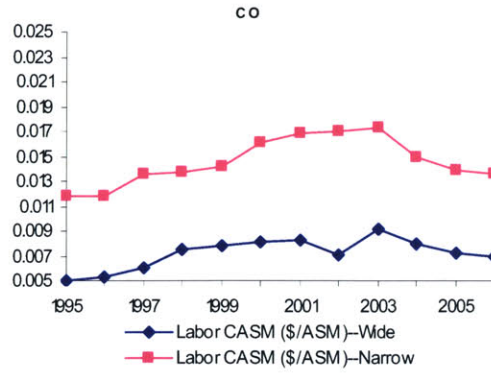
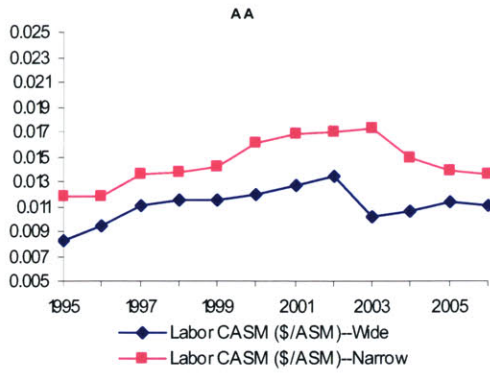


Figure 39 Fleet detail Analysis: NLC Labor CASM

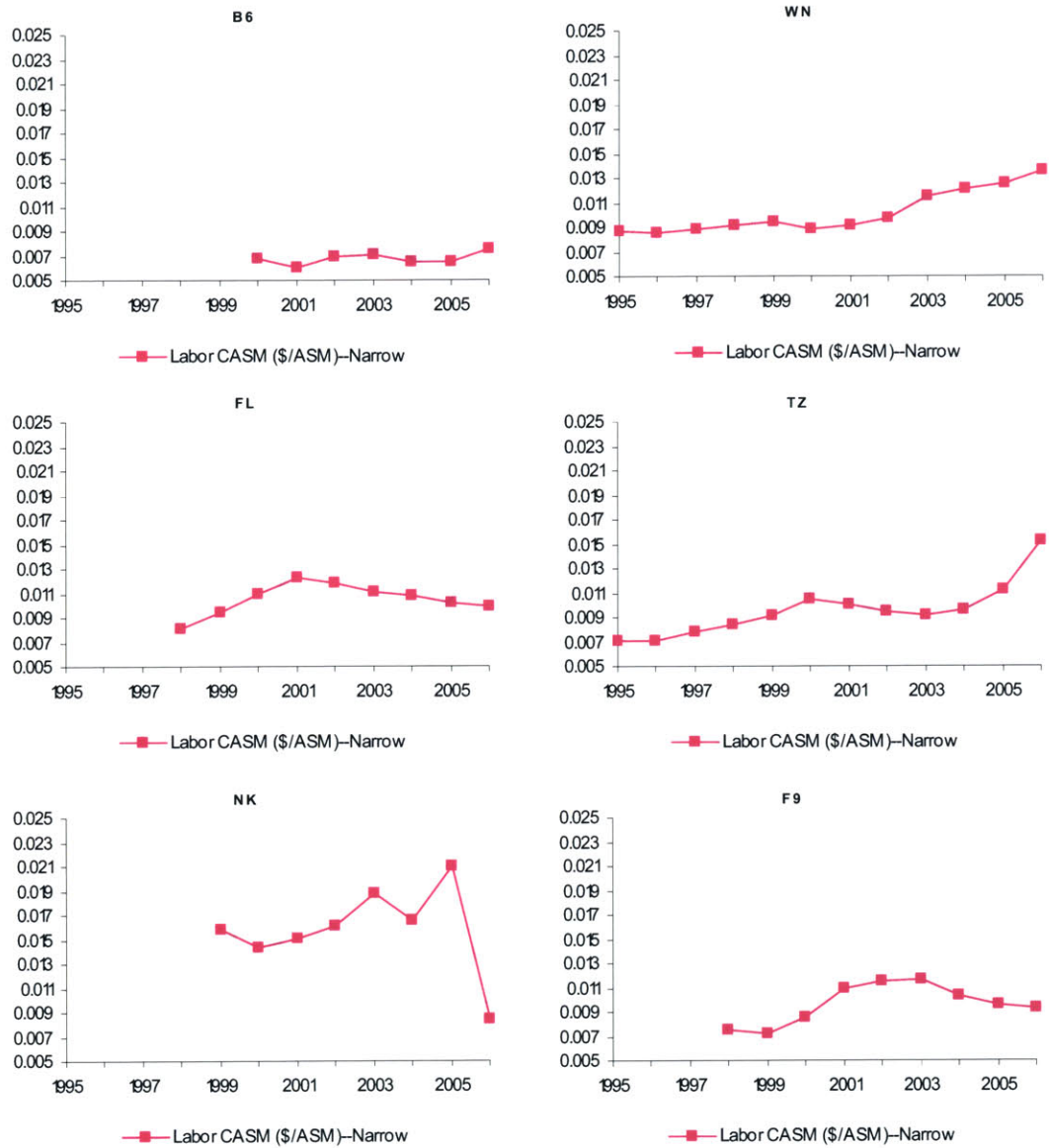


Figure 40 Fleet detail Analysis: LCC Labor CASM

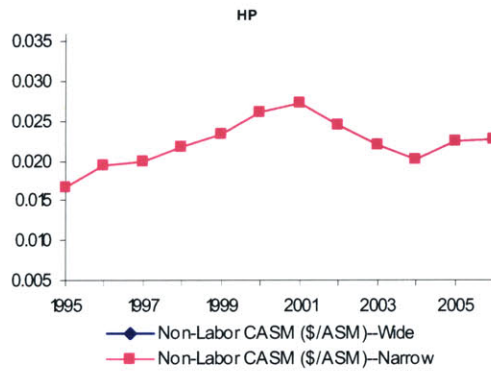
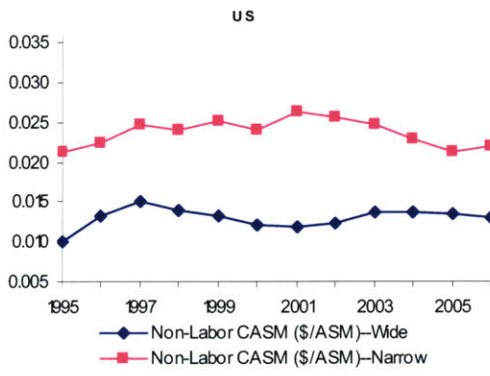
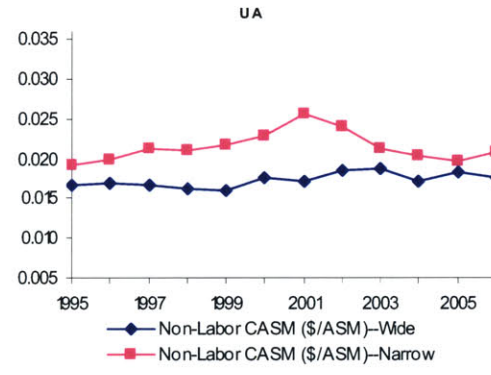
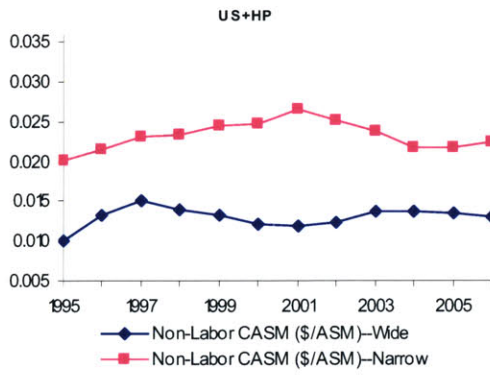
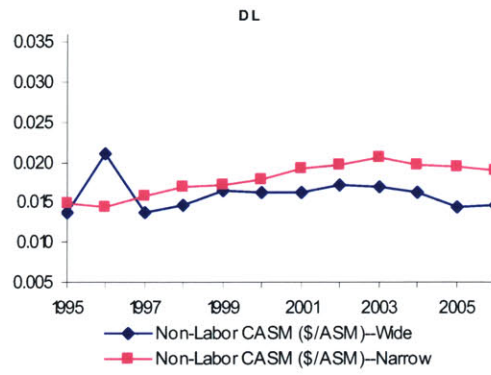
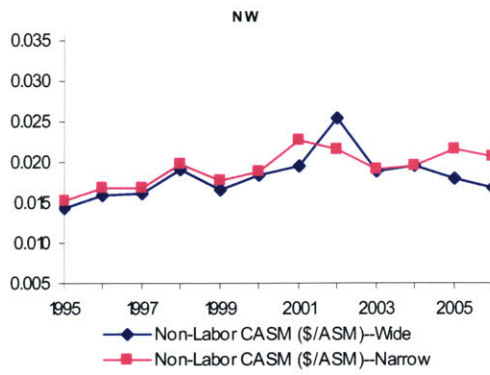
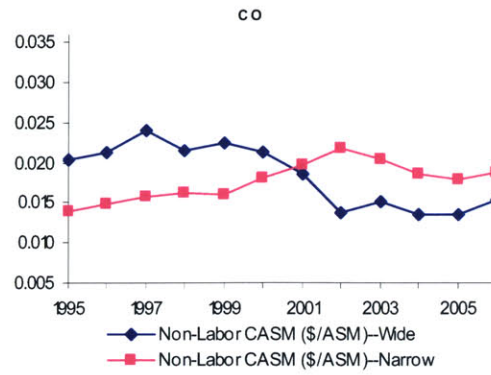
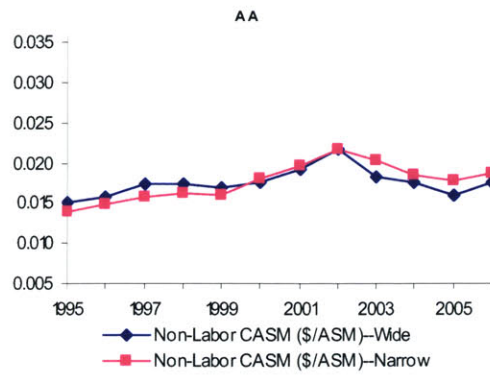


Figure 41 Fleet detail Analysis: NLC non-Labor CASM



Figure 42 Fleet detail Analysis: LCC non-Labor CASM

### *Summary of fleet-detail analysis*

The key findings from our fleet analysis are summarized below.

The results from our Legacy wide-body vs. narrow-body comparison clearly indicate that there are significant unit cost reductions associated with operating larger aircraft. This is reflected in the Legacy carriers' recent moves to increase their international flying operations.

The results from our Legacy vs. LCC narrow-body comparison show that LCCs have managed to retain a cost advantage in this category, but this advantage is shrinking. Typically a Legacy carrier still cannot compete with WN and B6 on the non-labor cost-side in domestic markets where narrow-body aircraft are used. However, Legacy carriers have caught up to some LCCs in 2006 in terms of both labor and non-labor CASM.

Fuel has impacted both groups very differently. Legacy carriers have had to pay much higher consequences. There are two main reasons for this:

- The aging narrow-body fleet
- WN's large hedged positions providing stability to the LCC average results

In conclusion we can see that Legacy carriers have managed to extract higher cost efficiency from their wide-body fleet than their narrow-body, but at the same time they have made improvements to both. In fact in 2006, only WN and B6 retain a clear narrow-body cost advantage over the Legacy carriers (not including the labor category). However in terms of labor costs, it seems that most LCCs retain a good advantage despite all the cost-cutting efforts from the previous years. The big exception to this is WN which has labor costs that are above some of the Legacy carriers. This will be examined in more detail in Chapter 6.





## Chapter 5

# Aircraft Productivity Analysis

This Chapter presents the results of our aircraft productivity analysis and is structured similarly to Chapter 4 (i.e. in increasing levels of detail). The first part examines aggregate results focusing on aircraft utilization and aircraft productivity differences between Legacy carriers and LCCs. In the second part we look at the results for individual airlines from both groups. The final section contains the fleet level analysis comparing wide-body and narrow-body trends in our two groups. We conclude the Chapter by summarizing the results and establishing productivity rankings in our sample set.

### **5.1. Aggregate Aircraft Productivity Comparison: NLC vs. LCC**

#### **5.1.1. Aircraft Utilization**

Figure 43 compares aircraft utilization (expressed in block hours per aircraft day) between Legacy carriers and LCC carriers. Unsurprisingly LCCs have had higher utilization rates than Legacy carriers throughout the whole period but what is more interesting is that the spread between both groups has been volatile and has increased. In the pre-9/11 period, utilization rates for both groups were very similar but started to diverge significantly in 2001. Indeed, while Legacy carriers were grounding planes and downsizing, LCCs captured market share and were offering an increasing number of flights. These two different strategies are partly responsible for the divergence seen starting in 2002. During this year LCCs were flying their planes 11 hours per

day on average while Legacy carriers had fallen below 9.5 hours. This gap of 1.5 hours per plane per day is very significant and has remained almost unchanged up to 2006. Theoretically the two most direct drivers of utilization are stage length and turn-around times. The higher the stage length, the higher the utilization rate and conversely the lower the turn-around times, the higher the utilization rate. Knowing that LCC carriers have a definite advantage in terms of turn-around times but that Legacy carriers generally have a much higher stage lengths it becomes less obvious to identify where the utilization advantage comes from just by looking at our aggregate results below. More explanations are thus given in the upcoming sections of this Chapter as we increase our analysis detail level.

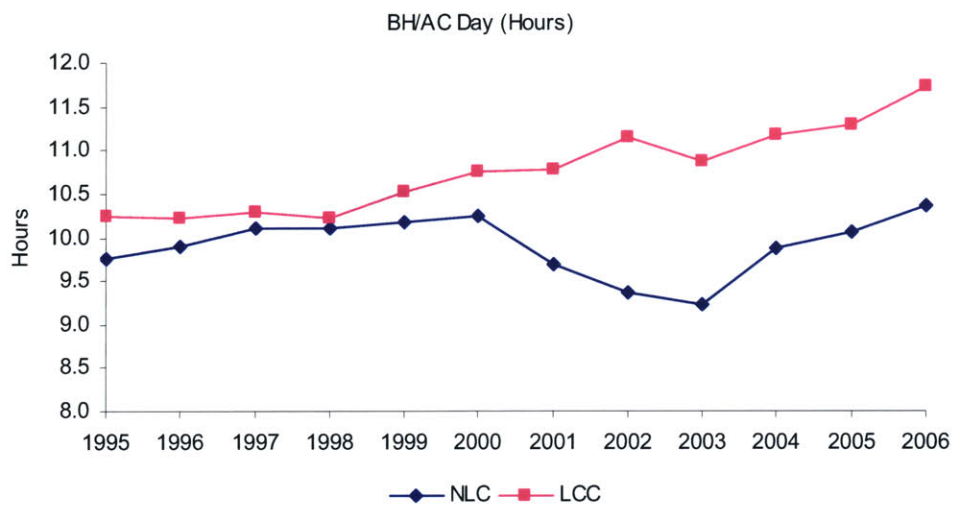


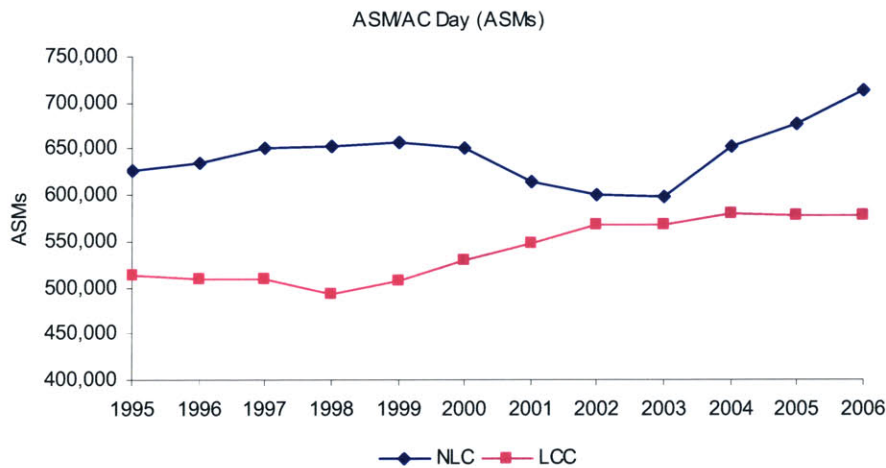
Figure 43 Aggregate comparison: aircraft utilization (BH/ACDay) 1995-2006

### 5.1.2. Aircraft Productivity (ASM/ACDay)

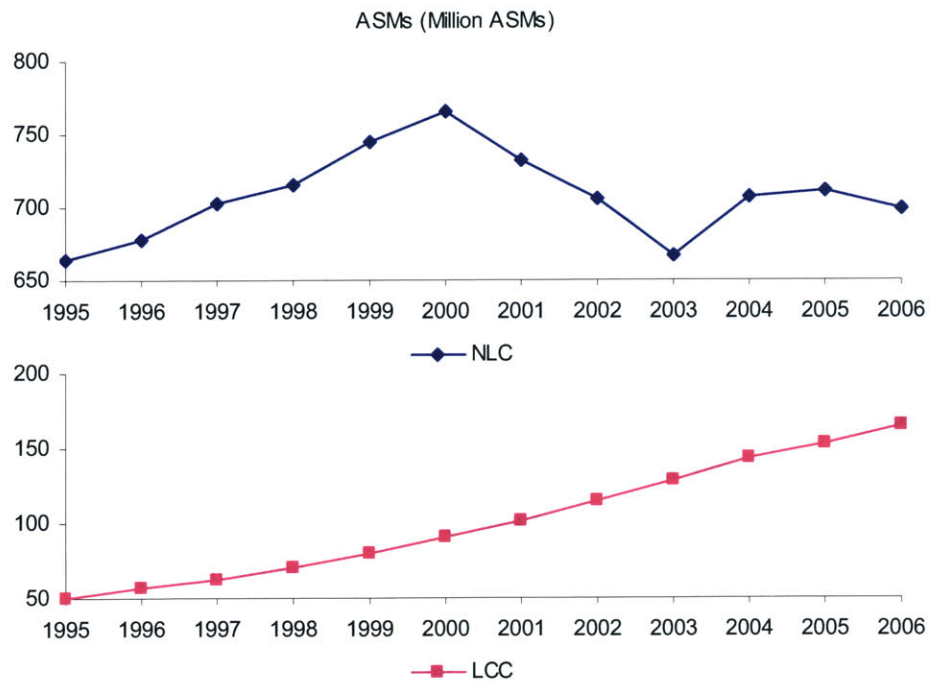
The results for our aircraft productivity comparison are shown in Figure 44. We can see that Legacy carriers have maintained higher productivity levels than the LCCs during the entire period but that the gap has been volatile. From 1995 to 2000, the Legacies retained a significant aircraft productivity advantage outputting around 650,000 ASMs per aircraft per day, while the LCCs' output stayed close to 520,000 on average. One year after, in 2001, we can see the direct effects of 9/11 on both groups and it is clear that the consequences were different for each. The Legacy down-sizing that occurred in 2001 created a great opportunity for LCCs to capture market share thus rapidly increasing their ASMs. They managed to do this very aggressively and reduced

the aircraft productivity gap from 125,000 ASM/ACday in 2001 to around 30,000 by 2003. Tying this back to the results in Figure 43, it is interesting to note that during the same period the LCC utilization did not vary much. We infer that the LCC growth in output seen here had to be driven by a real expansion of their networks (i.e. entering new markets with additional aircraft) rather than just improving their efficiency at utilizing their current fleet. This is also visible in Figure 45 which shows that LCC ASMs have been increasing steadily since 1995. Given that this expansion led to higher levels of productivity, it had to be the case that ASMs grew faster than the Aircraft Days required to produce them. One of the main reasons driving this result was that the new markets being targeted by the LCCs had longer average stage lengths.

However this trend only holds until 2003. After this year, the Legacies rebounded back strongly and increased their aircraft productivity to record levels. This rebound effect is a direct result of the strategic shift to international markets that started in early 2003. Curiously this increase in aircraft productivity was not driven by an increase in absolute ASMs, as can be seen in Figure 45. If anything, Legacy ASMs slightly decreased after 2003. To gain a better understanding of what happened we need to break-down aircraft productivity into its underlying components. These are: average stage length, average seats and departures per aircraft per day.



**Figure 44 Aggregate comparison: aircraft productivity (ASM/ACDay) 1995-2006**



**Figure 45 Aggregate comparison: NLC and LCC ASMs 1995-2006**

In theory, the higher any of these components is, the higher the resulting aircraft productivity. We can see the absolute values of each of these components in Figure 46, Figure 47 and Figure 48. In order to quantify the effect each has had on aircraft productivity levels, we created index graphs based on the 1995 levels and plotted their growth in Figure 49 (for Legacies) and Figure 50 (for LCCs). Each component is brought back to a base level of 100 representing the value in 1995. The subsequent years show how each variable has changed relative to this base. Analyzing these two Figures we obtain several interesting results: On the Legacy side we can see that average stage length has increased significantly while seats remained stable and departures/ACday decreased. This enforces the argument we gave earlier that the productivity gains for Legacy carriers have been obtained by a shift in strategy to fly more international markets. On the LCC side, the main driver of increased productivity has also been increased stage length while seats and departures/ACday decreased. Although it is not visible on the graph, the decrease in departures/ACday was actually driven by an increase in both departures and ACdays but the latter increased significantly faster than the former. This reinforces the previous argument we gave about real network growth as opposed to simply higher efficiency levels.

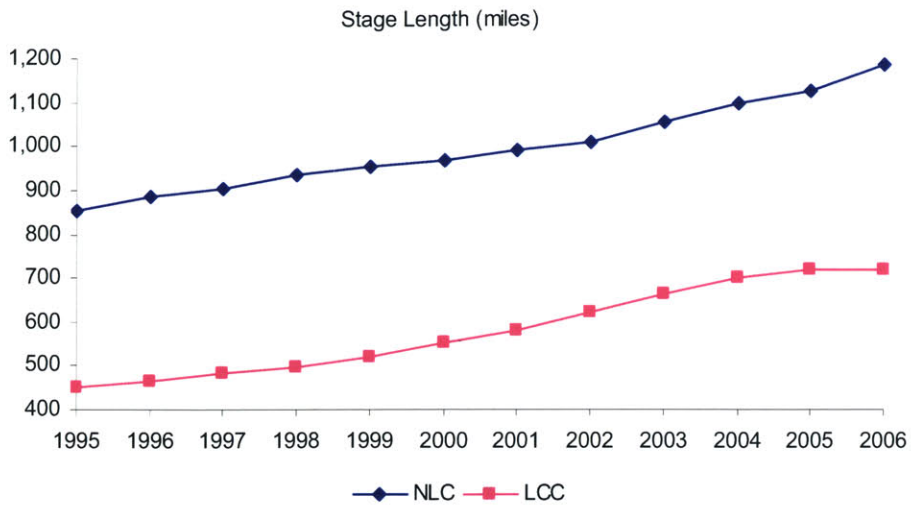


Figure 46 Aggregate comparison: Stage Length 1995-2006

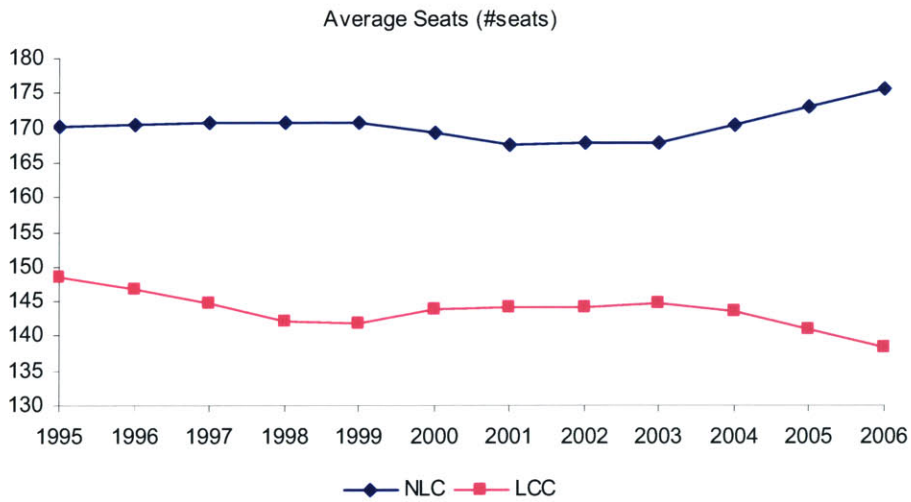
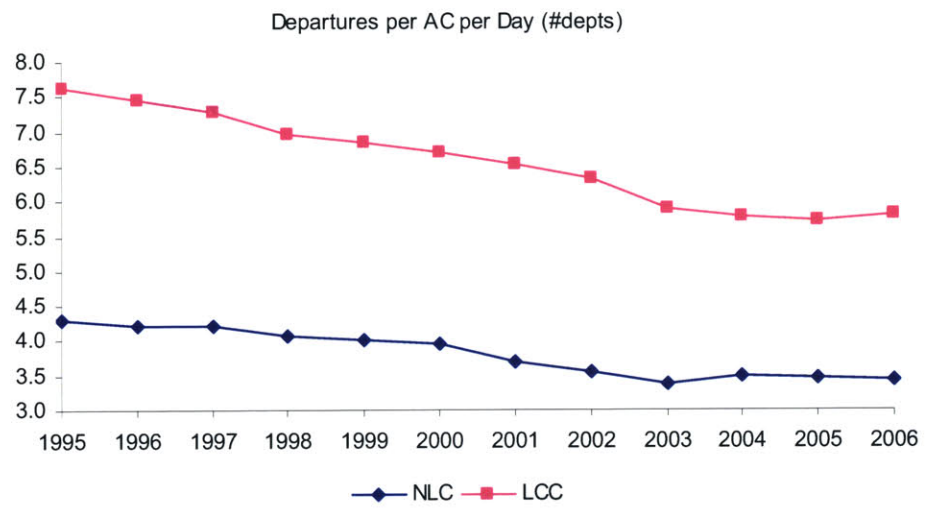


Figure 47 Aggregate comparison: Average seats 1995-2006



**Figure 48 Aggregate comparison: Departures 1995-2006**



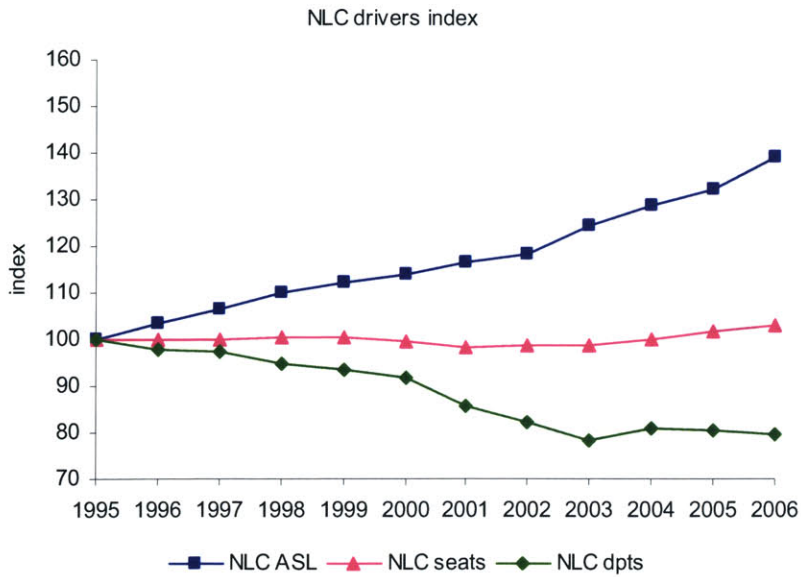


Figure 49 Aggregate comparison: NLC aircraft productivity drivers index 1995-2006

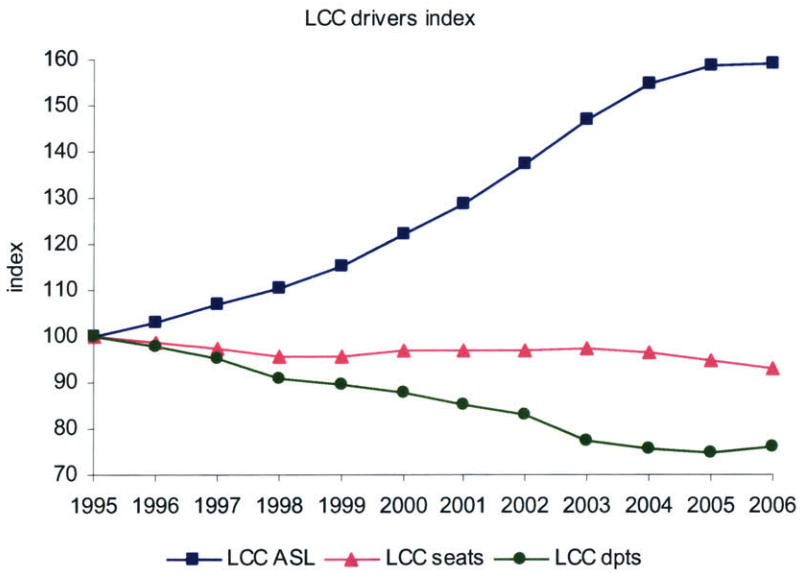


Figure 50 Aggregate comparison: LCC aircraft productivity drivers index 1995-2006

## 5.2. Individual Airline Aircraft Productivity Analysis

### 5.2.1. Aircraft Utilization (BH/ACDay)

Looking at carriers individually we can see in Figure 55 and Figure 56 that there are big differences in utilization across the airlines of our sample set.

Concerning the Legacies we can divide the carriers into two groups: Those that managed to significantly increase their utilization levels between 2003 and 2006 above the industry average and those that underperformed. In the first group we include CO, DL and UA which were very successful at increasing their utilization. In contrast NW, USHP and AA had more difficulties. This result is also reflected when looking at a different comparison period (between 2001 and 2006) shown in Figure 51 and Figure 52.

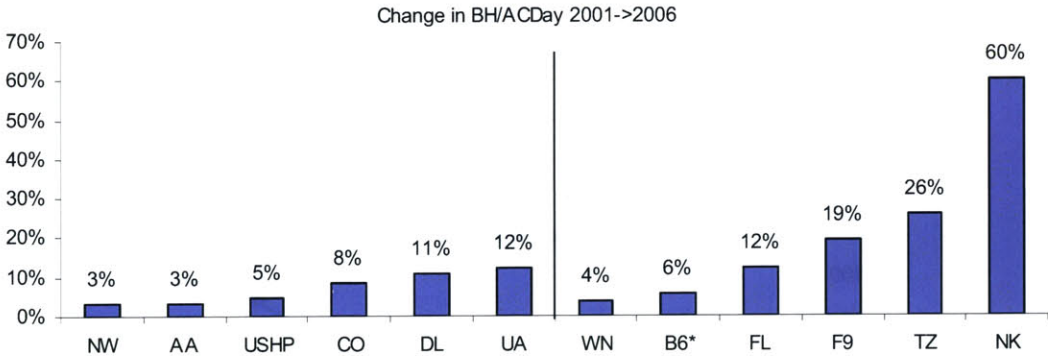


Figure 51 Change in aircraft utilization 2001->2006

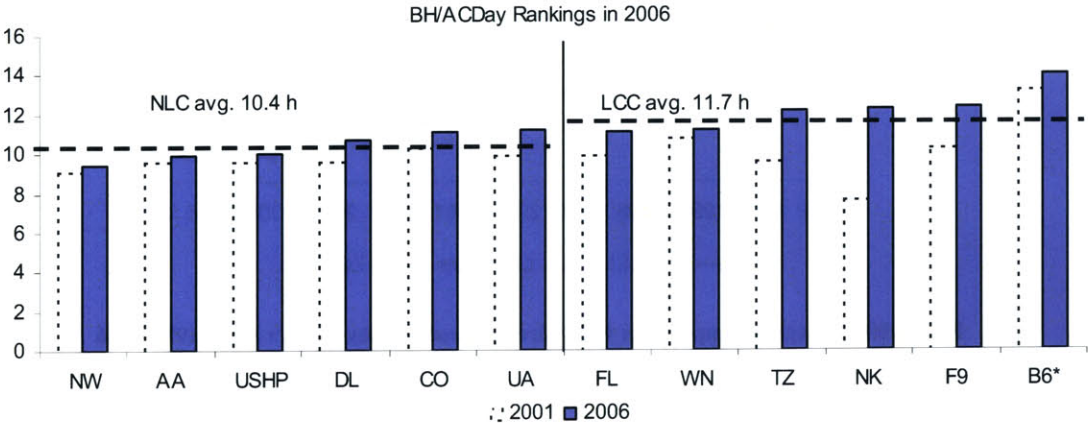


Figure 52 aircraft utilization rankings 2006



Concerning the underlying factors behind these results, we can use our general argument that Legacy carriers have been shifting to international markets which in turn has been increasing utilization. In Figure 53 and Figure 54 we can see increases in international ASMs and the percentage of international ASMs in 2006 for each airline. Combining these results with the results from Figure 51 we can see that there is a strong correlation between increases in international ASMs and increases in utilization. If we exclude UA from the sample set, the correlation coefficient between these two variables is 89%. Although this result provides evidence of a positive relationship between the two, UA is indeed a counterexample which reminds us that looking at an airline's international vs. domestic ASMs is not always enough to explain changes in utilization. In the case of UA for example, we would need to actually look at the nature of each individual market the airline flies in fly in to see if any patterns arise – a task that is not in the scope of this thesis.

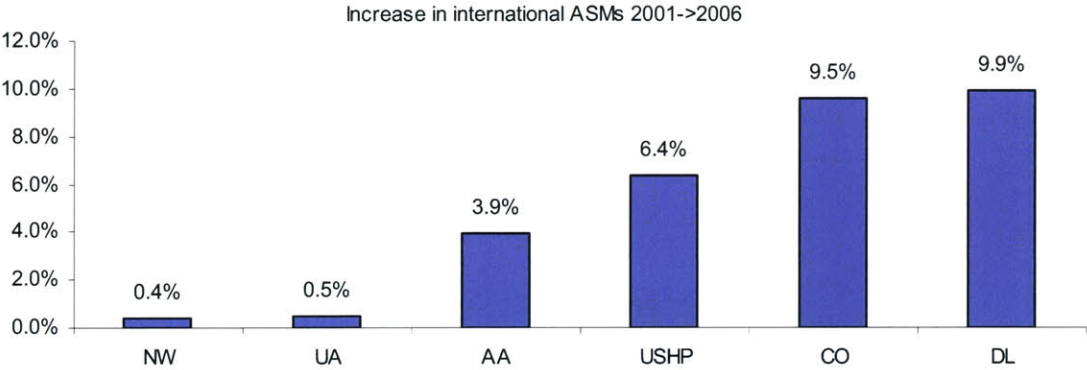


Figure 53 Increase in % of international NLC ASMs 2001 -> 2006

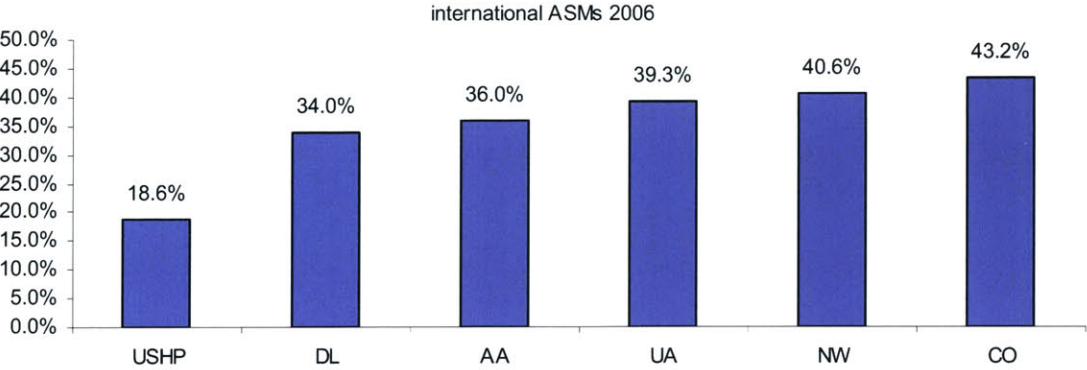


Figure 54 International ASMs as a percentage of total ASMs for NLCs in 2006

Looking at the results for LCCs in Figure 51 and Figure 52 we see that with the exception of B6 and WN, all LCC carriers managed to increase their utilization at a faster rate than the Legacies between 2001 and 2006. The results for B6 and WN might seem unexpected since they only increased their utilization by 3% and 4% respectively. In the case of B6 this is actually anticipated considering how high its utilization was above the industry average already. This is clearly visible in B6's results in Figure 56. Regarding WN we can see that although historically it managed to have utilization rates slightly above the average, it lost a lot of ground after 2001. In fact, after that year WN never managed to perform above the LCC average. The results in 2006 place it as the airline with second worst utilization rate in its group. This is surprising considering WN's reputation as having the quickest turnaround times in the industry. However looking at WN's stage length we are reminded that it also flies very short distances on average which definitely place a physical limit on its utilization rate.

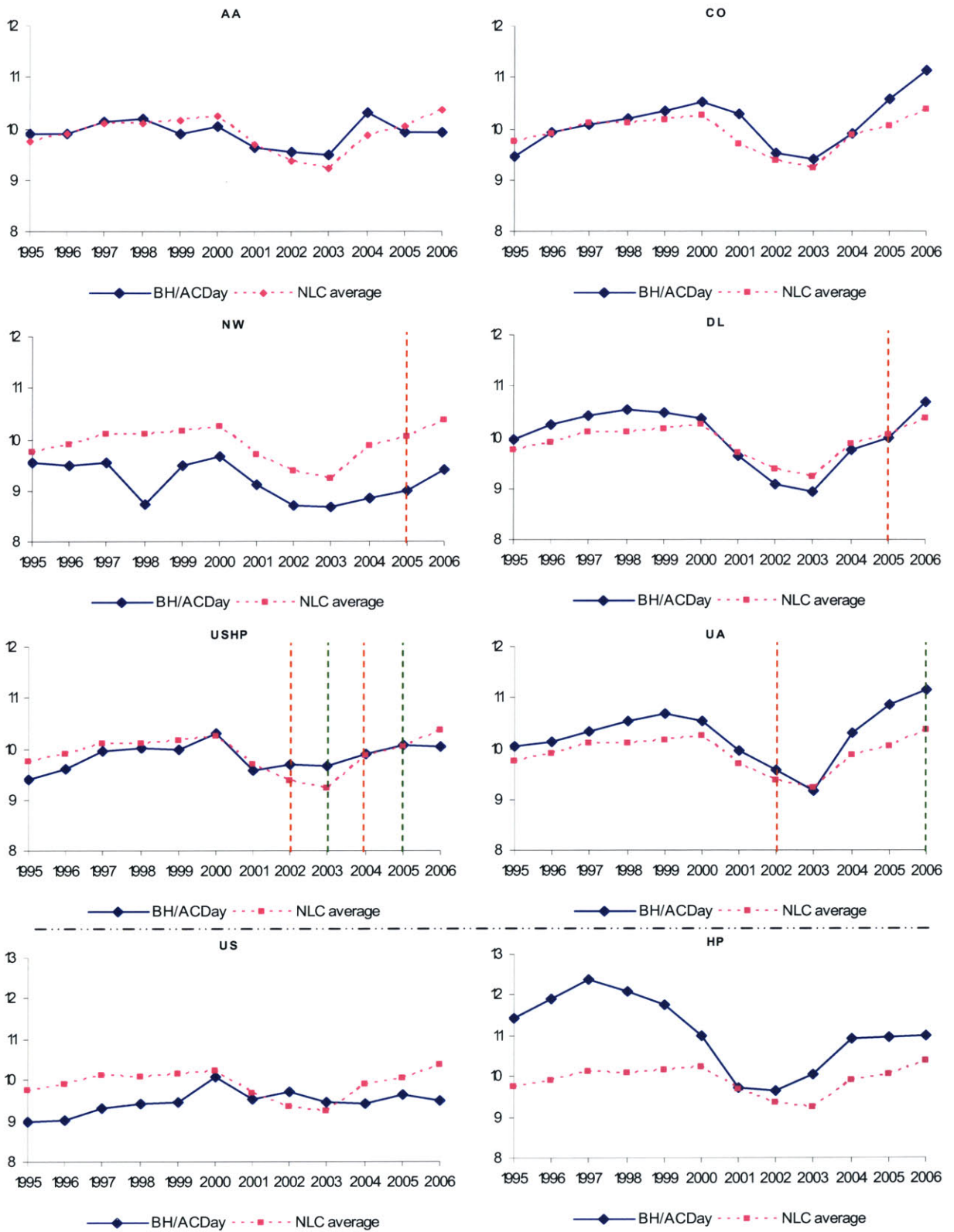


Figure 55 By-carrier analysis: NLC aircraft utilization

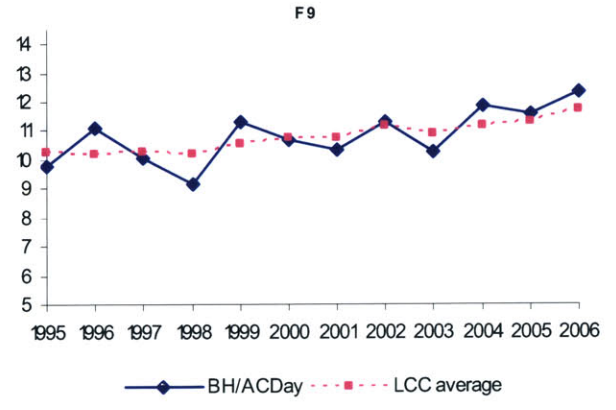
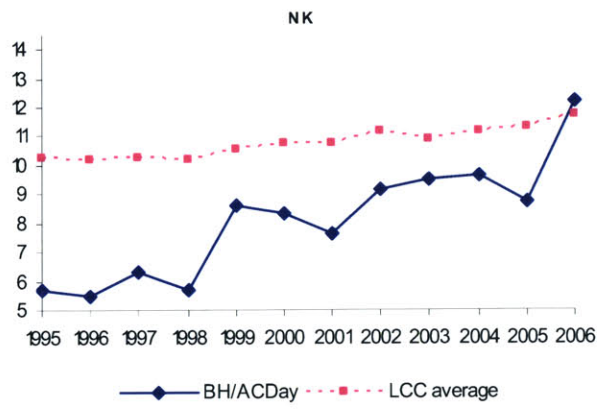
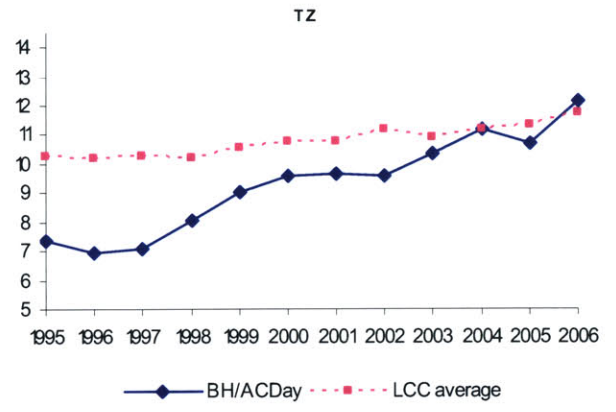
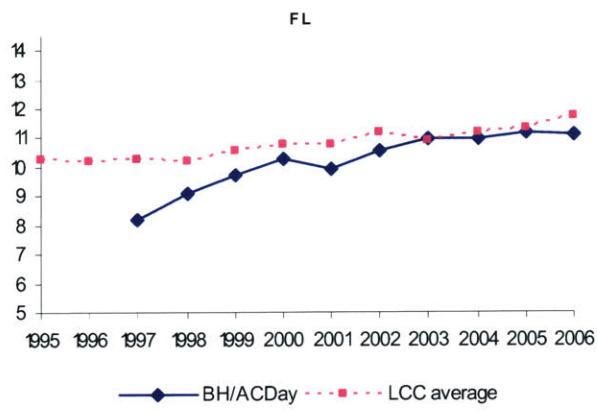
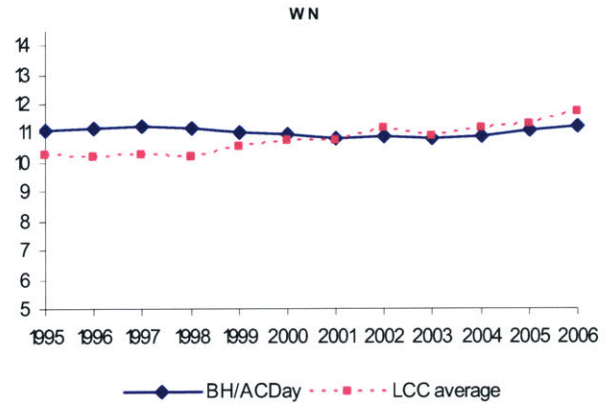
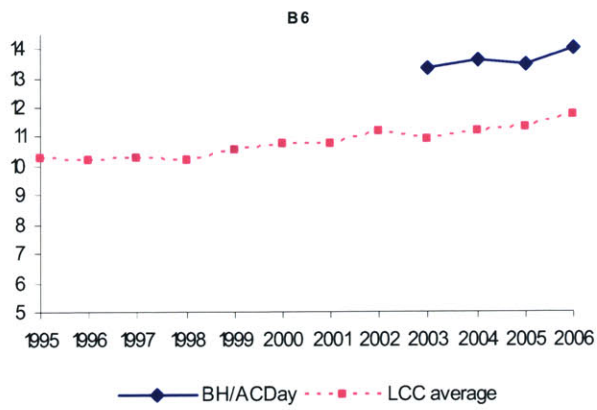
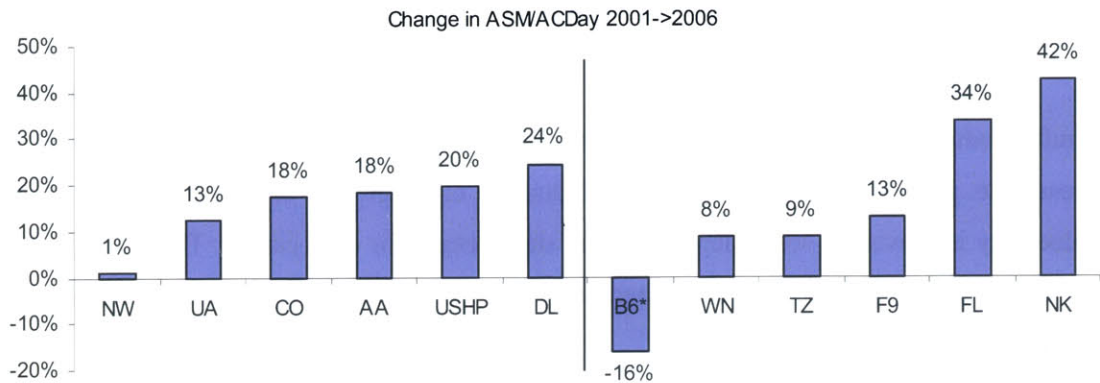


Figure 56 By-carrier analysis: LCC aircraft utilization

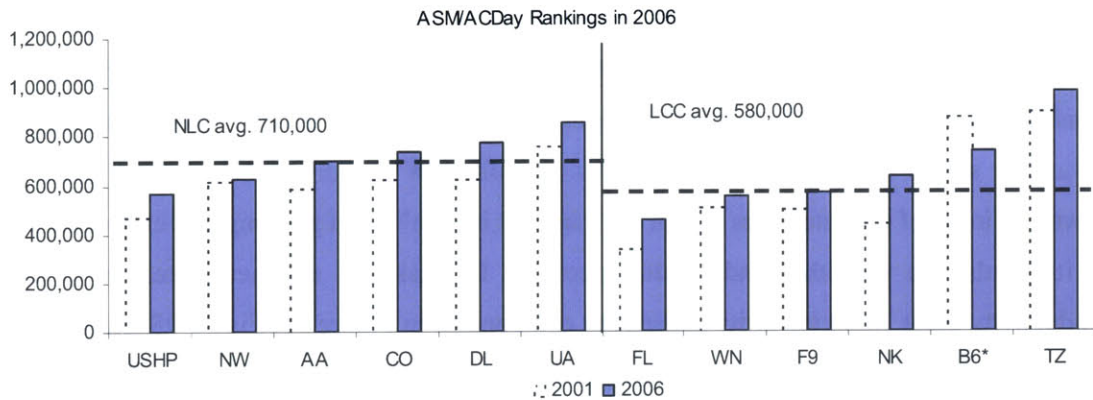
### 5.2.2. Aircraft Productivity (ASM/ACDay)

In Figure 57 we can see that almost all Legacy carriers had significantly increased their aircraft productivity between 2001 and 2006. The one exception is that of NW who only increased its productivity by 1%. As we had done in the aggregate section we also breakdown productivity into average seats, departures and stage length for each carrier. These are plotted in Figure 96 to Figure 101 in the annex. There are some interesting individual cases that we want to take a closer look at:

In the case of NW we see that it has underperformed in several categories. Its stage length (Figure 96) is well below the industry average and has diverged further during the last few years. Its number of departures/ACday (Figure 100) is also below or at the average benchmark although some improvement can be seen since 2003. On the flip side NW has had an average number of seats (Figure 98) that has historically been above the industry average although this advantage seems to be decreasing also. As a result, NW's poor performance is driven by a downturn in all of the categories which indicate that it hasn't been growing and expanding as fast as its rivals. On the other end of the spectrum, DL has had spectacular results in aircraft productivity gains. Looking at its underlying components in Figure 96, Figure 98 and Figure 100 we see that DL is above or at the industry average in all cases. Its stage length has been slightly below the benchmark historically but in 2006 it increased and achieved the industry average level. The number of departures/ACday has historically been above the industry average even though the advantage that DL has enjoyed in this category has been shrinking and reached industry average levels in 2006. The category where DL has the most advantage is in terms of average seats. Throughout the entire period the airline has had an average of seats well above that of its rivals and the gap does not seem to be shrinking. The final example we are discussing in this section is that of CO. Having mentioned earlier in the thesis that CO was one of the first players to shift its focus to international markets, we would expect its stage length to be well above the average. This is indeed the case as can be seen in Figure 96. Furthermore in terms of departures and average seats, CO is below the industry average. This is consistent with our findings as international flights tend to have fewer total seats (space taken by first and business class) and result in fewer departures/ACday for the airline given that each flight lasts longer on average.



**Figure 57 Change in aircraft productivity 2001 -> 2006**



**Figure 58 Aircraft productivity rankings in 2006**

Concerning the LCCs we can see in Figure 57 and Figure 58 that with the exception of B6, every carrier has managed to increase its productivity between 2001 and 2006. The most surprising results are those of FL and NK who respectively managed an important 34% and 42% increase since 2001. However in terms of absolute standings in 2006 their productivity levels were not outperforming the average meaning that they were starting off from a much lower base. Concerning B6, it experienced a 16% drop in productivity from 2001 to 2006 as a result of various factors. Firstly as we can see in Figure 58, B6's productivity remains the second highest of the LCCs, surpassed only by TZ. This means that its productivity levels are already high which makes it more difficult to improve further. In addition, if we break-down the productivity into its subcomponents we can see precisely what has driven B6's decline. In terms of its stage length it was maxed out in 2005 at nearly 1400 miles, higher than any other airline, but came back down significantly in 2006 (by more than 100 miles). As a result we can also see that B6's departures have been quite low compared to its peers although they have been steadily rising for the past few

years at the same time as the stage length has been falling. In terms of average seats, B6 retains a clear advantage of between 10 and 20 seats per plane above the average however the gap has been shrinking and B6's average seats have been decreasing. On the other end of our rankings, the story for TZ – the industry leader – is quite unique. In fact looking at TZ's results in Figure 97, Figure 98, Figure 99 and Figure 101, we see that its results do not look like typical LCC results. Its average stage length is very volatile and much higher than any other carrier in our sample set. As a result its number of departures is also very low. Lastly, it has a very high number of average seats per plane, in some years more than 50 above the benchmark. The combination of this and the longer stage length explain TZ's productivity advantage over all other carriers (including Legacies).



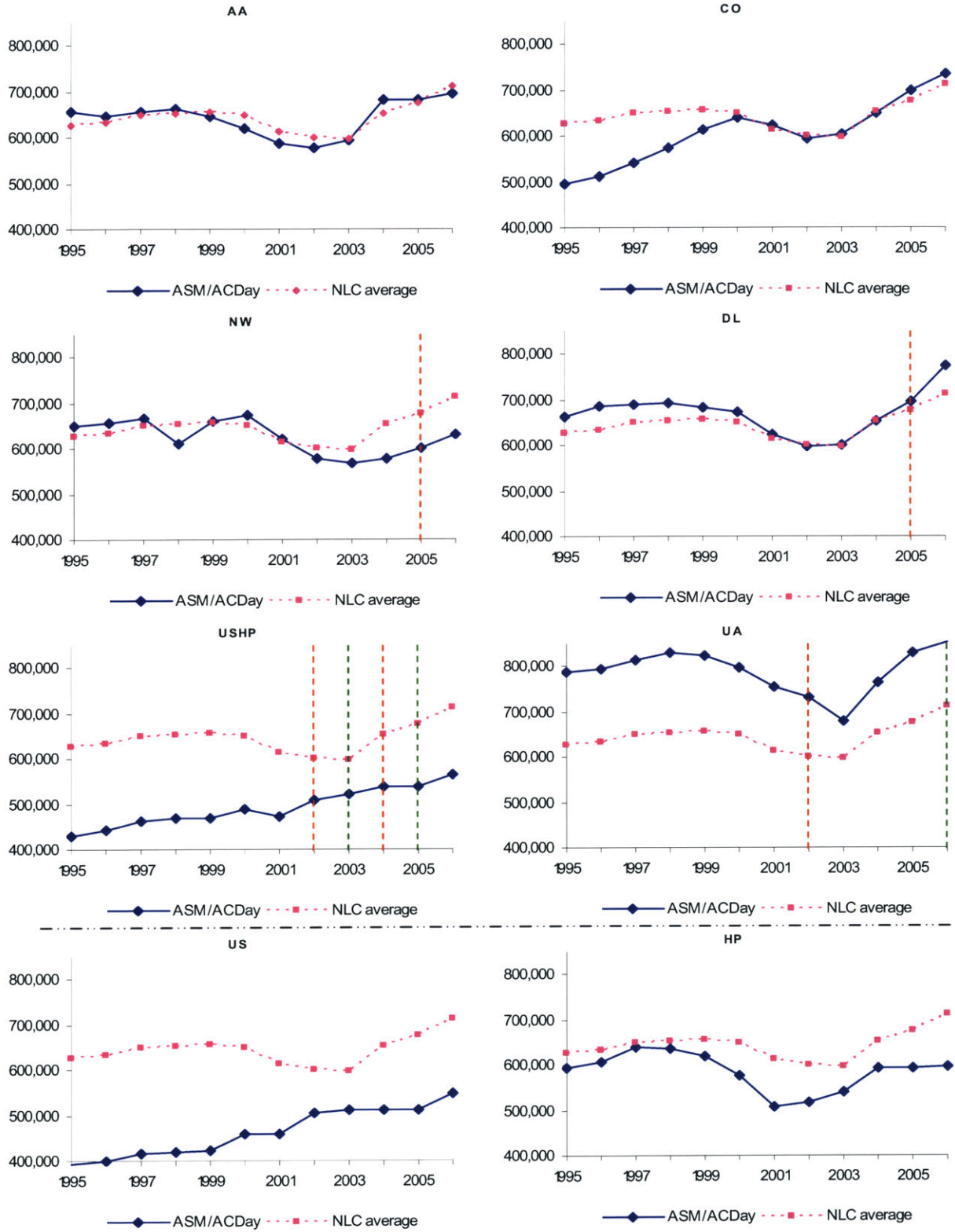


Figure 59 By-carrier analysis: NLC aircraft productivity



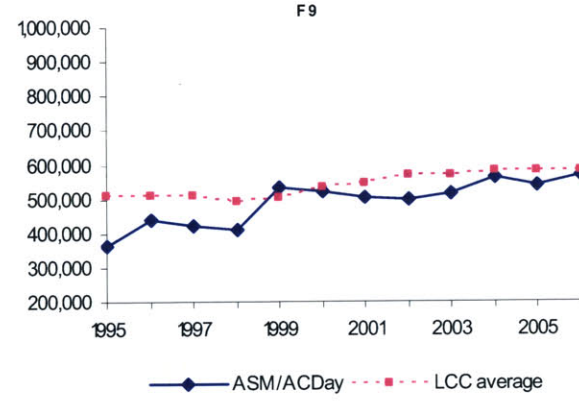
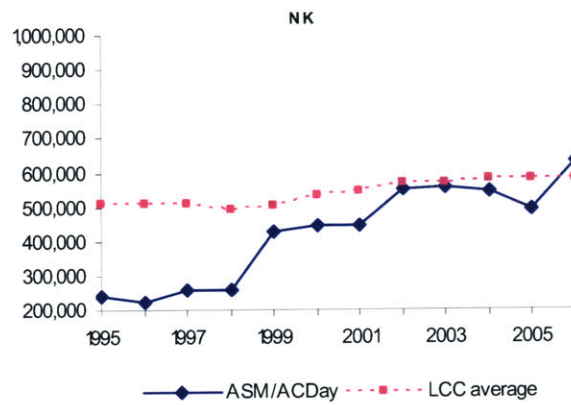
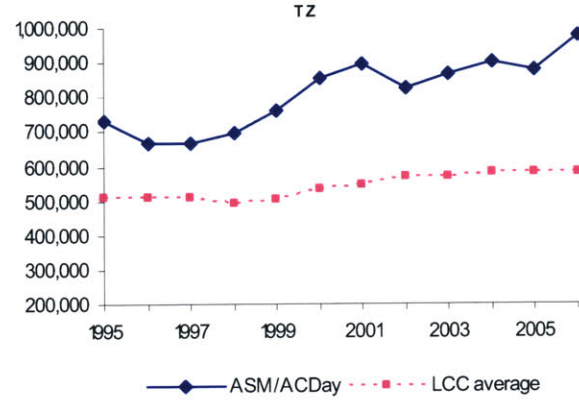
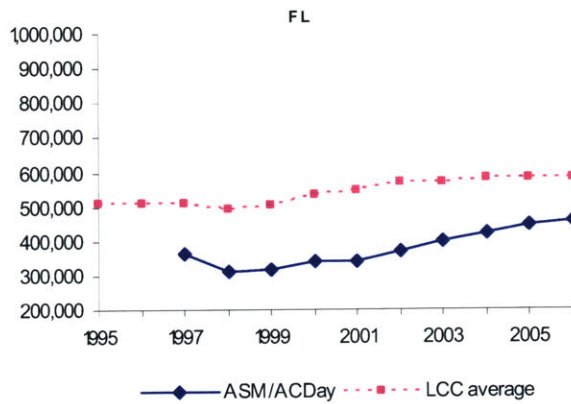
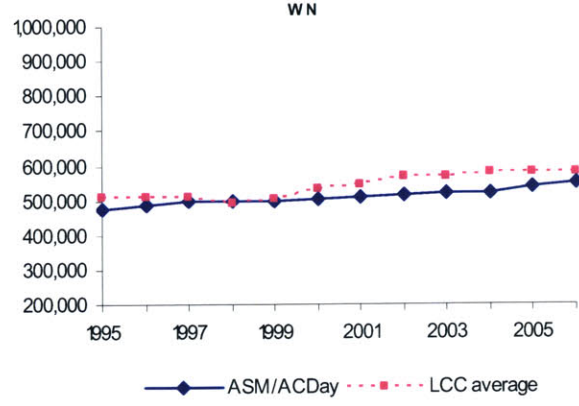
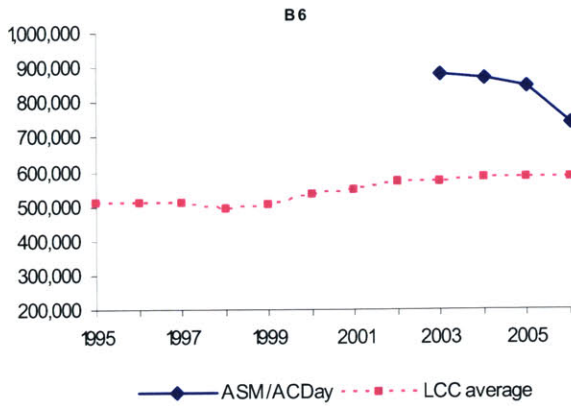


Figure 60 By-carrier analysis: LCC aircraft productivity

### 5.2.3. Airline Rankings Based on Aircraft Utilization and Productivity

Similarly to what we had done in section 4.2.6 we summarize the results of our findings by creating rankings of absolute aircraft productivity and utilization levels (Table 15) and also rankings of airlines who have had the greatest improvement from 2001 to 2006 (Table 16).

	Standings in 2006 (Rank and \$/ASM)			Biggest improvements 2001->2006	
	BH/ACDay	ASM/ACDay		BH/ACDay	ASM/ACDay
<b>AA</b>	<b>5</b> 9.9	<b>4</b> 696,380	<b>AA</b>	<b>5</b> 3.2%	<b>3</b> 18.3%
<b>CO</b>	<b>2</b> 11.1	<b>3</b> 733,895	<b>CO</b>	<b>3</b> 8.4%	<b>4</b> 17.7%
<b>DL</b>	<b>3</b> 10.7	<b>2</b> 774,341	<b>DL</b>	<b>2</b> 10.9%	<b>1</b> 24.4%
<b>NW</b>	<b>6</b> 9.4	<b>5</b> 628,901	<b>NW</b>	<b>6</b> 3.1%	<b>6</b> 1.3%
<b>UA</b>	<b>1</b> 11.2	<b>1</b> 852,194	<b>UA</b>	<b>1</b> 12.1%	<b>5</b> 12.7%
<b>USHP</b>	<b>4</b> 10.0	<b>6</b> 565,278	<b>USHP</b>	<b>4</b> 4.8%	<b>2</b> 19.6%
<b>B6*</b>	<b>1</b> 14.0	<b>2</b> 735,267	<b>B6*</b>	<b>5</b> 5.5%	<b>6</b> -16.1%
<b>F9</b>	<b>2</b> 12.3	<b>4</b> 568,628	<b>F9</b>	<b>3</b> 19.3%	<b>3</b> 12.8%
<b>FL</b>	<b>6</b> 11.1	<b>6</b> 456,352	<b>FL</b>	<b>4</b> 12.4%	<b>2</b> 33.6%
<b>NK</b>	<b>3</b> 12.2	<b>3</b> 630,971	<b>NK</b>	<b>1</b> 60.1%	<b>1</b> 42.2%
<b>TZ</b>	<b>4</b> 12.2	<b>1</b> 976,938	<b>TZ</b>	<b>2</b> 26.0%	<b>4</b> 8.8%
<b>WN</b>	<b>5</b> 11.2	<b>5</b> 550,474	<b>WN</b>	<b>6</b> 3.8%	<b>5</b> 8.5%

Table 15 Aircraft and utilization rankings in 2006

Table 16 Aircraft productivity and utilization improvements 2001 -> 2006

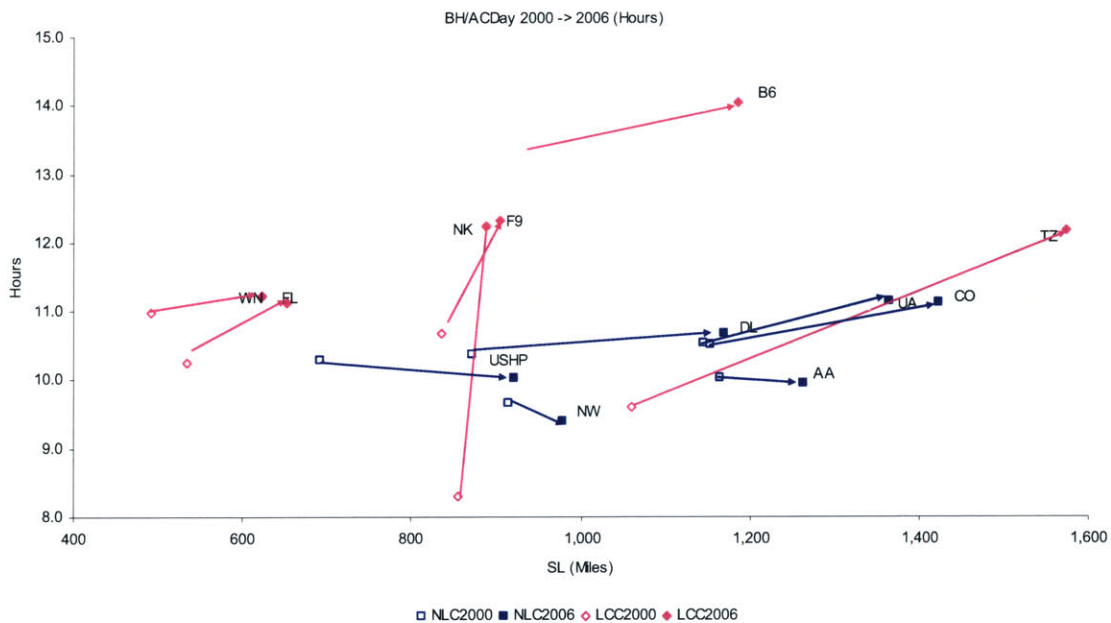
Concerning aircraft utilization and productivity, the Legacies with the best results have been UA, DL and CO while the most improved ones have been UA, DL and USHP. On the LCC side B6 and TZ have been leading the pack while WN seems to be lagging its competitors in both absolute rankings and improvement rankings. However in practice we know that these results are influenced by stage length. It is thus interesting to conduct stage length adjustments and to compare the entire sample again. This is done in the next section.

### 5.3. Stage Length Adjusted Productivity and Utilization

#### 5.3.1. Aircraft Utilization and Productivity vs. Stage length.

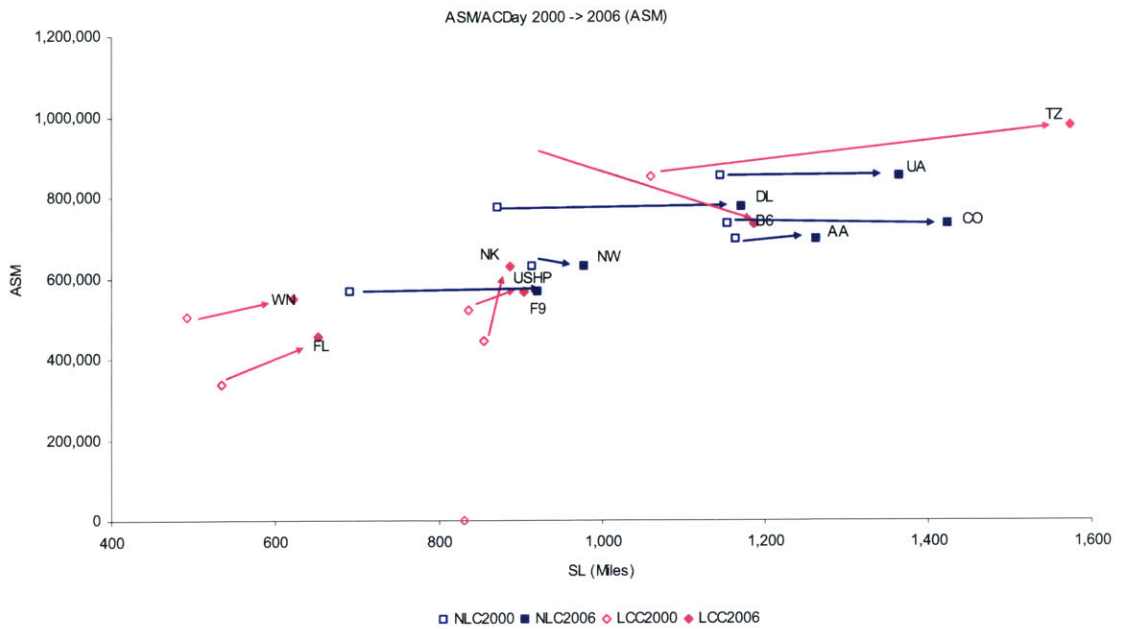
We can plot aircraft utilization and productivity measures against stage length in order to analyze the correlation that may exist between them. In the case of utilization the relationship between the two is theoretical while in the case of aircraft productivity there is a direct analytical link as was explained in the previous sections. In both cases, we expect our measures to increase with stage length, all else being equal. The results for aircraft utilization are given in Figure 61 and aircraft productivity is shown in Figure 62. For a given airline this positive correlation should be reflected by upward sloping vectors pointing toward the right in these Figures.

Regarding utilization we can see that in general increased stage lengths have indeed been positively correlated with increased utilization rates. This is especially true for LCC carriers while we can find three counterexamples for Legacy carriers (USHP, NW and AA). Concerning aircraft productivity, it seems to be following the same correlation for LCC carriers (except for B6 which decreased). However it is clear that the Legacy carrier vectors are mostly flat reflecting that increased stage length has not led to aircraft productivity improvements for this group.



**Figure 61 BH/ACDay vs. Stage Length**

*note: B6's results are given for 2003 and 2006*



**Figure 62 ASM/ACDay vs. Stage Length**  
*note: B6's results are given for 2003 and 2006*

To further analyze the importance of stage length we proceed by conducting regressions against stage length.

### 5.3.2. Stage Length Regressions

In this section we conduct linear and log-linear regressions of aircraft productivity and utilization against stage length to identify its importance in the 2006 results.

**1-variable Linear regression 2006**

Regression Group	STDEVY	STDEVX	Slope	stdError	stdErSlope	t-stat	Intercept	correl	R^2	
BH/Acd vs. SL	NLC	0.709	203.9	0.002754	0.484	0.00106	2.59	7.119	0.79	0.63
	LCC	1.048	358.9	0.001628	0.973	0.00121	1.34	10.607	0.56	0.31
ASMAcd vs. SL	NLC	102.6	203.9	0.404998	68.057	0.14927	2.71	228.056	0.80	0.65
	LCC	183.6	358.9	0.495103	51.620	0.06433	7.70	172.465	0.97	0.94

**Table 17 Linear regression: BH/ACDay and ASM/ACDay vs. Stage length**

1-variable Log-Linear regression 2006

Regression Group	STDEVY	STDEVX	Slope	stdError	stdErSlope	t-stat	Intercept	correl	R^2	
BH/Acd vs. SL	NLC	0.069	0.2	0.300574	0.049	0.12228	<u>2.46</u>	0.215	0.78	0.60
	LCC	0.084	0.4	0.157290	0.070	0.08864	<u>1.77</u>	1.424	0.66	0.44
ASMAcd vs. SL	NLC	0.1	0.2	0.695620	0.090	0.22573	<u>3.08</u>	1.639	0.84	0.70
	LCC	0.3	0.4	0.703850	0.099	0.12506	<u>5.63</u>	1.648	0.94	0.89

Table 18 Log-linear regression: BH/ACDay and ASM/ACDay vs. Stage length

The regression results in Table 17 and Table 18 show that stage length has played an important role in driving both utilization and aircraft productivity. The results are particularly significant in the log-linear model. Each slope is positive meaning that both measures increase with stage length and aircraft productivity seems to be the most affected of the two (higher coefficients).Table 19

We have plotted the log-linear results in Figure 63 which clearly shows the effects of stage length on the two measures.

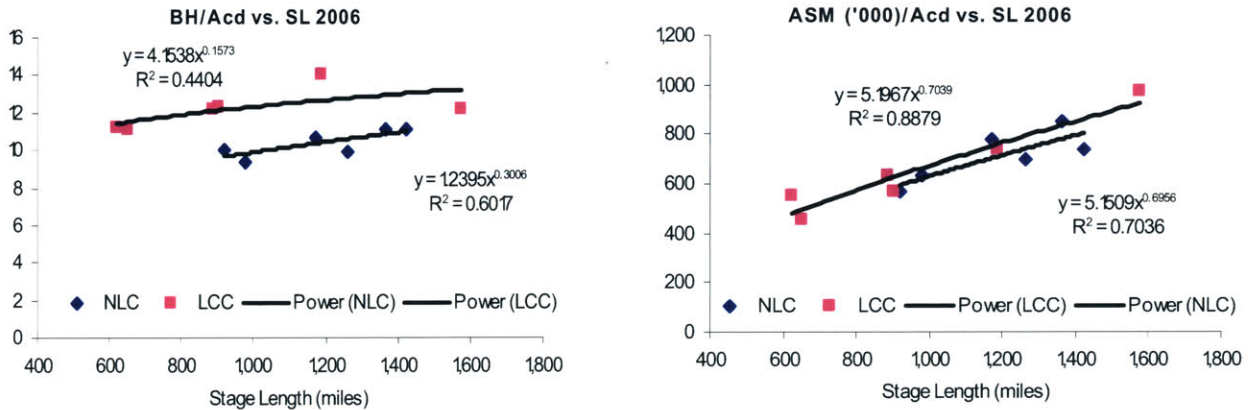


Figure 63 Aircraft utilization and productivity regressions vs. stage length

### 5.3.3. Stage Length Adjusted Results

Proceeding with our previous results, we calculate adjusted productivity and utilization figures using the methodology described in Chapter 3. The results are given in Table 19, shaded in grey.

NLC	BH/ACDay				ASM/ACDay					
	Regr.:	coeff	intr		Regr.:	coeff	intr			
		0.3	1.2			0.7	5.2			
		Raw	Trend	diff	Adj.	Raw	Trend	diff	Adj.	
	USHP	10.03	9.64	4.0%	10.82	DL	774.3	701.8	10.3%	781.8
	DL	10.68	10.36	3.0%	10.72	UA	852.2	780.6	9.2%	773.5
	UA	11.15	10.85	2.8%	10.69	NW	628.9	619.5	1.5%	719.3
	CO	11.12	10.99	1.2%	10.53	USHP	565.3	593.8	-4.8%	674.5
	NW	9.40	9.82	-4.3%	9.96	AA	696.4	739.8	-5.9%	666.9
	AA	9.94	10.60	-6.2%	9.76	CO	733.9	804.3	-8.8%	646.5

LCC	BH/ACDay				ASM/ACDay					
	Regr.:	coeff	intr		Regr.:	coeff	intr			
		0.2	0.01			-0.3	0.3			
		Raw	Trend	diff	Adj.	Raw	Trend	diff	Adj.	
	B6	14.04	12.65	11.0%	13.60	WN	550.5	481.1	14.4%	752.8
	F9	12.33	12.12	1.7%	12.47	TZ	976.9	924.4	5.7%	695.4
	NK	12.24	12.08	1.3%	12.41	NK	631.0	617.5	2.2%	672.3
	WN	11.22	11.43	-1.8%	12.03	B6	735.3	757.3	-2.9%	638.8
	FL	11.13	11.51	-3.3%	11.85	FL	456.4	497.4	-8.2%	603.7
	TZ	12.17	13.22	-7.9%	11.28	F9	568.6	625.8	-9.1%	597.9

Table 19 Stage length adjusted aircraft productivity and utilization results in 2006

We then compare these numbers to the rankings summary presented in section 5.2.3 and obtain the new set of results in Table 20.

*Adjusted (in black) and non-adjusted (in grey) rankings in 2006*

	<b>BH/ACDay</b>	<b>ASM/ACDay</b>		<b>BH/ACDay</b>	<b>ASM/ACDay</b>
<b>AA</b>	<b>6</b>	<b>5</b>		<b>1</b>	<b>4</b>
<b>CO</b>	<b>4</b>	<b>6</b>		<b>2</b>	<b>6</b>
<b>DL</b>	<b>2</b>	<b>1</b>		<b>5</b>	<b>5</b>
<b>NW</b>	<b>5</b>	<b>3</b>		<b>3</b>	<b>3</b>
<b>UA</b>	<b>3</b>	<b>2</b>		<b>6</b>	<b>2</b>
<b>USHP</b>	<b>1</b>	<b>4</b>		<b>4</b>	<b>1</b>
			<b>B6</b>		
			<b>F9</b>		
			<b>FL</b>		
			<b>NK</b>		
			<b>TZ</b>		
			<b>WN</b>		

**Table 20 SL adjusted and non-adjusted productivity and utilization rankings in 2006**

We can see that there are many differences between both sets of rankings. In terms of BH/ACDay, in the Legacy group, USHP jumps in first place from fourth, while the leader UA drops to third. Looking at their productivity levels, UA drops to second while DL edges up to first.

For the LCCs, B6 keeps its utilization dominance but slips from second to fourth place in terms of aircraft productivity. The other big story is that of WN which takes the number one spot coming back from fifth place in our non-adjusted rankings. WN therefore has much higher aircraft productivity than any other LCC if we adjust for its low stage length. This is line with its reputation in the industry as the most productive airline. However in terms of utilization WN remains in fourth place.



## 5.4. Detailed Fleet Level Analysis

### 5.4.1. Aggregate Analysis: Legacy vs. LCC Narrow-Body Fleets

This section compares productivity and utilization for Legacy and LCC carriers. Figure 64 gives the results comparing both groups and their narrow-body fleet. In terms of utilization we can see that as was the case in Figure 43, LCC carriers have had much higher utilization rates than the Legacies. Furthermore the gap seems to be widening since 2001. While LCCs have managed to steadily increase their aircraft utilization, the Legacy carriers experienced a big downturn and have struggled to bring their utilization levels back up. In 2006 they've managed to reach the utilization levels that they had in 2000 however the growth has been slow and only started in 2004.

In terms of aircraft productivity, the story is quite different than the results we had obtained in Figure 44. Whereas at the aggregate fleet level Legacy carriers had much higher aircraft productivity levels than the LCCs, the trend is reversed when isolating narrow-body aircraft. Indeed the results in Figure 64 show that narrow-body productivity levels strongly decreased after 2000 for Legacy carriers as the bulk of their downsizing efforts started initially in the domestic markets. At the same time LCCs profited from the situation and captured significant domestic market share while considerably boosting their productivity levels. However from the start of 2004 the situation was changing. As some Legacy carriers were restructuring and coming out of bankruptcy they experienced a major increase from 2003 to 2004 and another important one from 2005 to 2006. In 2006 they managed to regain most of the ground they had lost in 2001 however LCC carriers still retain a non-negligible advantage.

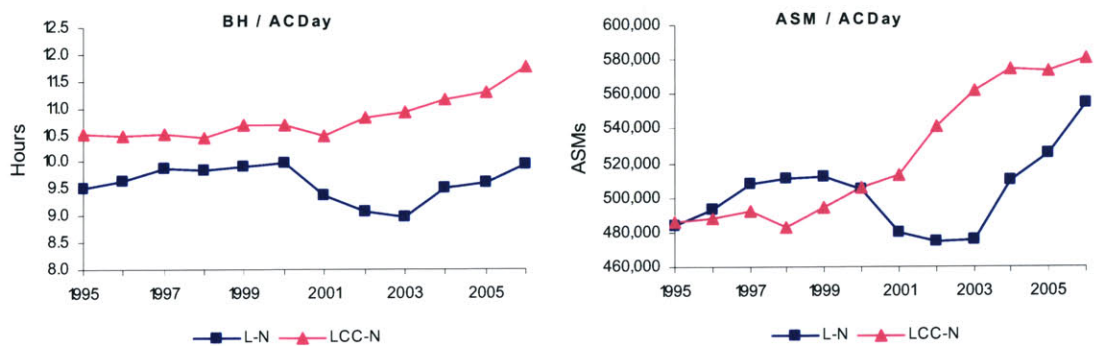


Figure 64 NLC vs. LCC aircraft utilization and productivity of narrow-body fleets



Regarding the drivers of this volatility in aircraft productivity we can see the absolute contribution of each component in Figure 65 while the relative contribution can be seen in Figure 66 and Figure 67. It is clear from these Figures that the main driver behind the slowdown in aircraft productivity for Legacy carriers has been decreased departures/ACday until 2003. This decrease has been so great that it completely overshadowed gains in average seats and stage length that had been achieved. Concerning the LCC growth it has been driven by a significant increase in average stage length while average seats and departures/ACday slightly decreased. These results reflect what we had mentioned earlier in this Chapter that post-9/11 LCC growth had been fueled by the Legacy's inability to cope with the crisis effectively which allowed the LCCs to grow their networks in terms of expanding their flights via increased departures and new markets.

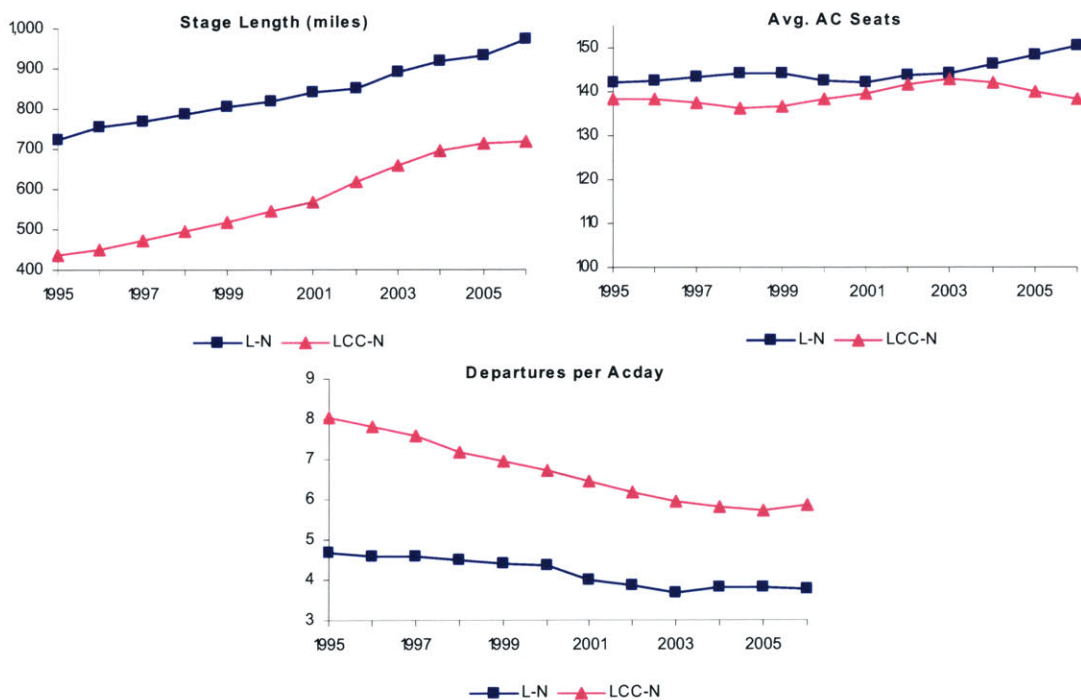


Figure 65 Legacy vs. LCC aircraft productivity drivers of narrow-body fleets

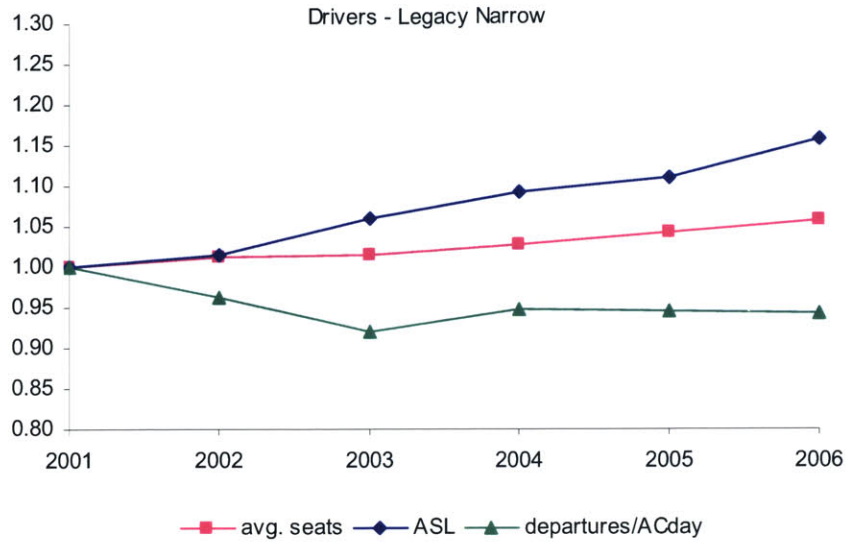


Figure 66 Legacy narrow-body aircraft productivity drivers index

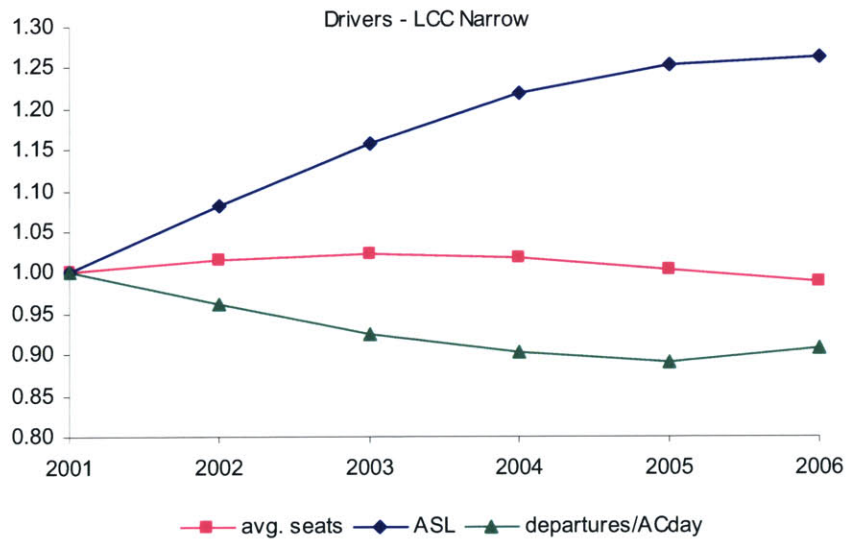


Figure 67 LCC narrow-body aircraft productivity drivers index

### 5.4.2. Aggregate analysis: Legacy Wide vs. Narrow-body Comparison

This section analyzes productivity and utilization for Legacy carriers comparing results between their wide-body and the narrow-body fleets.

In terms of aircraft utilization reported in Figure 68 we can see that both fleet types had very similar utilization patterns. As expected wide-body utilization remained significantly higher than narrow-body utilization – on average the gap was above 1.5 hours per AC day which is very wide. The curves are also highly correlated with a correlation coefficient of 83% throughout the period. This correlation breaks down slightly after 2003 as the shift to international flying pushed wide-body aircraft utilization growth higher than that of the narrow-body fleet.

In terms of aircraft productivity the results display a similar pattern. The two curves are slightly less correlated with a correlation coefficient just under 70% but this changes between 2003 and 2006 as the growth in wide-body productivity gains accelerated faster than the increases seen for the narrow-body fleet. Breaking down aircraft productivity into its sub-components in Figure 69 and Figure 70, we see that wide-body stage length has increased by around 20% while departures/ACday decreased by roughly half that amount and average seats remained flat. As a result wide-body productivity levels have only slightly increased if we compare from 1995 to 2006. Concentrating on the narrow-body fleet, as we can see in Figure 66 departures decreased by around 5% while stage length increased by a little more than 18% and average seats increased slightly by around 5%. As a result, narrow-body productivity has increased throughout the period.

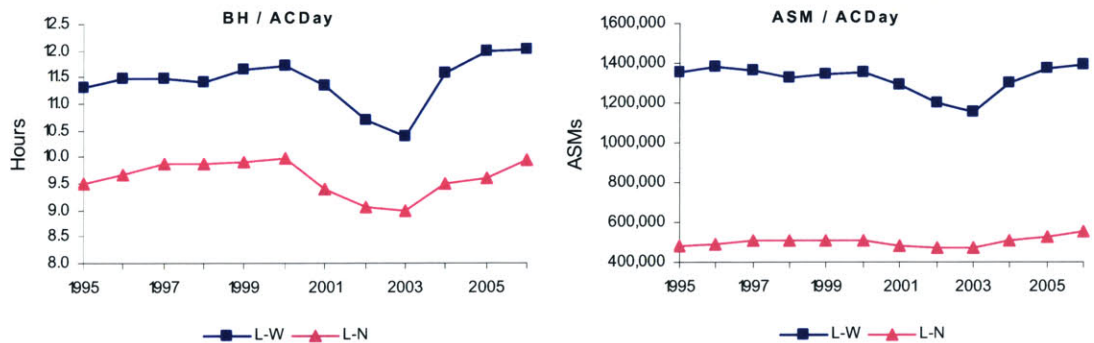


Figure 68 Legacy aircraft utilization and productivity of wide vs. narrow-body fleets

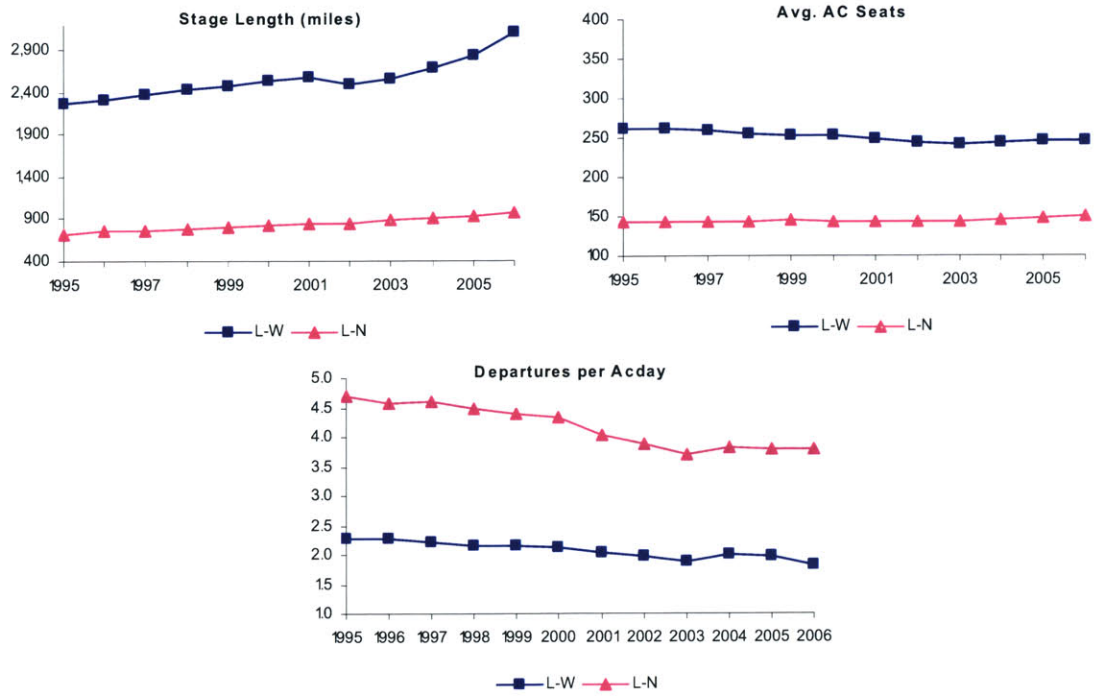


Figure 69 Legacy aircraft utilization and productivity drivers of wide vs. narrow-body fleets

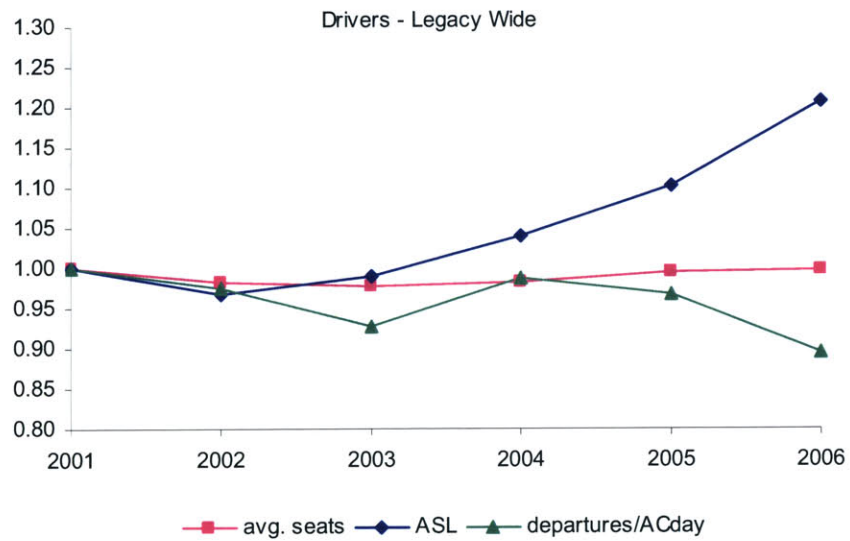


Figure 70 Legacy wide-body aircraft productivity drivers index

### 5.4.3. By-Carrier Analysis: Aircraft Utilization (BH/ACDay)

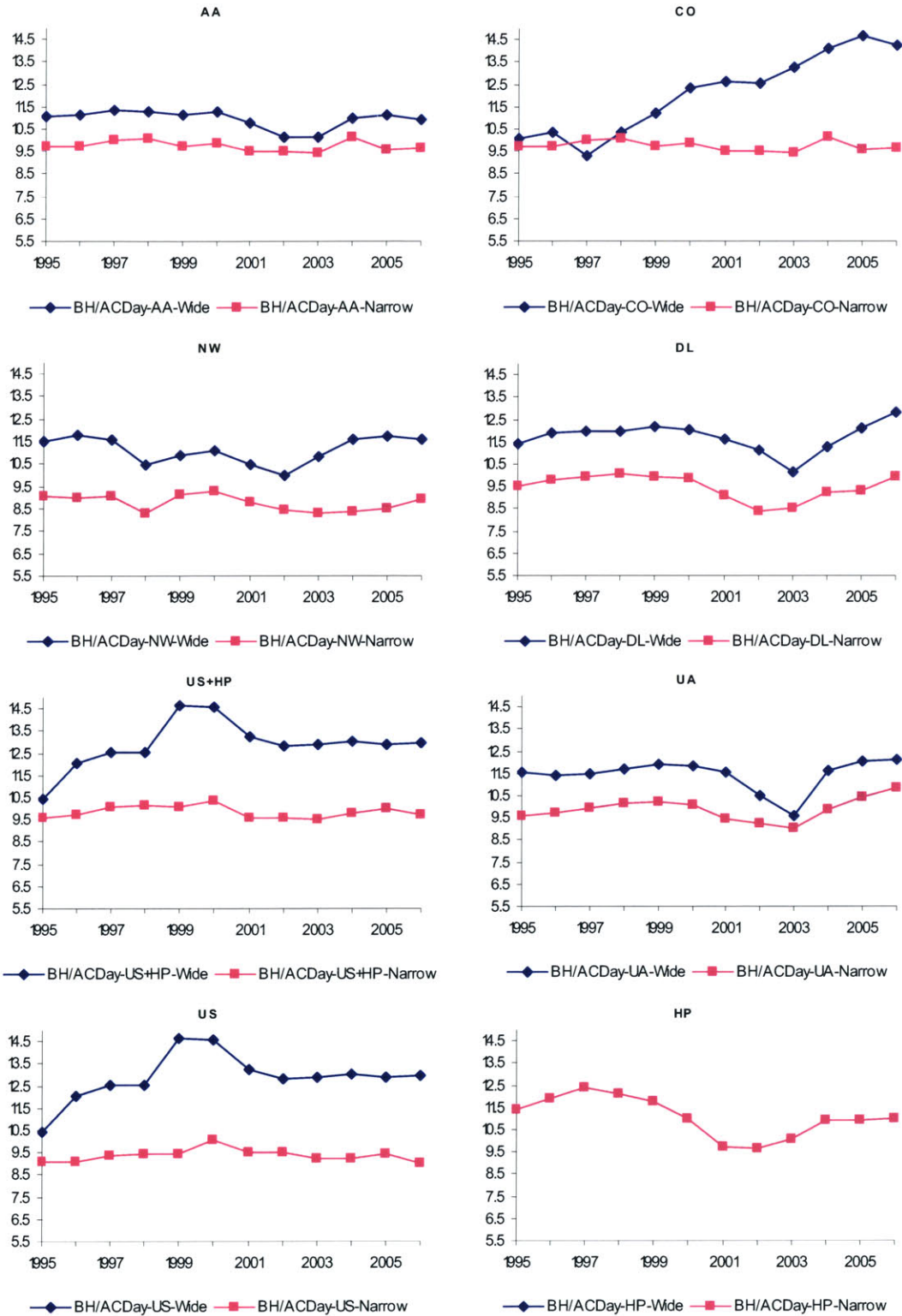
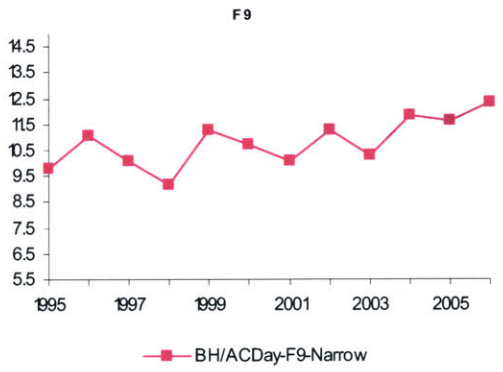
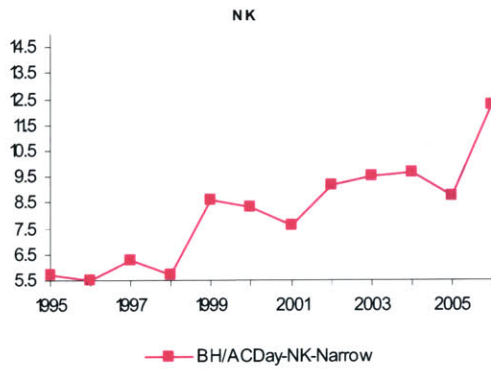
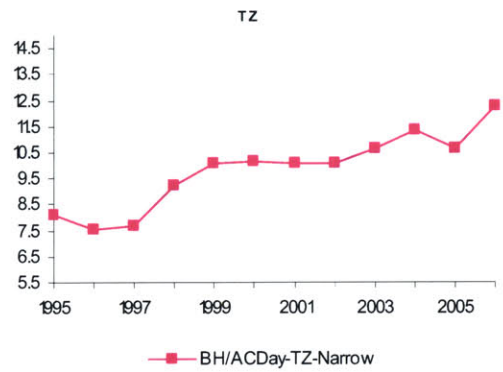
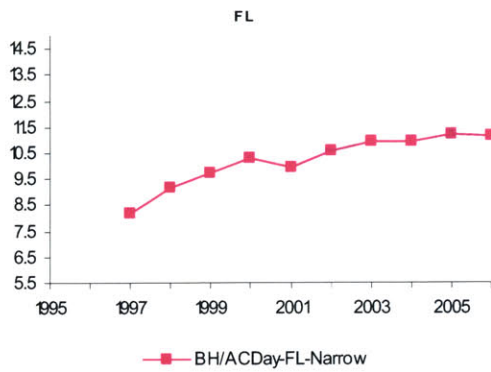
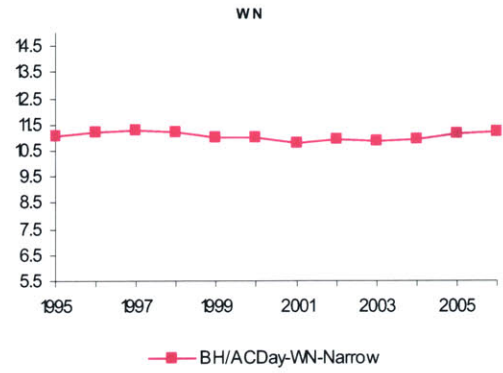
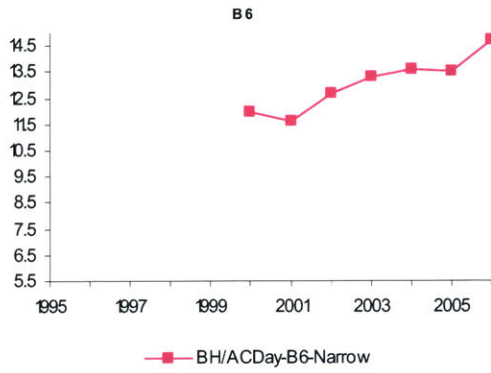


Figure 71 By-carrier Analysis: Legacy aircraft utilization, Wide vs. Narrow-body fleets



**Figure 72 By-carrier Analysis: LCC aircraft utilization of Narrow-body fleets**



Looking at the detailed utilization graphs in Figure 71 we see that the gap between utilization rates of wide-body and narrow-body aircraft vary greatly depending on the airline we are considering. For example AA and UA arguably have the lowest gap between their wide and narrow-body fleets (on average around 1 hour) while CO and USHP have a gap that's significantly higher (on average around 2 to 3 hours). These differences reflect the underlying network structures and strategies that each carrier has. In the case of CO for example we can see that their focus in shifting to international markets after 2002 significantly increased the gap between their narrow-body and wide-body fleet going from 3 hours in 2002 to almost 5 hours in 2006. In the case of USHP we expect its results to reflect the effects of the merger between the HP LCC component and the US Airways Legacy structure. Surprisingly though there is no visible shock on the graph at the time of the 2005 merger which indicates that utilization rates barely changed.

Concerning the LCC results we can see in Figure 72 that there has been a lot of volatility in utilization rates. The leader of the group is indisputably B6 which went from 11.5 hours of utilization in 2001, to more than 14.5 hours in 2006. This high level of utilization is astounding and places B6 as the number one carrier in terms of utilization, not only within its LCC group but across the entire industry. B6's success is attributable to its high stage length but also to its quick turn-around times. The other turn-around time leader WN however has had less success in achieving ultra-high utilization rates no-doubt limited by its lower average stage length. Its utilization levels have barely changed since 1995 and have been kept on average at around 11 hours per AC day. This is actually not higher than its peers which slightly demystifies WN's reputation as the utilization leader in the industry.

### 5.4.4. Case-by-case: Legacy Carriers ASM/ACDay

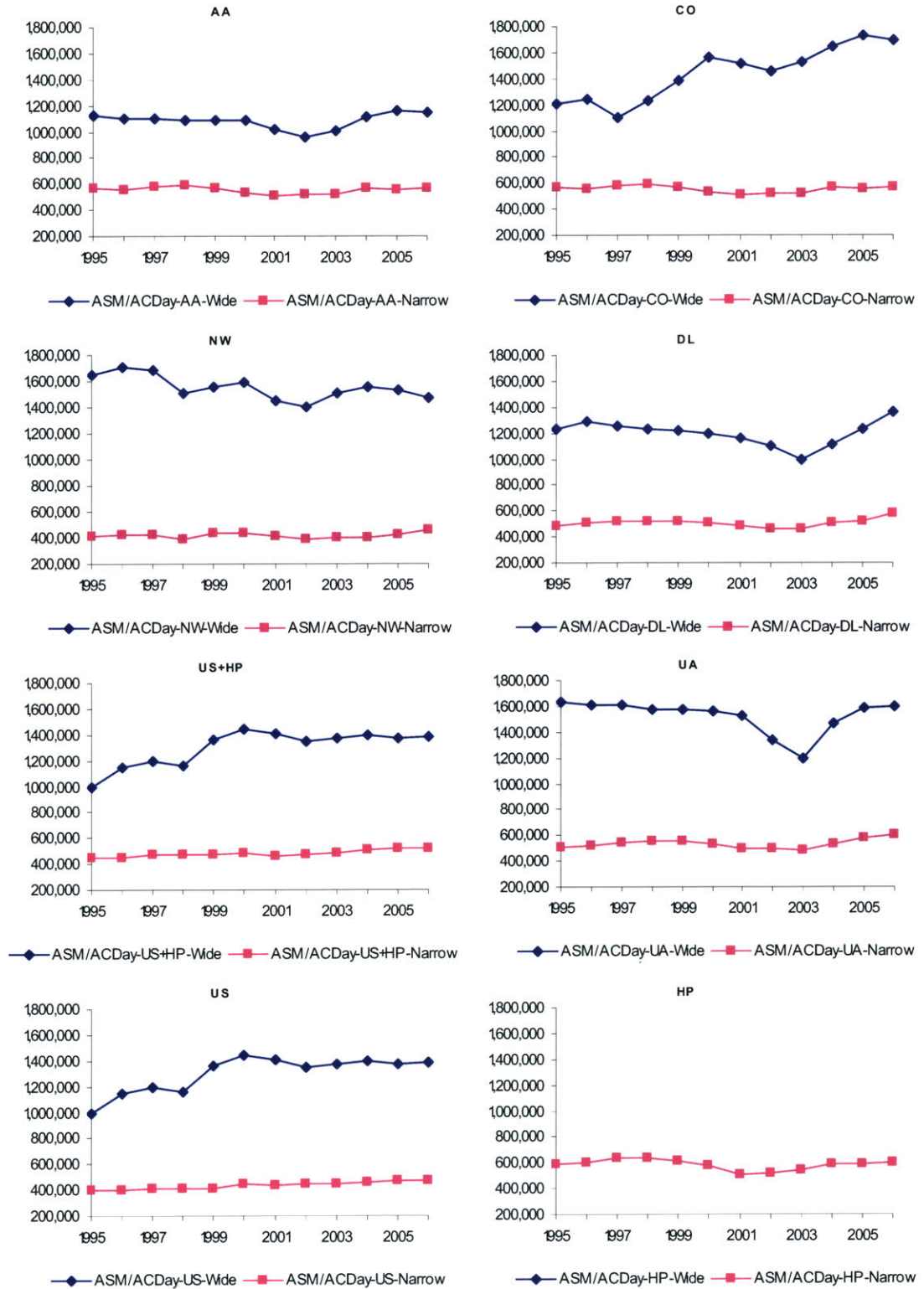


Figure 73 By-carrier Analysis: Legacy aircraft productivity, Wide vs. Narrow-body fleets



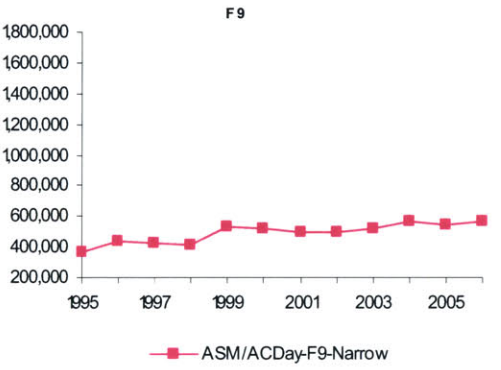
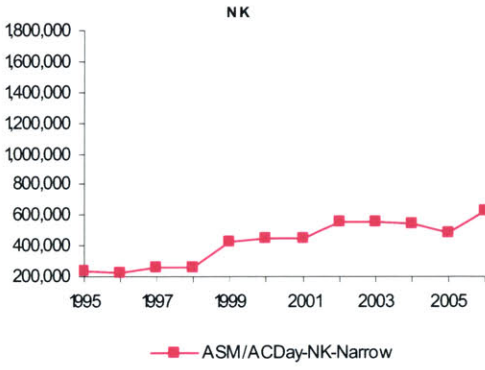
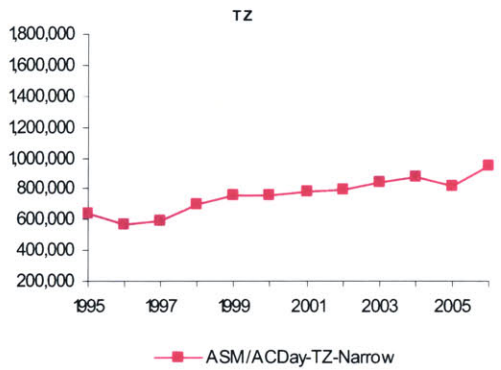
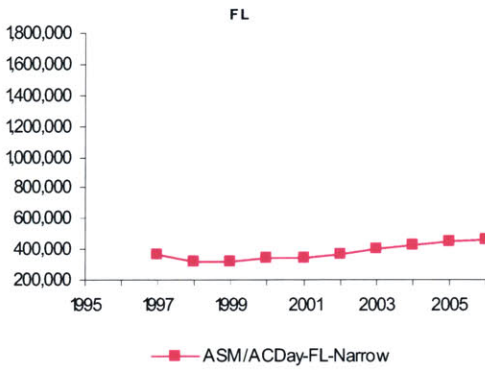
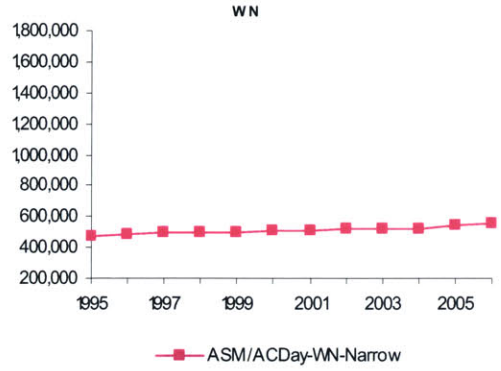
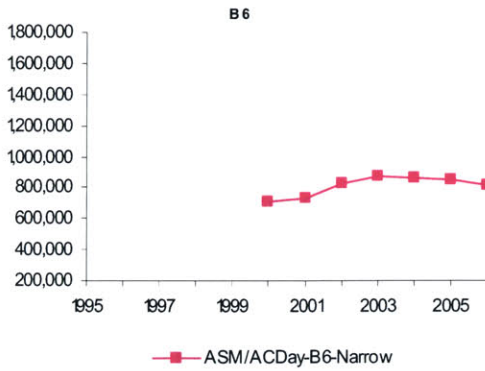


Figure 74 By-carrier analysis: LCC aircraft productivity of narrow-body fleets

The results for aircraft productivity are given in Figure 73 and Figure 74. Comparing wide-body to narrow-body fleets we can see that wide-body productivity has been substantially higher than that of the narrow-body for all Legacy carriers in our data set. The most striking example is CO whose wide-body vs. narrow-body productivity gap has been increasing quickly since 1997. In fact by 2006 CO wide-body planes were almost three times more productive than narrow-body. Some other interesting results are NW and UA who have been respectively around three and four times more productive with their wide-body fleet than with their narrow body. Furthermore these three carriers are also the ones with the highest percentage of international ASMs as was shown in Figure 54. There thus seems to be a logical positive correlation between % of international ASMs and aircraft productivity – hence the general focus observed since 2003 on international markets.

We can also try to tie these results back to the aircraft utilization results we obtained in the previous section. The logic would be that airlines with higher utilization rates should also have higher aircraft productivity levels and vice versa. Analyzing our set of Legacy carriers we can see that this result holds to a great extent. For example our top three airlines in terms of utilization – CO, DL and UA, are also the top three players in terms of productivity (although not in the exact same order). Looking at this from a quantitative perspective the correlation between both measures is positive and very high – we obtain a correlation coefficient of 88% for the Legacy carriers and 92% for the LCCs.

#### 5.4.5. Summary of Aircraft Utilization and Productivity Results

In this Chapter we have analyzed the differences in aircraft utilization and productivity between Legacy carriers and LCCs and have found the following:

LCCs achieved higher utilization rates than the Legacy carriers during a time that they also captured significant market share after the 9/11 crisis. They also improved the aircraft productivity deficit that existed since 1995 although they did not manage to surpass the Legacies in this area. This amelioration was driven by a real growth of their networks and expansion of their flights and average stage length. Furthermore in terms of the underlying components that drove the productivity results we noted the following: Legacy carriers raised their stage length and reduced their departures/ACday while keeping their average seats unchanged. This reflects the downsizing effect after 9/11 but also the strategic shift to expand their flying into the international markets. On the LCC side, the productivity gains were driven by increased stage length which more than offset decreases in departures/ACday. Again this reflects the real network growth that LCCs experienced during this period.

Continuing with our analysis at the individual carrier level we noted that the best performing Legacy carriers in terms of aircraft productivity gains were the ones that had the most increase in percentage of international ASMs. We also established a positive correlation link between utilization rates and productivity rates suggesting that both are subject to the same type of underlying forces. Regarding the LCCs we were somewhat surprised to find that the historical industry leader Southwest was actually not as productive with their aircraft as we could think. In fact it is only after adjusting our results for stage length that WN's reputation as one of the most productive airlines was actually justified. Furthermore, the regressions in this Chapter show that both aircraft utilization and productivity are significantly influenced by stage length and adjusting for this variable showed how much different the rankings could be (i.e. WN going from fifth to first in terms of aircraft productivity).

The last step of our analysis was to compare these results on the fleet level looking at wide-body and narrow-body trends. We found that the main growth in productivity and utilization

for Legacies came from their wide-body fleets. In fact by comparing narrow-body results between Legacy carriers and LCCs we found that the productivity trend that had Legacy carriers in front was actually reversed. When isolating narrow-body aircraft it was clear that LCCs had a significant advantage over Legacy carriers in terms of both aircraft utilization and productivity.

## Chapter 6

# Employee Productivity Analysis

This Chapter comprises the final part of our study and concentrates on employee productivity. It is structured in the same way as Chapters 4 and 5. We start by presenting the results for our aggregate analysis and continue with the individual carrier analysis. This part is followed by a brief analysis performed at the fleet level and we conclude the Chapter by summarizing our results.

### **6.1. Aggregate Industry Employee Productivity Comparison: NLC vs. LCC**

#### **6.1.1. Number of Employees**

Looking at raw employee numbers in Figure 75 we can see how dramatic the Legacy downsizing efforts have been on labor. From 2000 to 2006 they cut more than 30% of their workforce which represents over 100,000 employees from our sample set of 6 airlines. At the same time the LCCs saw their employment numbers increase gradually and gained over 20% from 2000 to 2006. These two opposite trends reflect how differently both groups dealt with the economic crisis we have mentioned in the previous Chapters.

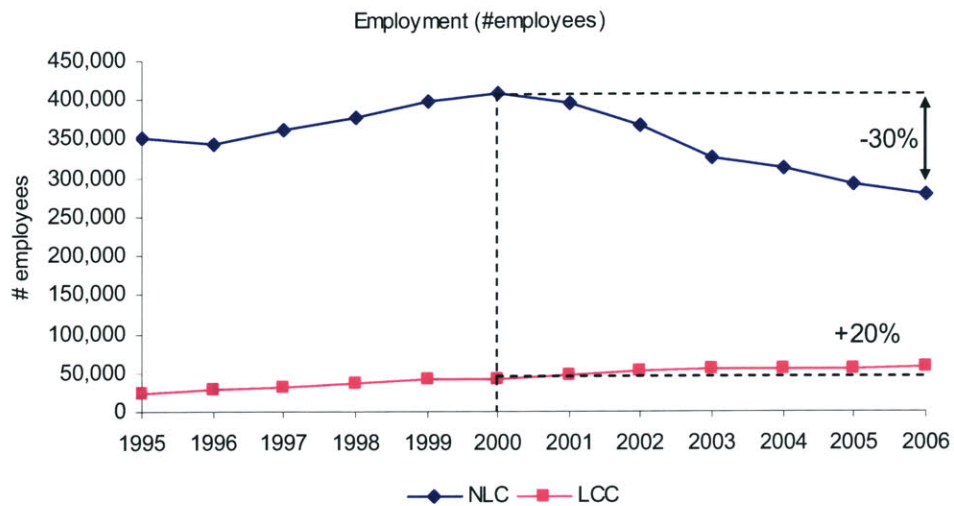


Figure 75 Aggregate Analysis: Employment numbers 1995-2006

### 6.1.2. Total Salaries and Benefits per Employee

In Figure 76 we see the change in average total salaries and benefits per employee over time. In 2006 the average total compensation for LCC employees surpassed that of the Legacy carriers by about \$4,000 per year. This first-time result is a consequence of the cost-cutting efforts that the Legacy carriers initiated after entering the crisis period in 2001. We will get more confirmation throughout this Chapter that the bulk of their cost-cutting efforts essentially targeted labor savings, also confirming our findings from Chapter 4.

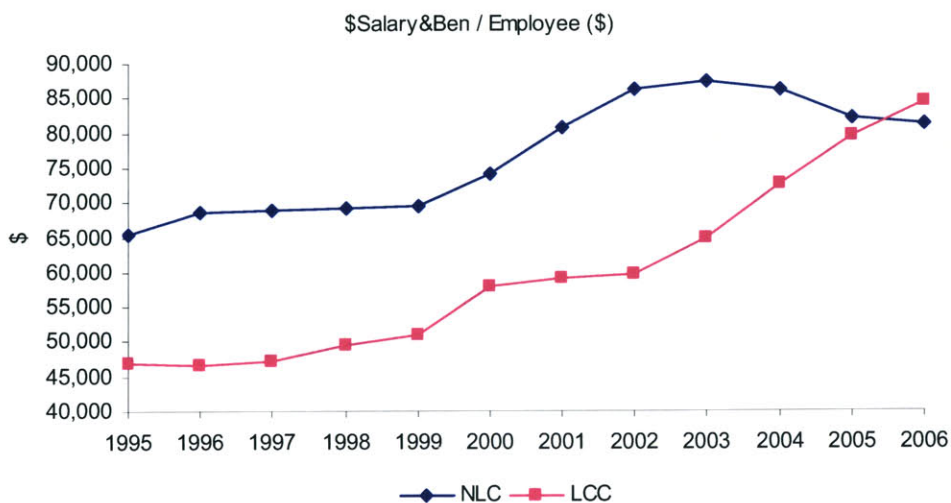


Figure 76 Aggregate Analysis: Total salaries and benefits per employee 1995-2006

### 6.1.3. Employee Productivity

To assess employee productivity we use four different measures: ASM/employee (Figure 77), ASM/\$salary and benefits (Figure 78), enplaned passengers/employee (Figure 79) and enplaned passengers/employee dollar (Figure 80).

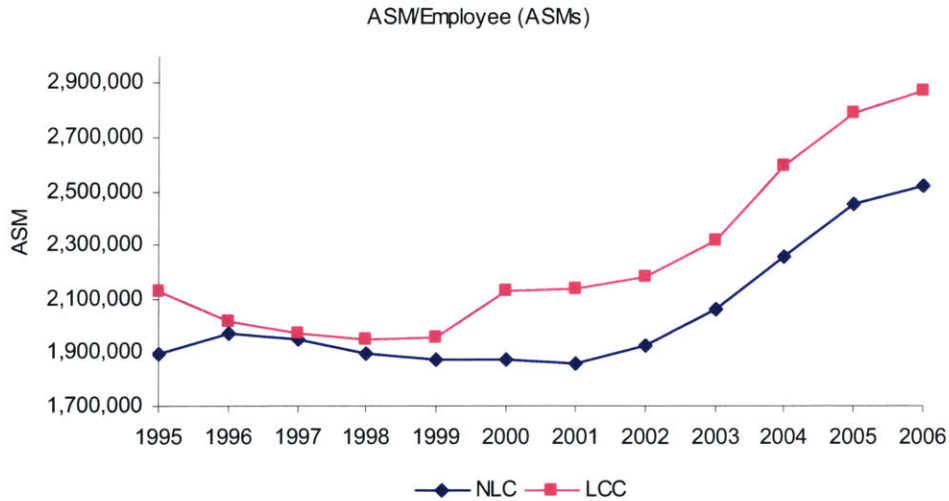
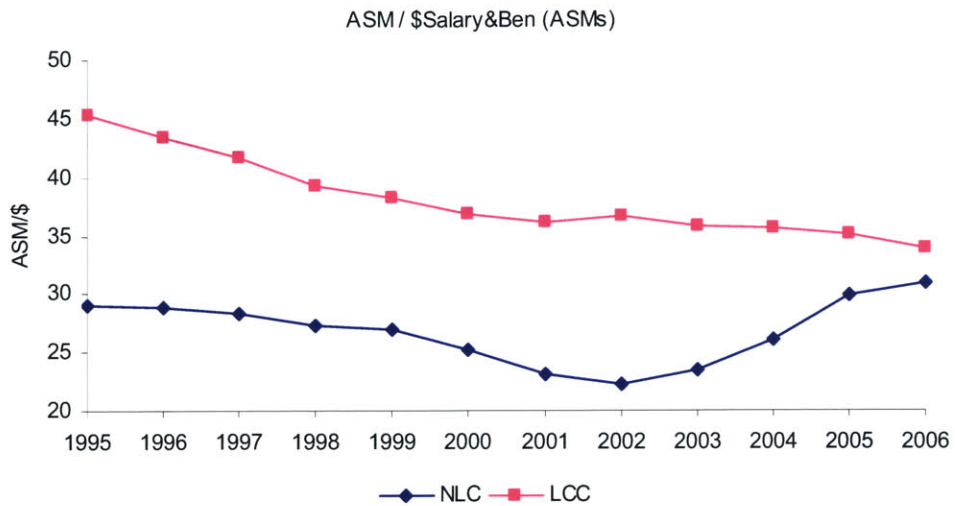


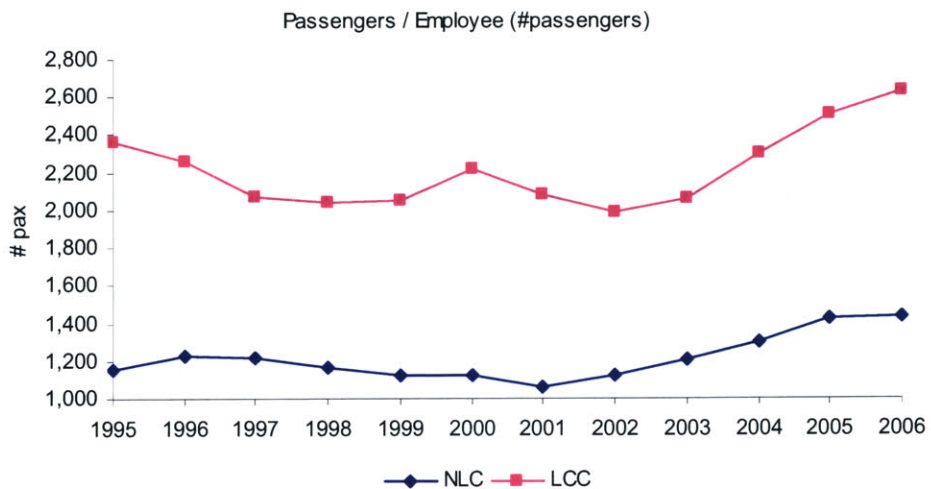
Figure 77 Aggregate Analysis: Employee productivity 1995-2006

Figure 77 constitutes our primary measure of employee productivity and we can see that throughout our entire sample period, the LCC carriers were outputting more ASMs per employee than the Legacy carriers. The gap between the two groups increased in 2000 and has remained almost constant until 2006 at around 200,000 ASMs per employee. In terms of employee productivity the LCCs thus hold a clear advantage over the Legacy carriers with no evident sign of convergence observable. Another interesting trend visible here is just how significantly the employee productivity has been increasing since 2001 for both groups. For the Legacy carriers this can be tied back to the results we obtained for ASMs in Figure 45 and number of employees in Figure 76. From these two Figures it is clear that the increase in employee productivity has been driven by a faster decrease in employment numbers than the ASM decrease experienced after 2001. In this sense we can describe this productivity gain as resulting from labor cuts. On the other hand looking at LCCs we can see that their productivity gain resulted from their employment numbers increasing more slowly than their ASMs. The LCC employee productivity gains result from efficient network expansion confirming our findings from Chapter 5.



**Figure 78 Aggregate Analysis: Employee wage productivity 1995-2006**

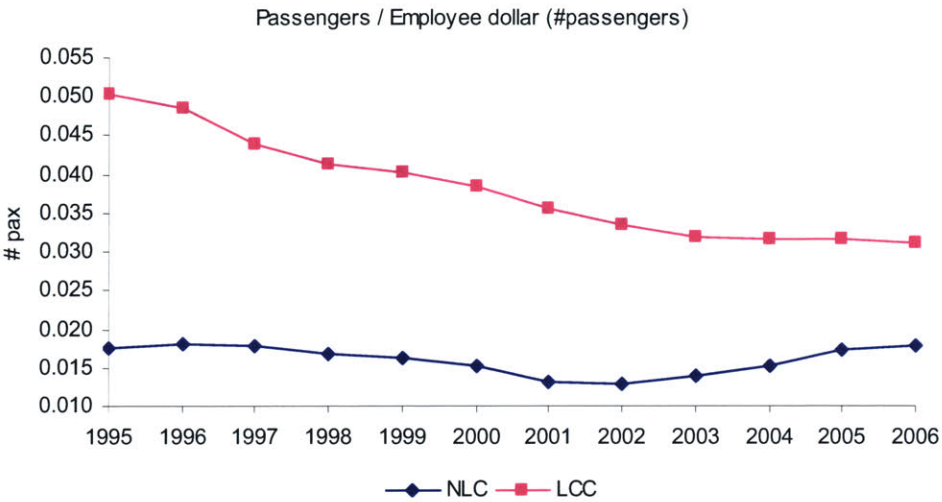
In Figure 78 we have plotted another measure of employee productivity in terms of ASMs produced per total dollar paid out to employees. Although historically LCCs had been outputting more ASMs per labor dollar we can see that the spread between them and the Legacy carriers has been narrowing since 2002. The peak value was reached during that year and the gap was at 15 ASMs per dollar. By 2006 Legacies had increased their productivity and closed the spread to just 4 ASMs per dollar. This convergence is the result of the labor cost-cutting efforts we described in Chapter 4 that the Legacies utilized while in bankruptcy protection during the crisis period. At the same time the LCC productivity decline that has been going on since 1995 shows the effects of the staff becoming more senior and demanding higher pay levels.



**Figure 79 Aggregate Analysis: Passengers per employee 1995-2006**



Figure 79 shows the results of another measure of employee productivity given in terms of passengers enplaned per employee per year. The LCCs have a clear advantage here enplaning on average around 1,200 more passengers per employee in 2006. This gap is quite large and has remained at this high level throughout the entire sample period. We can see that there have been some improvements for both groups starting 2002 for the Legacy carriers and 2003 for the LCCs as both managed to start increasing this measure after several years of decline.



**Figure 80 Aggregate Analysis: Passengers per employee dollar 1995-2006**

Figure 80 shows the results of our last measure of employee productivity shown in terms of passengers per total employee compensation and benefits paid out. This graph has the same types of trends as Figure 78 and the convergence seen here has the same underlying reasons. The one difference we can see here is that convergence seems to be happening at a slower pace than in Figure 78.

## **6.2. Individual Airline Employee Productivity Analysis**

### **6.2.1. Employee Productivity (ASM/Employee)**

The results from the previous section show that there has been a significant increase in employee productivity for both Legacy and LCC carriers. The Figures in the next page illustrate the contribution of each carrier to this result. Figure 81 shows the increase in employee productivity for each carrier from 2001 to 2006. We notice that every airline has contributed in a positive way to the aggregate results.

On the Legacy side the increases range from 11% at USHP to 48% at UA. Combining this with the results from Figure 82 that show change in employment numbers we see that all Legacy carriers reduced their workforce during the same period. The decreased ranged from 7% at CO to 41% at UA. It is thus not coincidental that UA led the pack in employee productivity increase given how severe their labor cuts were. On a side note, we also notice in Figure 82 that AA and CO – the only two airlines that did not go through bankruptcy protection – are also the ones with the lowest workforce decreases. Despite this they both managed to improve their employee productivity considerably. In the case of CO it was principally due to an increase in ASMs that came from their international flying while in the case of AA it was a combination of increased ASMs and decreased workforce.

On the LCC side we see even more dramatic changes in employee numbers. With the exception of NK and FL, LCCs increased their workforce numbers significantly. B6 had an astonishing 340% increase from 2001 to 2006 followed by an 88% increase at F9 and a 75% increase at FL. On the other hand WN only increased its employment numbers by 4% indicating that the airline was more conservative regarding growth. The remaining two LCCs saw a decline in their employee numbers. The most significant was at TZ which cut its workforce by 60%. This was a result of the airline being taken private as we mentioned in Chapter 4.

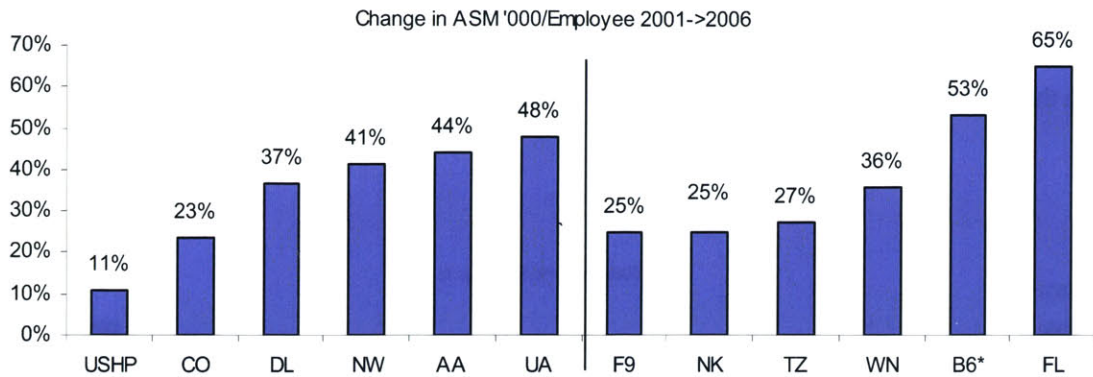


Figure 81 Change in employee productivity 2001 -> 2006

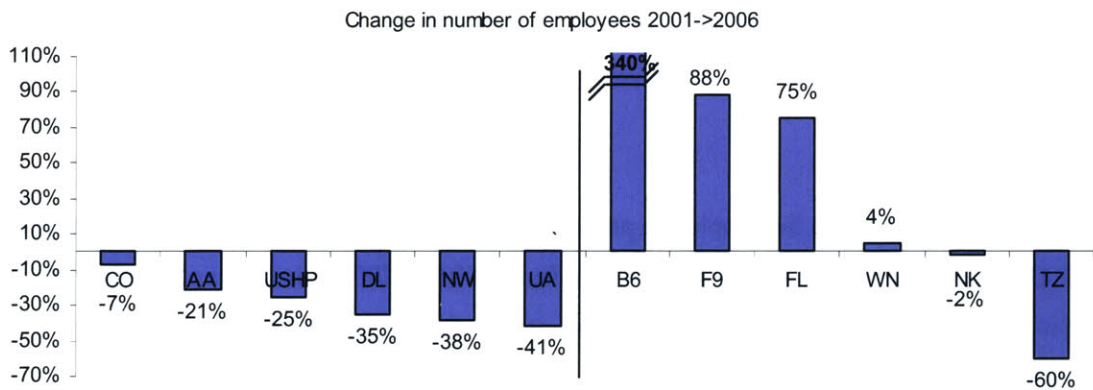


Figure 82 Change in number of employees 2001 -> 2006

Figure 83 gives the 2006 rankings in terms of absolute levels of employee productivity and we can see how these levels changed from 1995 to 2006 in Figure 84 and Figure 85. Leading the Legacy group are NW and DL while CO and USHP take the two last spots. In the case of NW we can see that they've been steadily increasing their employee productivity since 2001 and they have been above the industry average since 1999. Part of the explanation lies in their low employee numbers. Indeed NW is the Legacy carrier with the lowest number of employees as we can see in the annexes in Figure 102. In the case of USHP we might consider its ranking in last place as surprising given its merger with low-cost HP and the results from the previous section

showing that LCCs had much higher employee productivity levels. In fact prior to completing the merger US was actually above the industry average as we can see in Figure 84. It must be the case that the synergies from the merger were not yet apparent in 2006.



**Figure 83 Employee productivity rankings in 2006**

*Note: B6 results are given for 2003 and 2006*

On the LCC side the employee productivity leader in 2006 was TZ followed by B6 and WN. Given that TZ cut its workforce by 60% from 2001 to 2006 it is thus not very surprising to find it in first place in terms of employee productivity. Looking at B6 the story is also interesting given its dramatic increase in employment since 2001 of 340%. The fact that B6 remains a productivity leader despite this strong employee increase reflects the airline's expertise at handling rapid growth and expansion. However looking more closely at B6's results in Figure 85 we see that its employee productivity seems to have hit a plateau and has actually slightly decreased over the past 3 years suggesting that employee growth has been outpacing ASM growth. This could indicate that B6's opportunities to grow ASMs within the domestic markets where it does most of its flying could be drying up. Lastly if we look at WN's results in Figure 85 we see that the carrier has actually been below the industry average and only crossed above in 2006. This said WN's curve has always been close to the industry average trend line without large deviations. As one of the more mature LCCs we expect its results to be smoother than the other carriers and they are.

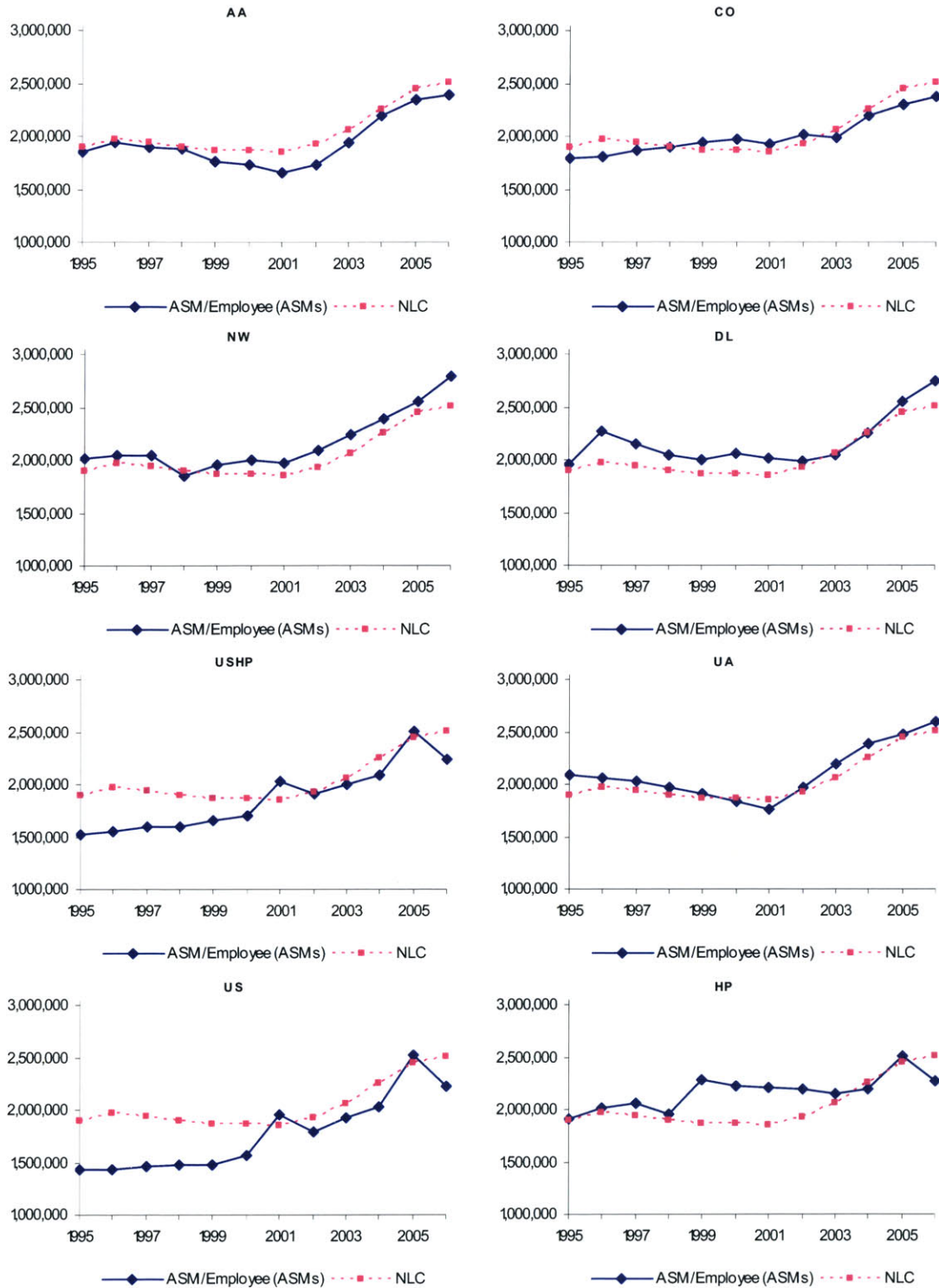


Figure 84 By-carrier Analysis: NLC employee productivity



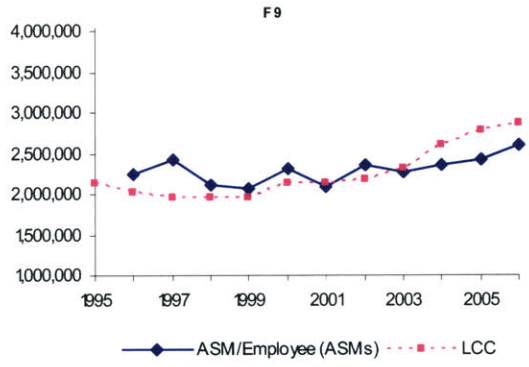
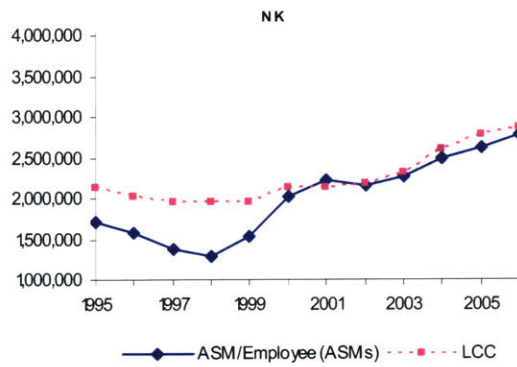
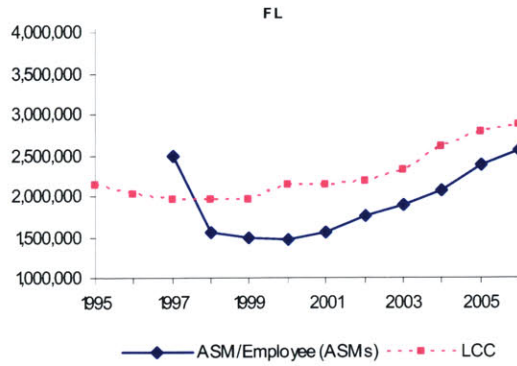
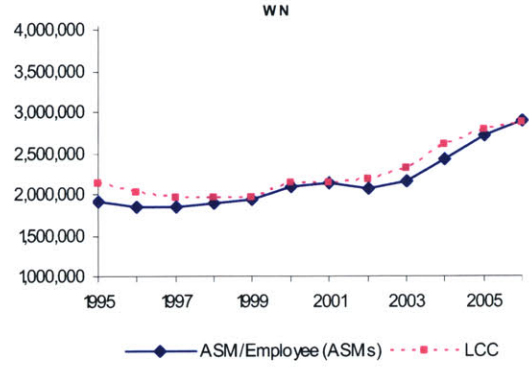
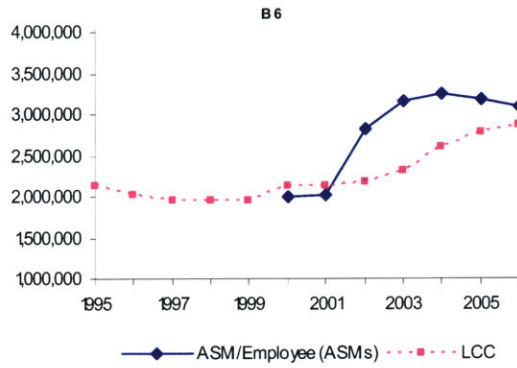


Figure 85 By-carrier Analysis: LCC employee productivity

### 6.2.2. Employee Wages (Total Salary & Benefits /Employee)

The following set of Figures gives details about the average total compensation including benefits paid out to employees. In Figure 86 we see how wages have changed from 2001 to 2006. In the Legacy group there has been a modest increase in wages. The greatest increase was at AA while USHP and UA were the only two carriers that reduced total package compensation during this period. There is a strong contrast here with the results for the LCC group which all experienced significant increases ranging from 29% at F9 to 60% at TZ. In fact an average employee working for an LCC carrier from 2001 to 2006 would have earned an increase of almost 44% in total compensation & benefits whereas the corresponding Legacy carrier employee would have had less than a 1% increase.

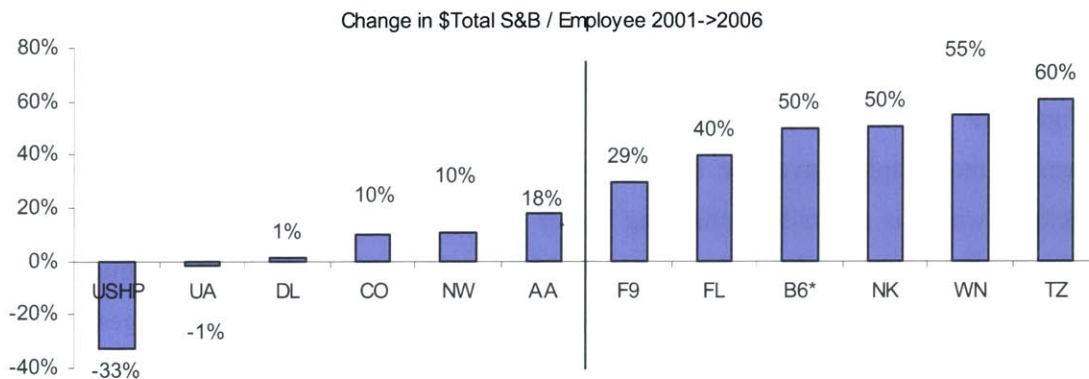


Figure 86 Change in total \$ salaries & benefits per employee 2001 ->2006

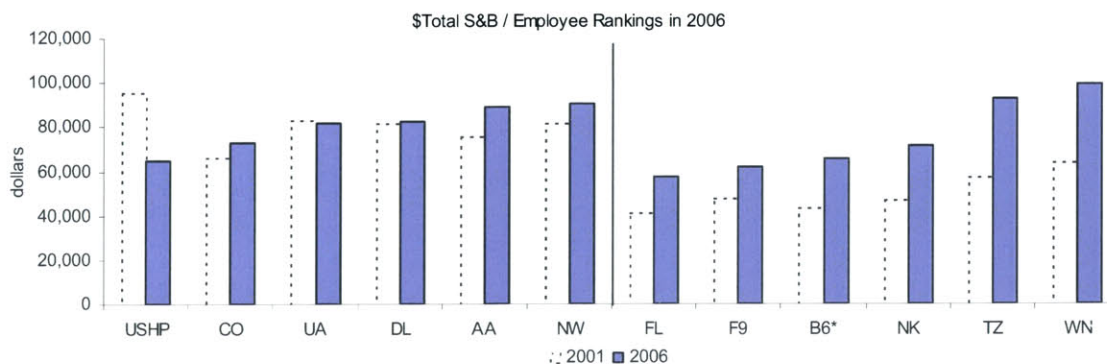


Figure 87 Total salaries & benefits rankings in 2006

In terms of how the airlines compare on an absolute scale we see in Figure 87 that on average in 2006 Legacy carriers still pay their employees significantly more. The exceptions are USHP on the Legacy side and TZ and WN on the LCC side. The results for USHP are not surprising given their merger with USHP. In fact looking at the separate US and HP graphs in Figure 88 we see that HP's salaries were significantly lower than the rest of the Legacy players. The merger between US and HP thus resulted in the decrease in average salaries & benefits paid out seen previously.

Regarding the LCCs, TZ's high pay scale is actually above all Legacy carriers. Again this is due to the carrier being taken private and is not necessarily representative of the LCC as a group. Lastly the LCC leader in terms of highest pay package in 2006 is WN at an average of almost \$100,000 total salaries and benefits paid out per employee. This is also the highest pay package among our entire set of airlines. More insight can be gained into WN's results by looking at Figure 89. The airline has always been above the LCC trend-line and its spread has been increasing more rapidly over the last few years. This is a direct consequence of WN's aging workforce which is naturally demanding higher packages as they get more senior. This could eventually become a problem in terms of WN's profit margin as its cost structure starts resembling more that of a Legacy carrier's. We can see the effects of these high wages in the next section where we look at productivity in terms of ASMs per total package paid out to employees.



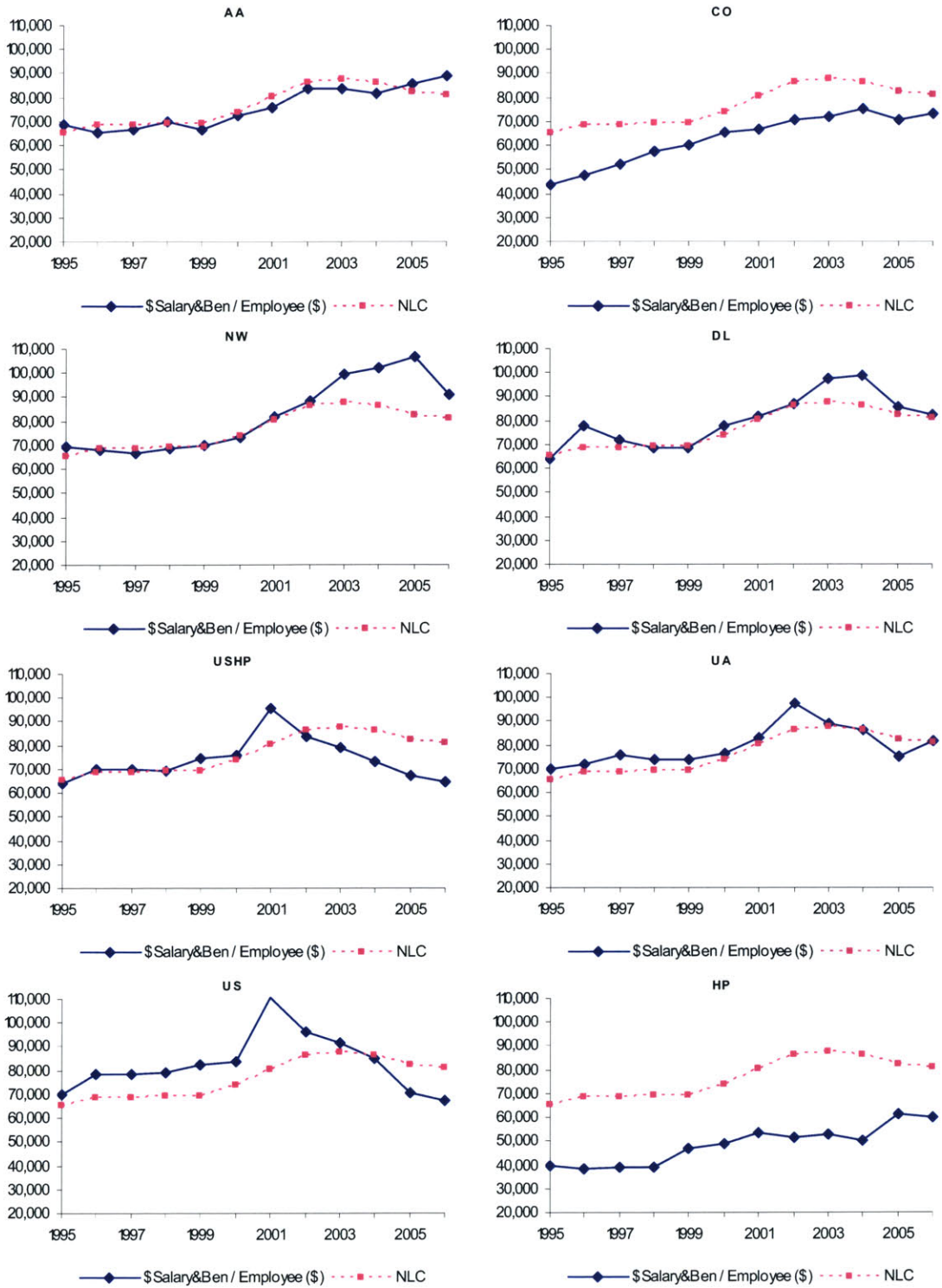


Figure 88 By-carrier Analysis: NLC employee wage productivity

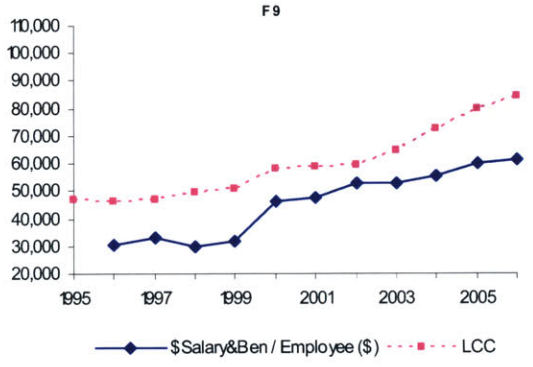
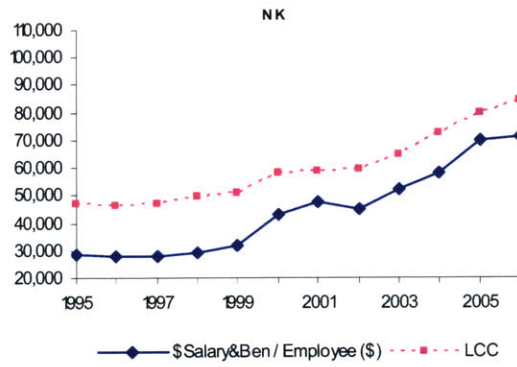
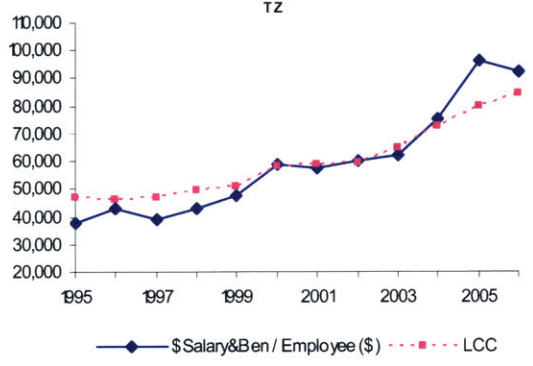
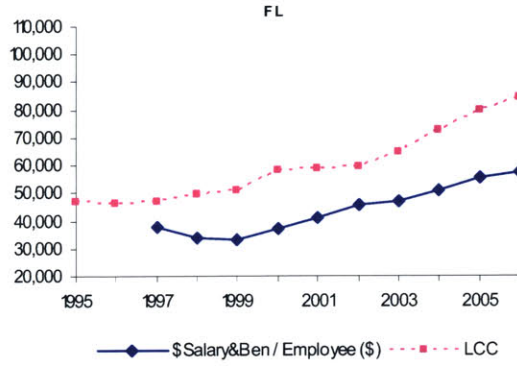
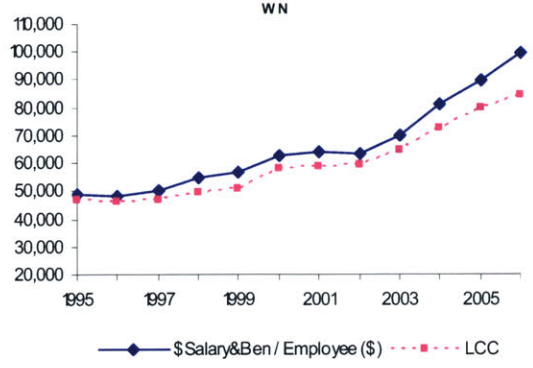
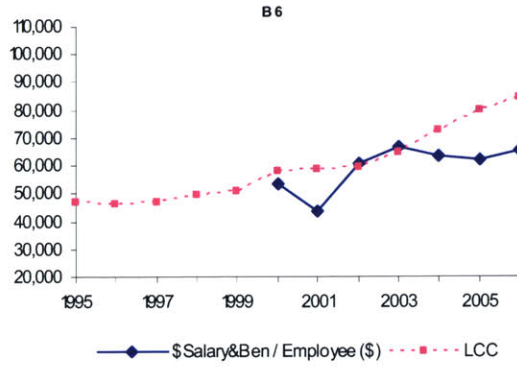


Figure 89 By-carrier Analysis: LCC employee wage productivity

### 6.2.3. Employee Wage Productivity (ASM / Dollar of Salary & Benefits Paid)

In our aggregate analysis in Figure 78 an evident convergence could be seen between the Legacy carriers and the LCCs in this measure of employee productivity. Figure 90 below shows how ASMS per dollar paid out have changed since 2001 for each airline. We can see that the Legacy carriers all experienced an important increase in this measure starting with USHP at 64.2%. As we have seen before these increases are due to the decrease in salaries and employees that the Legacy carriers have undertaken since 2001. Conversely on the LCC side we see the opposite trend arising. In terms of absolute rankings seen in Figure 91, USHP as the Legacy with the lowest pay package per employee also has the highest employee wage productivity. Looking at the LCCs we find WN to have the lowest employee wage productivity of all LCCs resulting from the fact that it also has the highest pay package among all carriers.

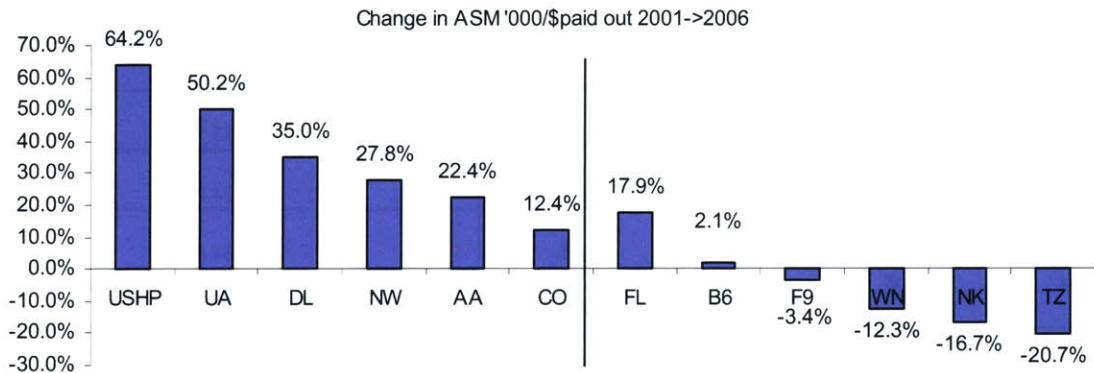


Figure 90 Change in ASMs/\$paid out 2001 ->2006

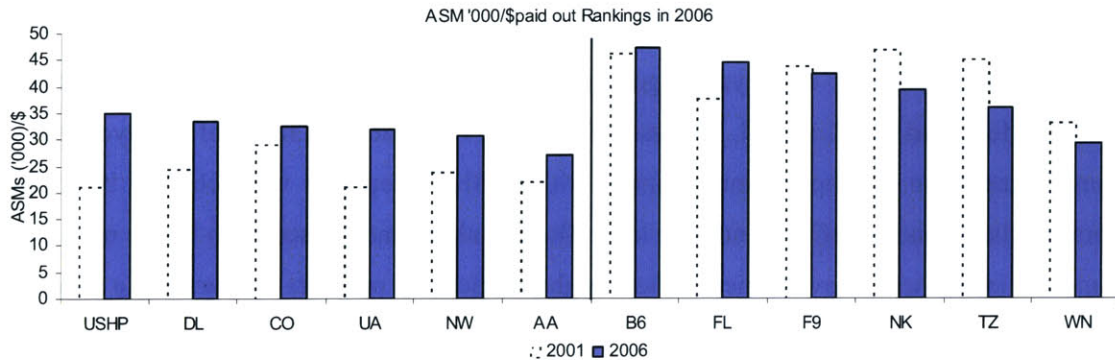


Figure 91 ASMs / \$paid out rankings in 2006

## 6.2.4. Employee Productivity Rankings

Table 21 summarizes our findings in this section ranking each airline in different productivity categories.

	Standings in 2006 (Rank and value)				Biggest improvements 2001->2006		
	ASM/Empl.	\$S&B/Empl.	ASM/\$Sal		ASM/Employee	\$S&B/Empl.	ASM/\$Sal
<b>AA</b>	<b>4</b> 2392	<b>2</b> 88,881	<b>6</b> 26.9	<b>AA</b>	<b>2</b> 44.0%	<b>1</b> 17.7%	<b>5</b> 22.4%
<b>CO</b>	<b>5</b> 2378	<b>5</b> 72,929	<b>3</b> 32.6	<b>CO</b>	<b>5</b> 23.5%	<b>3</b> 9.8%	<b>6</b> 12.4%
<b>DL</b>	<b>2</b> 2753	<b>3</b> 82,627	<b>2</b> 33.3	<b>DL</b>	<b>4</b> 36.5%	<b>4</b> 1.1%	<b>3</b> 35.0%
<b>NW</b>	<b>1</b> 2789	<b>1</b> 90,636	<b>5</b> 30.8	<b>NW</b>	<b>3</b> 41.2%	<b>2</b> 10.5%	<b>4</b> 27.8%
<b>UA</b>	<b>3</b> 2602	<b>4</b> 81,915	<b>4</b> 31.8	<b>UA</b>	<b>1</b> 48.1%	<b>5</b> -1.4%	<b>2</b> 50.2%
<b>USHP</b>	<b>6</b> 2244	<b>6</b> 64,422	<b>1</b> 34.8	<b>USHP</b>	<b>6</b> 10.7%	<b>6</b> -32.6%	<b>1</b> 64.2%
<b>B6*</b>	<b>2</b> 3083	<b>4</b> 65,315	<b>1</b> 47.2	<b>B6*</b>	<b>2</b> 53.1%	<b>4</b> 49.9%	<b>2</b> 2.1%
<b>F9</b>	<b>5</b> 2601	<b>5</b> 61,582	<b>3</b> 42.2	<b>F9</b>	<b>6</b> 24.7%	<b>6</b> 29.1%	<b>3</b> -3.4%
<b>FL</b>	<b>6</b> 2564	<b>6</b> 57,554	<b>2</b> 44.5	<b>FL</b>	<b>1</b> 64.6%	<b>5</b> 39.6%	<b>1</b> 17.9%
<b>NK</b>	<b>4</b> 2784	<b>3</b> 71,183	<b>4</b> 39.1	<b>NK</b>	<b>5</b> 25.0%	<b>3</b> 50.1%	<b>5</b> -16.7%
<b>TZ</b>	<b>1</b> 3303	<b>2</b> 92,425	<b>5</b> 35.7	<b>TZ</b>	<b>4</b> 27.3%	<b>1</b> 60.5%	<b>6</b> -20.7%
<b>WN</b>	<b>3</b> 2884	<b>1</b> 99,483	<b>6</b> 29.0	<b>WN</b>	<b>3</b> 35.8%	<b>2</b> 54.8%	<b>4</b> -12.3%

Table 21 Summary of employee productivity rankings

Given the results above we can say that the leading airlines in 2006 in terms of employee productivity were NW on the Legacy side and TZ on the LCC side. They were followed by DL and B6. The rankings for employee wage productivity on the other hand puts USHP and B6 in first place followed by DL and FL. TZ was propelled to first place as a result of its buyout and the dramatic reduction in employment numbers while USHP's top spot was achieved by keeping average salaries and benefits at industry lows. On the other hand B6 seems to be the only airline from our sample set to have achieved these high productivity numbers by pursuing a successful strategy of growth and expansion.

### 6.3. Stage Length Adjustments

As we had done in previous Chapters, we proceed by conducting productivity regressions against stage length to assess what role it has played in the results. However in this section we also conduct a regression of productivity against average seats as we expect there to be a logical relationship between the two. Indeed given two airplanes and all else being equal, we expect the one with the higher number of seats to yield a higher employee productivity. The results for linear and log-linear regression models are given in Table 22 and Table 23.

#### 1-variable Linear regression 2006

Regression	Group	STDEVY	STDEVX	Slope	stdError	stdErSlope	t-stat	Intercept	correl	R^2
ASM/Em vs. SL	NLC	221.8	203.9	-0.073658	247.438	0.54271	-0.14	2,613.612	-0.07	0.00
	LCC	285.1	358.9	0.658961	178.011	0.22184	<u>2.97</u>	2,230.125	0.83	0.69
ASM/Em vs. seats	NLC	221.8	13.0	14.434473	133.192	4.59485	<u>3.14</u>	8.908	0.84	0.71
	LCC	285.1	26.1	10.176858	115.349	1.97545	<u>5.15</u>	1,388.245	0.93	0.87

Table 22 Linear regression: ASM/Employee vs. stage length or vs. seats

#### 1-variable Log-Linear regression 2006

Regression	Group	STDEVY	STDEVX	Slope	stdError	stdErSlope	t-stat	Intercept	correl	R^2
ASM/Em vs. SL	NLC	0.1	0.177	-0.005	0.098	0.248	-0.02	7.865	-0.01	0.00
	LCC	0.1	0.354	0.213	0.070	0.089	<u>2.40</u>	6.504	0.77	0.59
ASM/Em vs. seats	NLC	0.1	0.076	0.984	0.051	0.299	<u>3.29</u>	2.756	0.85	0.73
	LCC	0.1	0.168	0.547	0.038	0.101	<u>5.41</u>	5.242	0.94	0.88

Table 23 Log- linear regression: ASM/Employee vs. stage length or vs. seats

The regression results against average seats are more significant than the results vs. stage length for this measure suggesting that the former plays a more primary role in determining employee productivity. The regression against average seats has a positive coefficient indicating that the higher the average seats, the higher the resulting employee productivity. This is in line with the theoretical expectations. Furthermore there seems to be a greater effect on the NLC carriers than on the LCCs given the size of their respective coefficients. The NLC carriers' employee productivity grows almost linearly with average seats while the LCCs have a



dependence that resembles a square root relationship (coefficient close to 1/2). Figure 92 shows the results of the log-linear regression in graphic format.

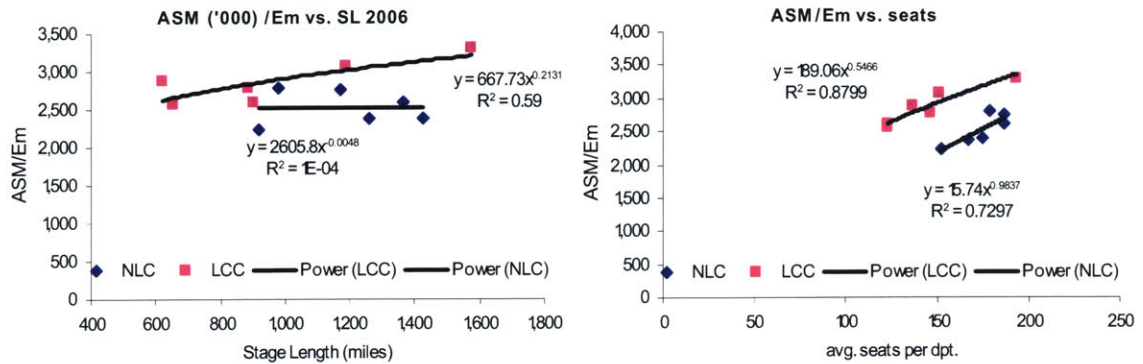


Figure 92 Log-linear regression: ASM/Employee vs. stage length or vs. seats

Given this relationship that we have just characterized, we proceed to calculate seat adjusted employee productivity numbers using the same methodology as in the previous Chapters. The results are shaded in grey in Table 24

ASM/Empl vs. a seats									
NLC					LCC				
Regr.:	coeff	intr			Regr.:	coeff	intr		
	0.984	15.7				0.55	189.1		
	Raw	Trend	diff	Adj.		Raw	Trend	diff	Adj.
NW	2,789	2,589	7.7%	2,719	B6	3,083	2,941	4.8%	3,016
DL	2,753	2,703	1.8%	2,570	WN	2,884	2,777	3.9%	2,989
USHP	2,244	2,216	1.3%	2,556	F9	2,601	2,627	-1.0%	2,849
CO	2,378	2,418	-1.6%	2,483	TZ	3,303	3,360	-1.7%	2,829
UA	2,602	2,690	-3.3%	2,441	FL	2,564	2,623	-2.3%	2,812
AA	2,392	2,528	-5.4%	2,388	NK	2,784	2,883	-3.4%	2,779

Table 24 Seats-adjusted employee productivity in 2006 ASMs/employee

The adjusted results are interesting in that they display a slightly different picture than our previous rankings. Indeed in this case, the top LCCs in employee productivity adjusting for seats seem to be B6 and WN. This is more in line with the general consensus in the industry that consistently ranks these two airlines as the most productive. The result is especially interesting for WN which finds itself just slightly below B6 whereas it was just in the average in the non-adjusted results. On the Legacy side we see that the rankings haven't changed much – on the top we still find NW and DL leading the group.

## 6.4. Detailed Fleet Level Analysis

### 6.4.1. Aggregate Analysis: Legacy vs. LCC Comparison

Unfortunately the fleet analysis section in this Chapter is a little less rich than the previous ones. Indeed since airlines cannot report employees at the aircraft level, we are unable to determine all of the productivity measures we would like at the fleet level. The only measure we are able to analyze in this section is ASMs per total labor expenses relating to pilots and maintenance. The aggregate results are given in Figure 93.

Regarding the Narrow-body fleets (graph on the left side) we can see that Legacy carriers have increased their ASM/\$S&B (for pilots and maintenance) significantly since 2002 and have managed to reach the LCC levels. At the same time LCC carriers saw their pilots & maintenance wages productivity decrease steadily. These two trends resulted in a complete convergence of narrow-body productivity levels in 2006.

Comparing wide-body and narrow-body productivity measures (graph on the right side) we see that wide-body productivity levels are consistently higher as expected but also that both curves are highly correlated. Indeed the correlation coefficient we obtain is 96%. This shows that changes in the productivity of paid out wages do not depend on the size of the carriers airplanes (even though absolute productivity levels obviously do).

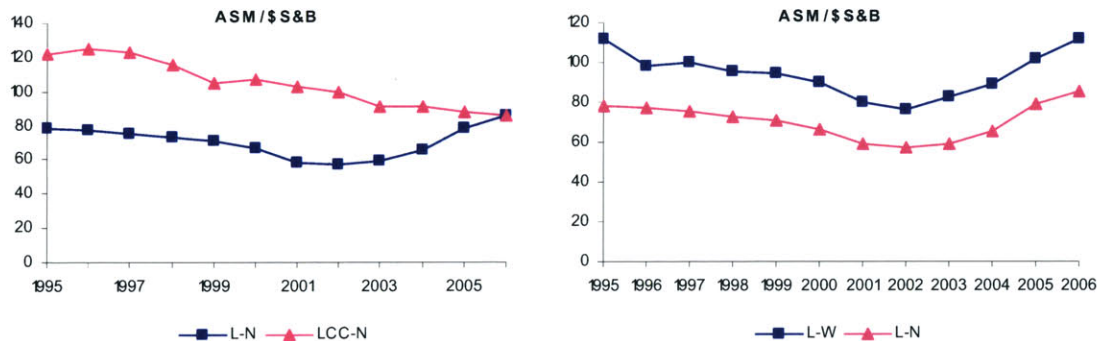


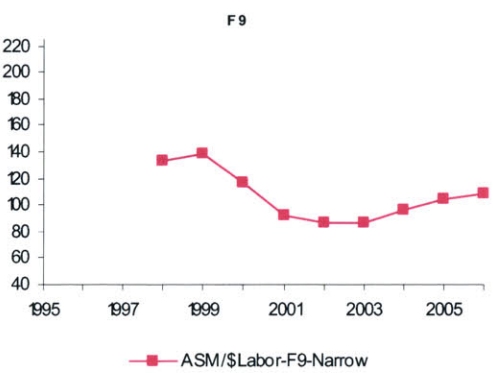
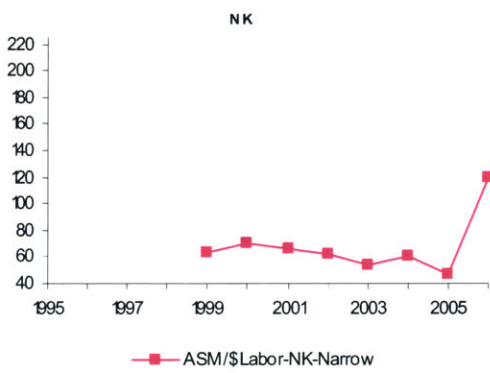
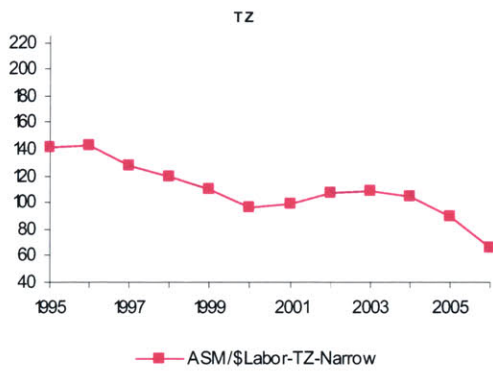
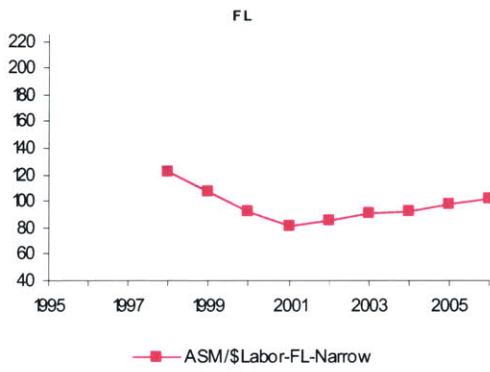
Figure 93 Fleet Analysis: Aggregate ASMs/\$S&B

#### **6.4.2. Case-by-case: Pilots and Maintenance Wage Productivity, NLC vs. LCC**

Figure 94 and Figure 95 detail each carrier's contribution to the aggregate results seen previously. On the LCC side in Figure 94 we see that actually not all carriers experienced a decrease in this productivity measure. Indeed FL, NK and F9 actually increased their productivities from 2005 to 2006. NK had the most significant increase going from just 40 ASM/\$ in 2005 to over 120 ASM/\$ in 2006. However this result should be taken with caution. Indeed in 2006 Spirit retired 14 of its aircraft from the MD-8x family which substantially decreased its total compensation package to pilots for that year. What is not clear is if the 2006 data that we have includes the numbers for the Airbus 320's that were used to replace those retired planes.

On the Legacy side we see that with the exception of AA, all carriers increased their productivities from 2004 to 2006 at least with the key turnaround date starting around 2003 for most carriers. Again, this is a consequence of the 30% decrease in employment numbers we showed in Figure 75. This decrease resulted in a dramatic reduction of total compensation packages paid out to employees across all airlines starting 2003. Furthermore it is also the case that for some airlines, the increase in this productivity measure was driven by increased ASMs obtained from shifting the wide-body fleets to international markets. The clearest example of this trend is CO in Figure 88. Starting from 2003, there is a sharp contrast between CO's narrow-body and wide-body productivities: Indeed their wide-body productivity increased rapidly while their narrow-body followed a slower trend. This fully reflects CO's strategy to shift its wide-bodies to higher stage lengths flights via increased international markets producing a gain in ASMs and the subsequent gain in productivity.





**Figure 94 Fleet Analysis: LCC Individual ASMs/\$S&B**

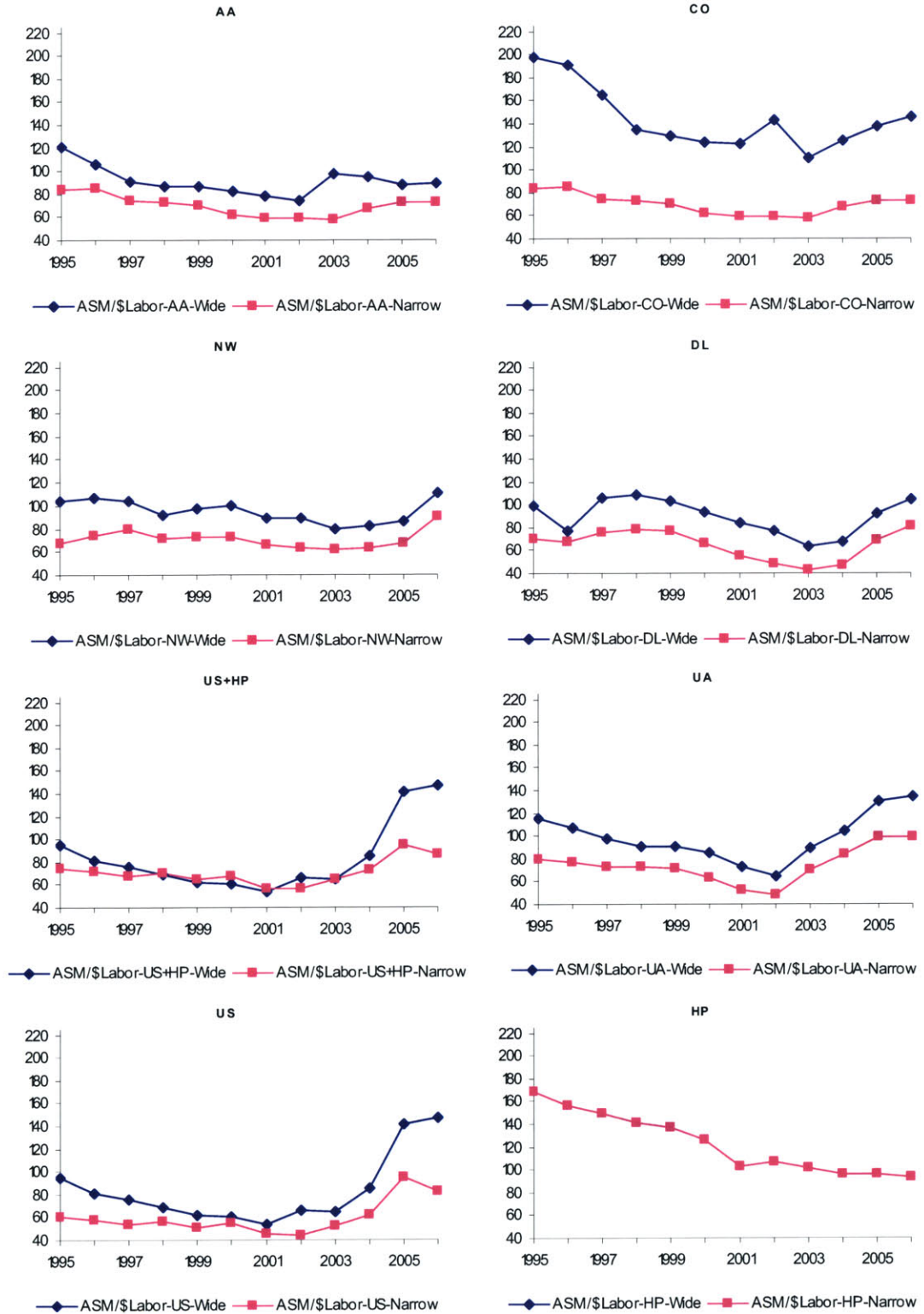


Figure 95 Fleet Analysis: NLC Individual ASMs/\$S&B

## 6.5. Summary of Employee Productivity Results

As we have seen in this Chapter, employee productivity has been changing in different directions for Legacy carriers and LCCs. The forces driving these changes have been variations in employment numbers, salaries and ASMs.

From 2001 to 2006 Legacy carriers reduced their workforce by over 30% representing more than 100,000 job cuts. This downsizing was achieved by utilizing bankruptcy protection or threats of bankruptcy and even an outright buyout by private companies as was the case for TZ. At the same time these measures were also used to reduce average salaries and benefits paid out and an employee working for a legacy carrier would have seen his average annual total compensation decrease by around 7% during that period. On the other hand LCC carriers pursued a strategy of growth and captured significant market share (primarily measured in ASMs) from their Legacy peers. The LCC group increased its employee base by 20% and average salaries and benefits shot up by more than 40% since 2001. In fact by 2006, LCC employees were receiving higher total salary and benefit packages on average than Legacy carrier employees – this was a big surprise.

These two opposing strategies have led to mixed results regarding employee productivity. Looking at ASMs per employee and at passengers enplaned per employee we found that both groups had made significant increases but that there was no sign of convergence. Indeed they were both increasing at roughly the same speed although they were both driven by opposite underlying strategies (downsizing versus growth). However analyzing ASMs per total salaries and benefits we saw that there was a clear convergence occurring – Legacy carriers had managed to reduce this measure while LCCs and especially WN were struggling to keep it from increasing too fast. By 2006 the spread between both groups had almost been reduced to zero. This result shows that LCCs have had to deal with increasing demand for higher pay packages at the same time as they've been incurring higher costs from their aging fleets. This result could be a warning sign for LCC carriers as their historical wage advantage over Legacy carriers seems to be disappearing. This is especially true for WN as in 2006 it became the airline with the highest pay packages across the entire industry (including Legacy carriers). There was though one significant exception to this trend and that was B6. Indeed this airline's results were impressive because not only did it manage to keep its increases in pay levels in check but it also managed to increase employee productivity during a period of exponential network growth. This is quite difficult to achieve as it requires increasing ASMs without increasing employees at the same pace.



## Chapter 7

# Summary of Results & Conclusion

### 7.1. Summary of Results

In this thesis we have shown that during the period 2000-2006, both Legacy carriers and LCCs have gone through a period of increased volatility which has greatly affected their productivities and unit costs. This volatility is being driven by many factors but we have identified the increase in fuel prices as the initial spark that set off a series of fundamental shifts in airline operational strategies.

The Legacy carriers have had a difficult time in dealing with the consequences of 9/11 and the turbulent fuel environment. The effect was so pronounced that four out of the six US Legacy carriers went into bankruptcy between 2001 and 2005. During this period the focus was shifted to downsizing and cost-cutting in an effort to regain profitability. The measures taken by the Legacy carriers were as severe as the threat they were facing. The focal point of their cost-cutting strategy was the labor category. Employment was cut by 30% in just five years representing over 100,000 jobs lost while wages were also cut by 7%. At the same time, the most airlines sought productivity gains by focusing on increasing their stage lengths via an expansion into international markets.

The LCC carriers were also affected by the crisis period but their reaction to the situation was opposite to that of the Legacy carriers. Indeed most LCCs sought to accelerate their network growth and captured significant market share from their Legacy peers. They expanded into new markets with new aircraft and more flights. However during the same period the LCCs were also

facing increasing labor costs driven by an aging fleet and by the fact that their staff was becoming more senior. The effects on costs and productivity resulting from the changes we have just mentioned have been numerous and very diverse.

The cost-cutting efforts put in place were not enough to offset the increased fuel prices driving the unit cost of both groups substantially higher from 2001 to 2006. Breaking down unit costs into the underlying components we had identified, we found that the labor unit costs dramatically decreased for Legacy carriers while they increased for LCCs. This led to a clear labor cost convergence between both groups and the historical advantage that LCCs have had in this category was effectively wiped away by 2006. Getting down to the fleet level we showed that the majority of this convergence can be attributed to cost gains from the Legacy wide-body aircraft. Indeed we showed that the wide-body fleet benefited from the shift to international markets which substantially reduced unit costs. On the other hand despite all the restructuring efforts following from the bankruptcy processes, the Legacy carriers still cannot compete with all the LCCs in terms of narrow-body unit costs. Southwest and Jet Blue continue to hold a clear cost advantage in this category. These contrasting results did not provide a net positive picture for either group's unit costs and overall from our regressions we found that the traditional relationship existing between stage length and unit costs did not hold in 2006 for the airlines in our sample set which indicates that other factors were more important during this year.

To assess the changes that occurred on aircraft productivity and utilization we looked at standard measures including ASMs/ACday and BH/ACday. The results again were mixed. Legacy carriers seemed to dominate on an aggregate level in terms of aircraft productivity while LCCs were on top in terms of aircraft utilization. There was no sign of convergence between the two groups. Getting into a more detailed analysis, we established a positive correlation between the increase in international ASMs and the increase in Legacy aircraft productivity levels. We also established a positive correlation between aircraft productivity and aircraft utilization suggesting that both variables could be driven by the same underlying forces. In terms of what these underlying forces are, we identified increased stage length as the main reason behind the aircraft utilization and productivity gains for both Legacies and LCCs. Our regression analysis confirmed these results but also showed that the effects were greater on aircraft utilization than on aircraft productivity. Getting into the fleet details we found that, as was the case for unit costs, the wide-body aircraft were the main driver effectively increasing aircraft productivity and utilization levels for Legacy carriers. On the other hand, isolating the narrow-body fleet we showed that the

productivity advantage was reversed and LCCs had a clear upper hand in terms of both aircraft utilization and productivity. This suggests that most of the convergence that has occurred between these two groups has resulted from international flying while LCCs still retain an advantage in the domestic US markets that are dominated by narrow-body aircraft.

The last category we focused on was employee productivity and we found several interesting results: The first was that employee productivity measured in the traditional sense (ASMs/employee) increased for both groups. But while Legacy carriers were extracting most of their employee productivity gains via labor cuts, LCCs were achieving higher productivity levels by an exponential expansion of their networks, managing to increase their ASMs faster than their employees. One of the underlying factors behind this success was again shown to be increased stage lengths. Given that both groups were increasing their productivities at roughly the same speeds there were no evident signs of convergence at the aggregate level. On the other hand the story for employee wage productivity was very different. We found that LCCs experienced a substantial increase in salary and benefits payments which kept continuous downward pressure on their wage productivity levels since 2001. During the same period the Legacy carriers benefited from their labor cuts and significantly increased their wage productivity to the point that they had almost completely caught up to the LCCs by 2006.

These opposite directions created an important convergence trend between both groups. Indeed we showed that in 2006, the carrier with the highest labor expense per employee in the industry was Southwest. Their labor expenses resulted mainly from increased staff seniority. So although in terms of traditional labor productivity we found that LCCs were still ahead, they had indeed lost most of their wage productivity. Indeed for the first time in 2006, LCC employees had on average a higher total compensation and benefits package than their Legacy counterparts. In fact looking at the fleet level we also showed that this has resulted in total convergence for wage productivity levels between Legacy and LCC narrow-body fleets. This is an important result because although we showed that LCCs still had a certain advantage flying smaller airplanes in terms of unit costs and aircraft productivities, they effectively lost their advantage when it comes to wage productivity.

## **7.2. Conclusion and Further Research**

In conclusion, we can say that there are clear and evident signs of convergence in the airline industry between Legacy carriers and LCCs that have occurred since 2001. The convergence obviously depends on the category under consideration and we found that the most important changes have taken place on the labor front. We can confidently say that the Legacy carriers have caught up and in some cases even surpassed the LCCs in terms of labor productivity. However further improvements would still need to be achieved specifically in the narrow-body fleet to be able to make the LCC efficiency advantage vanish in the domestic US market.

In terms of directions for future research, there are several questions that surface from our findings: An immediate response we could have to the results would be to ask where this trend of convergence will lead to in the future and if there is a physical barrier to how much Legacy carriers can change to resemble their low-cost rivals? Specifically the role of hub-and-spoke networks versus point-to-point has not been addressed but it does play a role in determining certain airline characteristics that influence productivities and costs. Quantifying the role of network structures in these characteristics could provide further information about possible forecasts for costs and productivity limits between both groups. This analysis could also lead to a better understanding of the LCC cost and productivity advantage that seems to persist when isolating narrow-body fleets and domestic flying.

Furthermore we can also ask ourselves if there are any long-term implications to the different strategies that have been chosen by each group of carriers. The fact that Legacy carriers have gained productivity levels via severe labor cuts raises the question of the sustainability of these results. On the LCC side we can ask what the future sources of growth could come from. As Legacy carriers seem to be recovering from their bankruptcies it will become increasingly difficult for the LCCs to keep expanding their domestic networks as they did in the immediate post-9/11 period. One of the possible solutions would be to seek growth in the international markets where competition is sometimes less intense. However this in turn raises the question of whether LCCs are able to enter these markets with their current network structures. A preliminary answer to this is that they most likely will not since they do not have the adequate personnel or aircraft to do international flying. Should they be forced down this path, a fundamental change in their network structure would have to take place. In fact, we can see that this strategy would lead



LCC carriers to start looking more and more like Legacy carriers. And conversely we have shown that Legacy carriers are aiming to look more and more like LCCs. This then brings to light our ultimate question of what is this convergence going to lead to? Will today's barrier between Legacy and low-cost airlines disappear effectively giving way to a set of new hybrid airlines that have integrated the best of both worlds?



# Annex 1- Aircraft Productivity Drivers



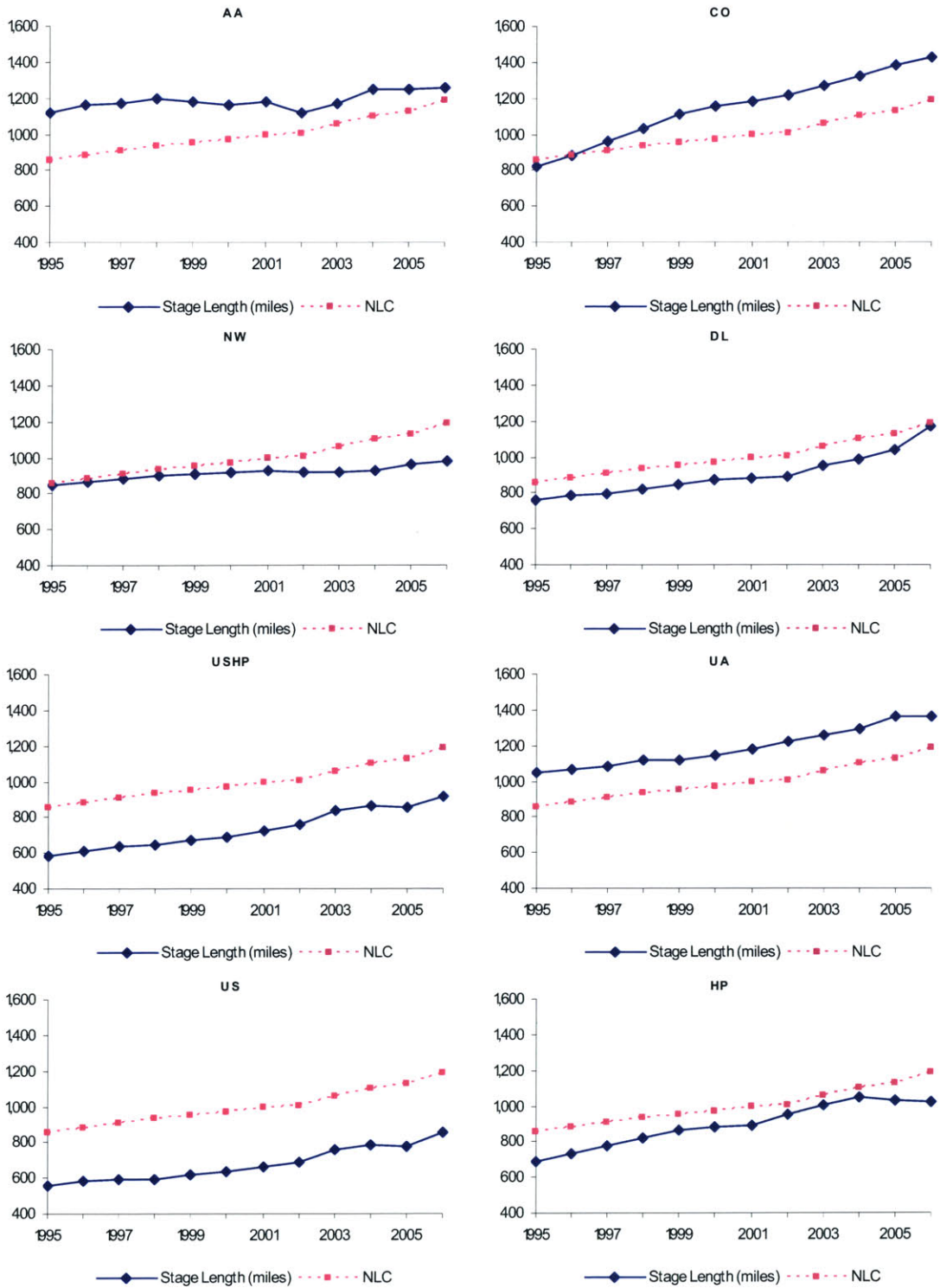


Figure 96 By-carrier Analysis: NLC Stage length

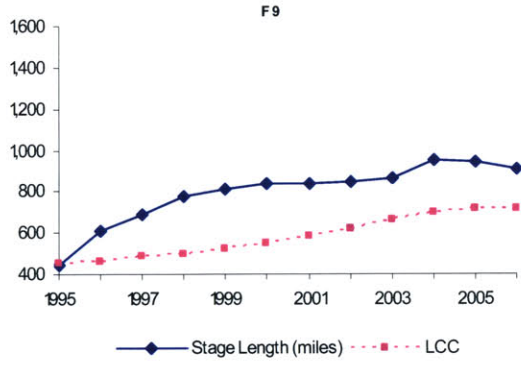
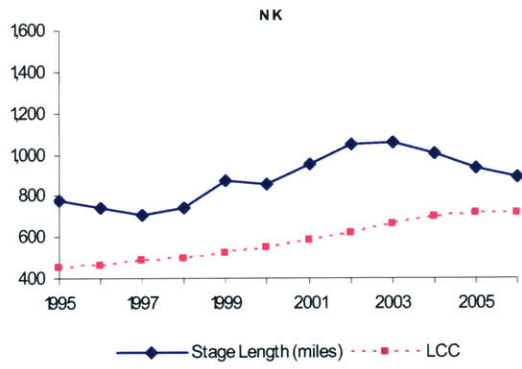
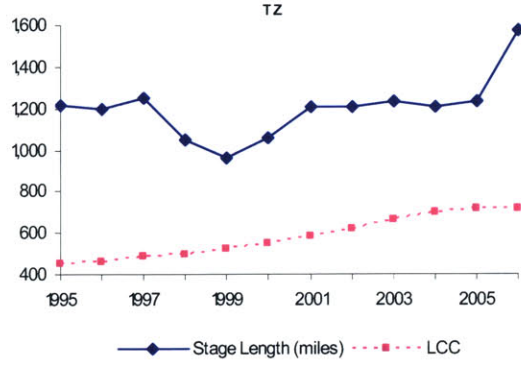
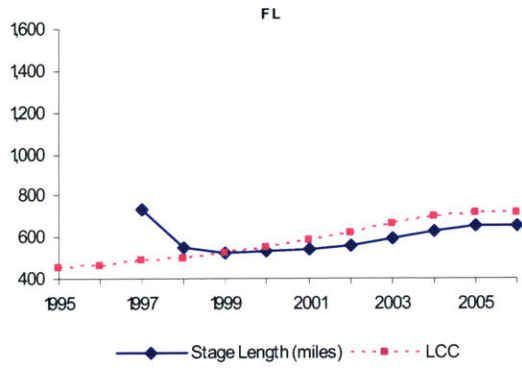
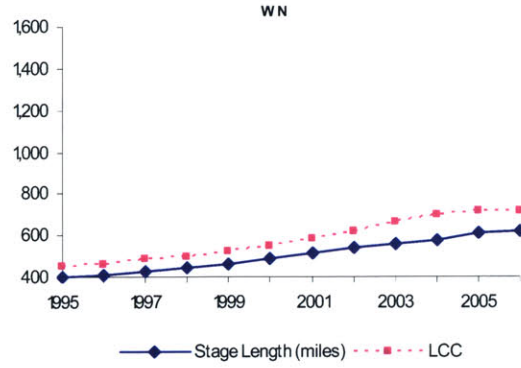
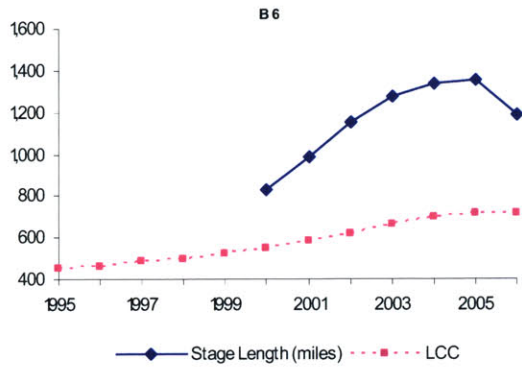


Figure 97 By-carrier Analysis: LCC Stage length

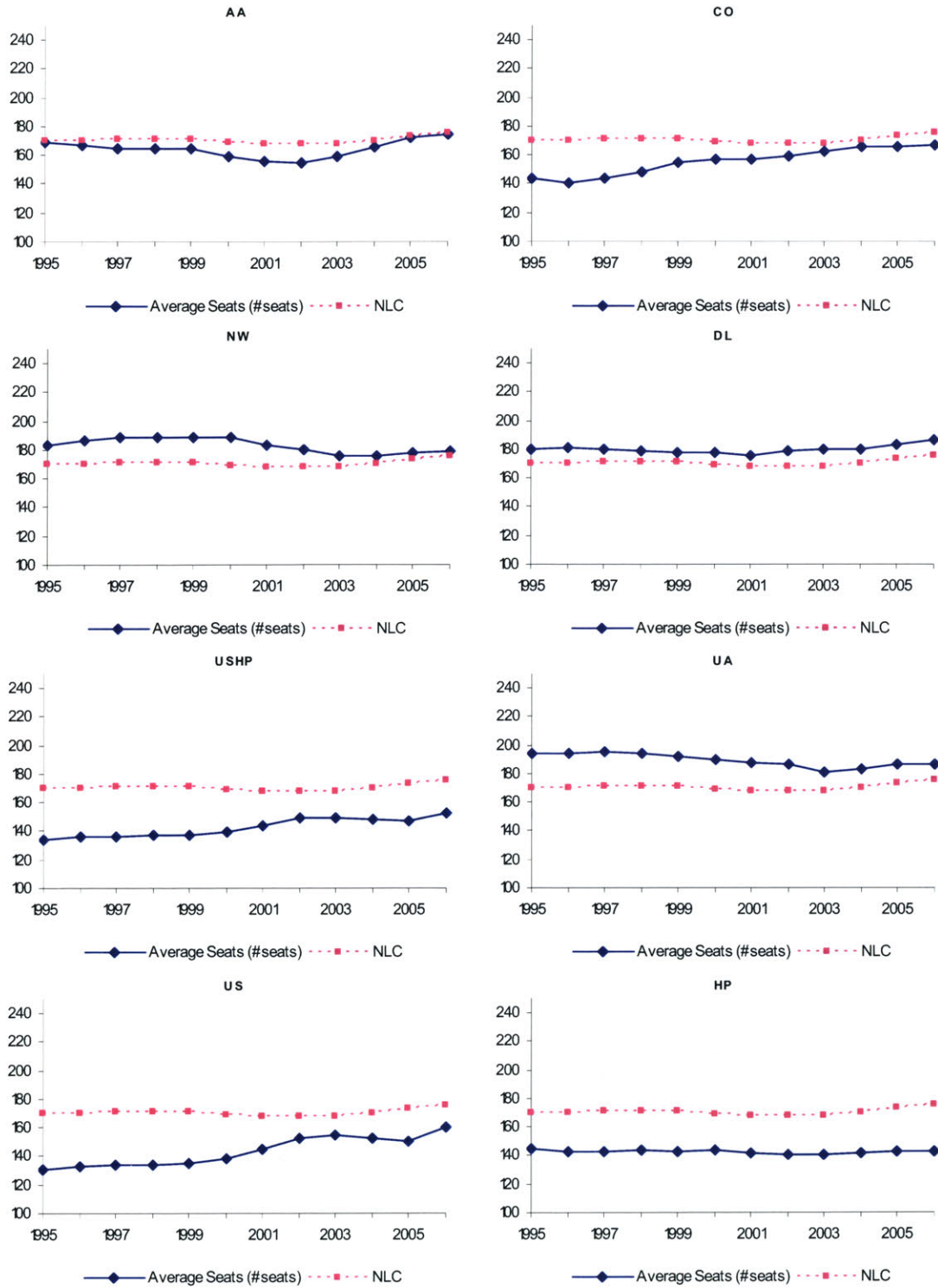


Figure 98 By-carrier Analysis: NLC average seats

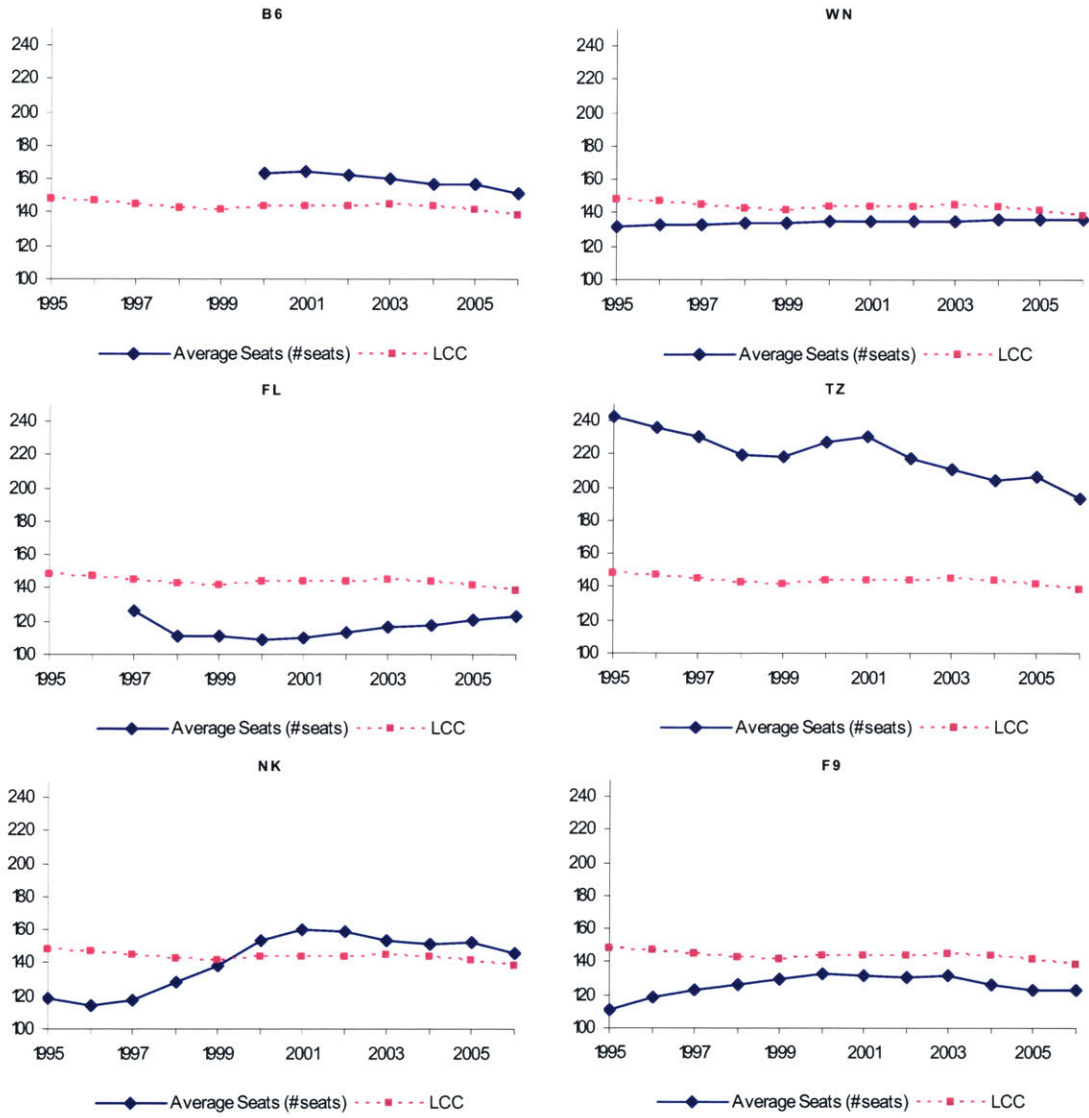


Figure 99 By-carrier Analysis: LCC average seats



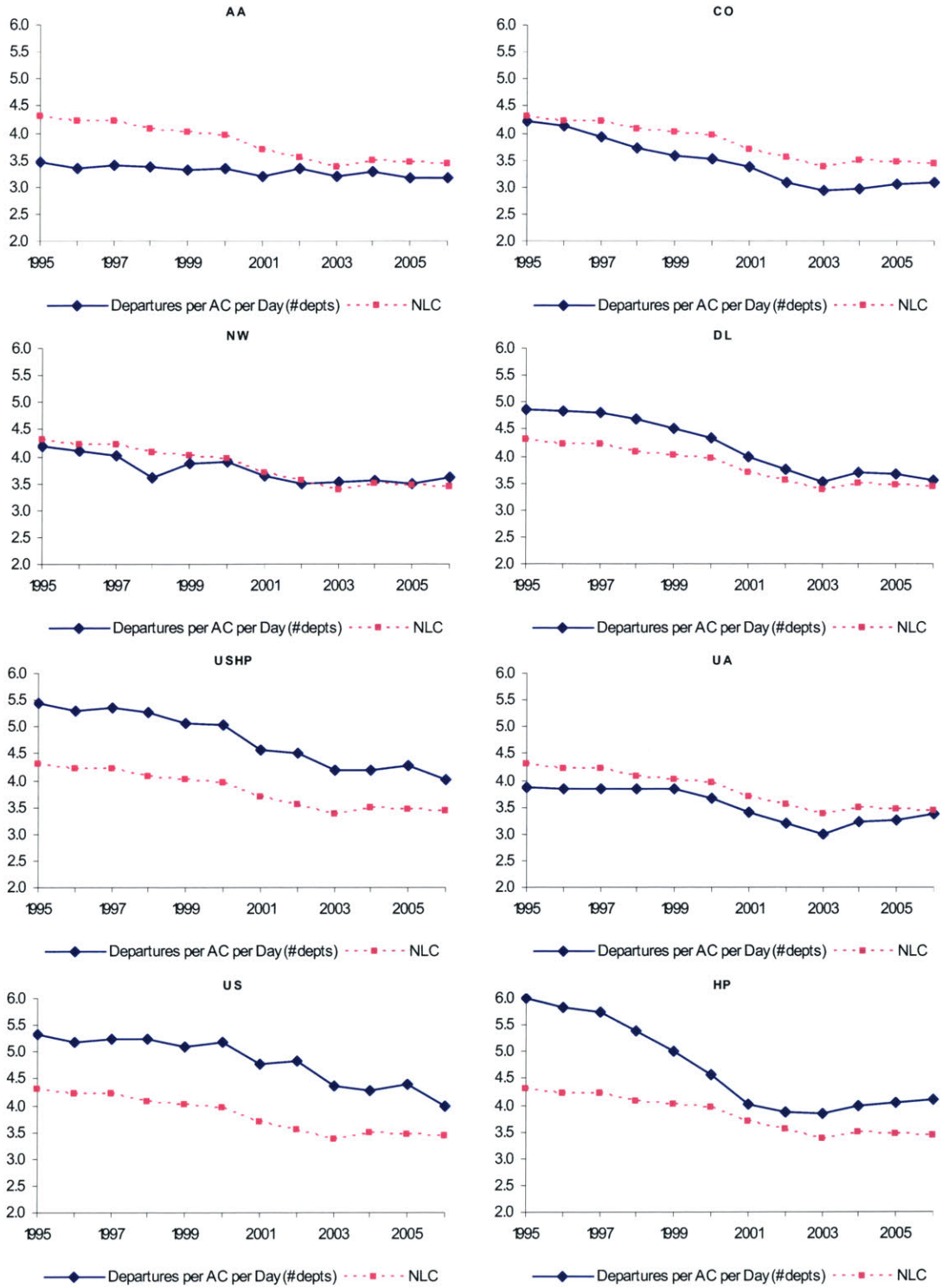


Figure 100 By-carrier Analysis: NLC departures

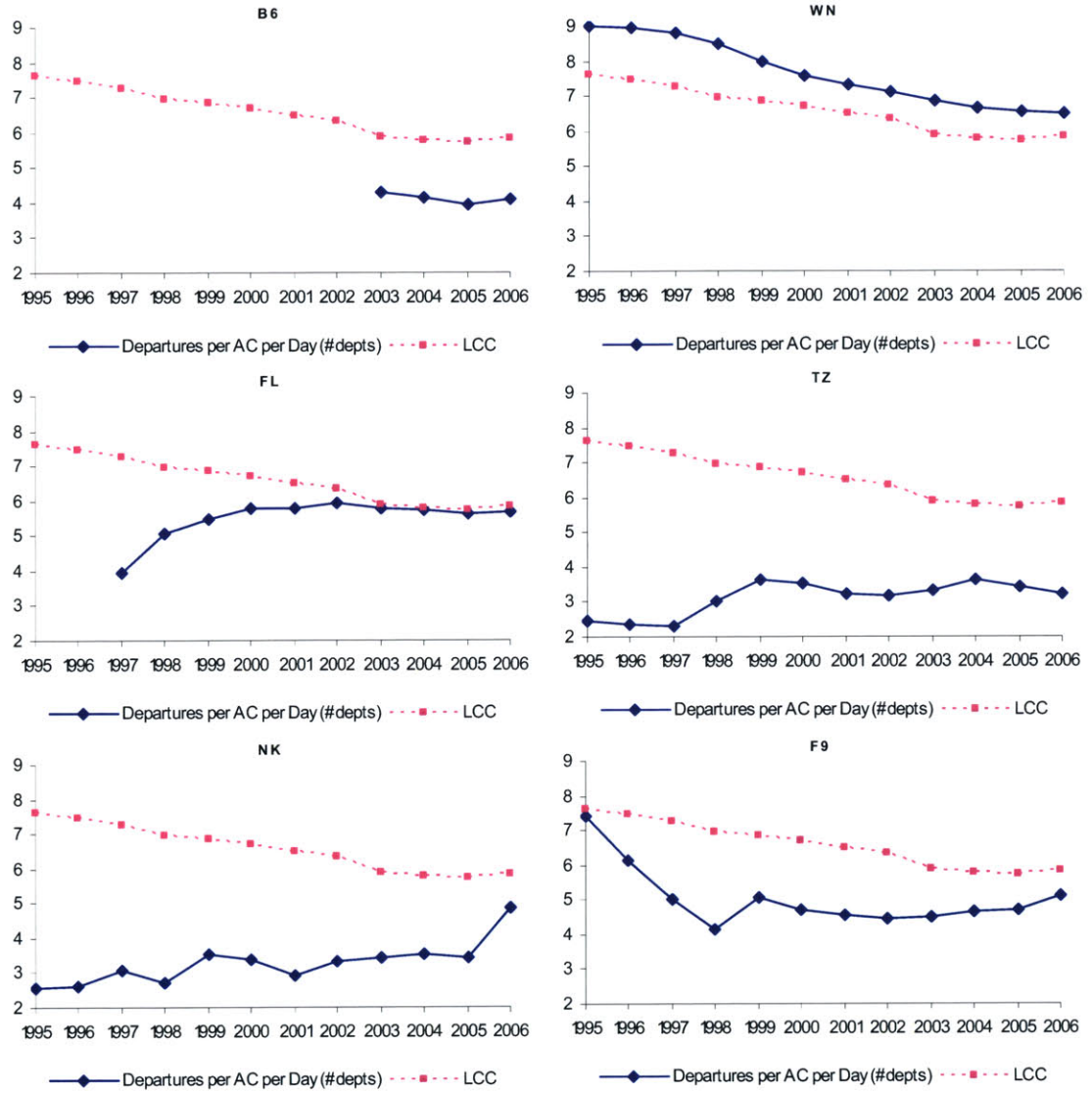


Figure 101 By-carrier Analysis: LCC departures

## Annex 2 – Additional Employee Productivity Figures

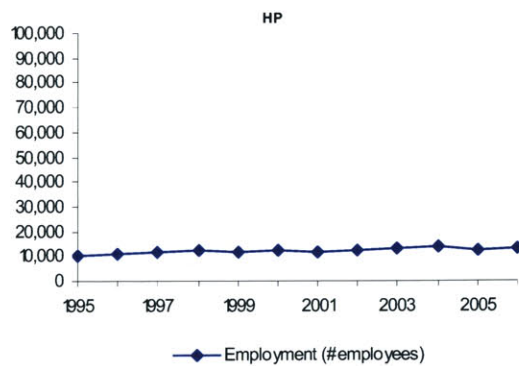
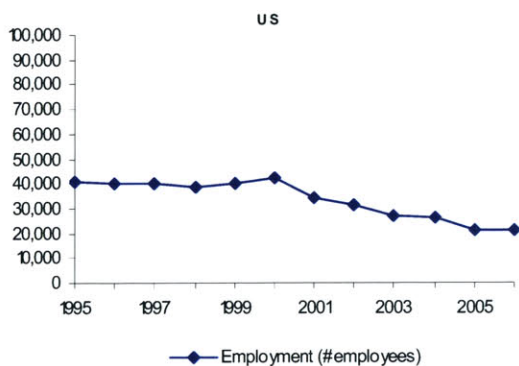
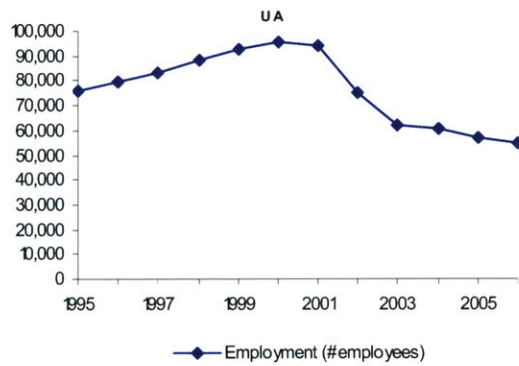
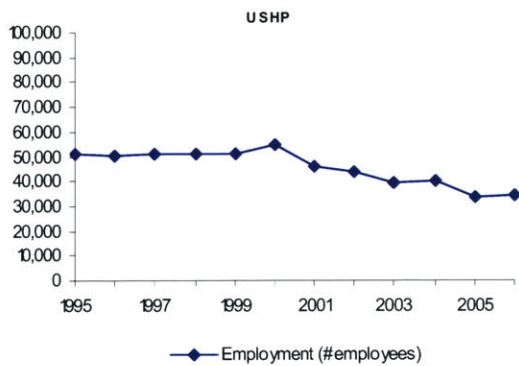
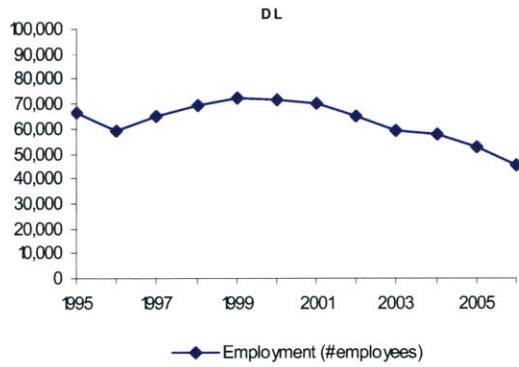
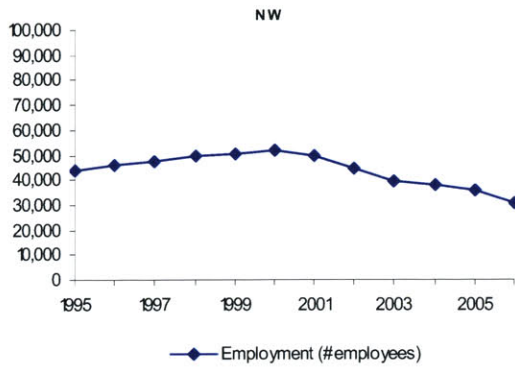
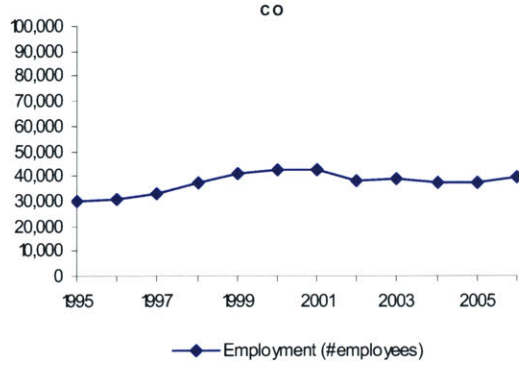
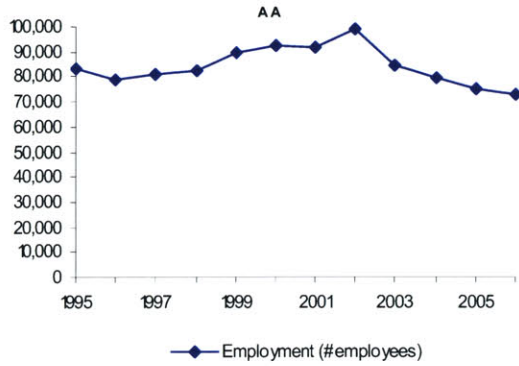


Figure 102 By-carrier Analysis: NLC employees

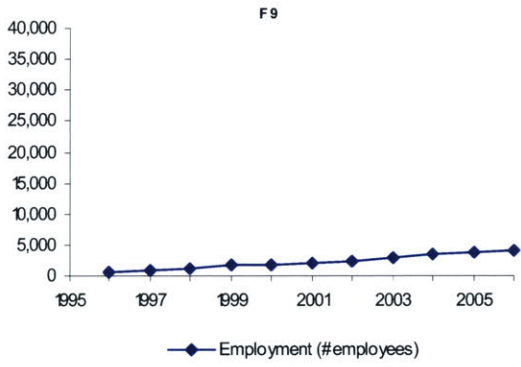
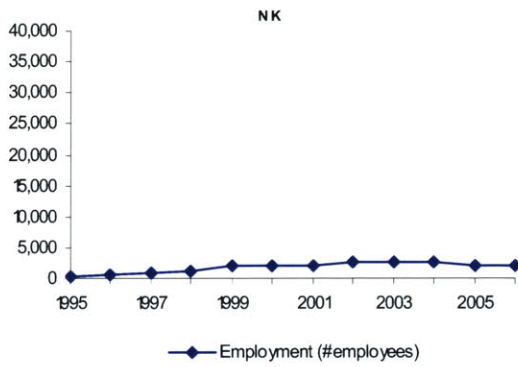
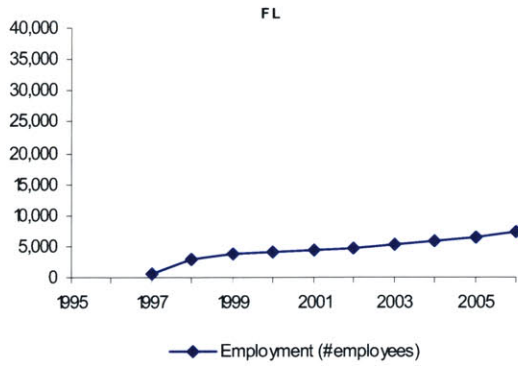
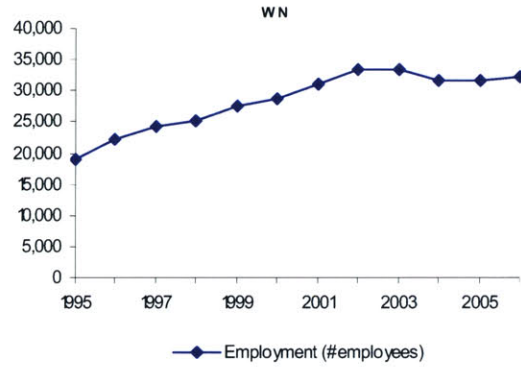
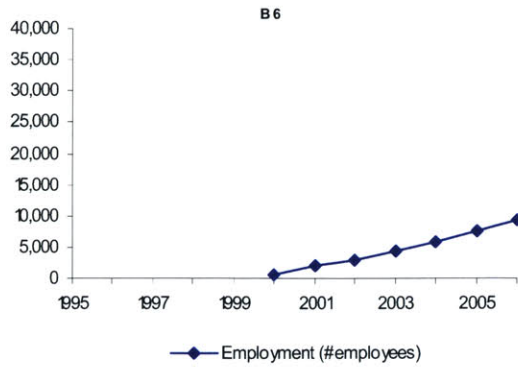


Figure 103 By-carrier Analysis: LCC employees

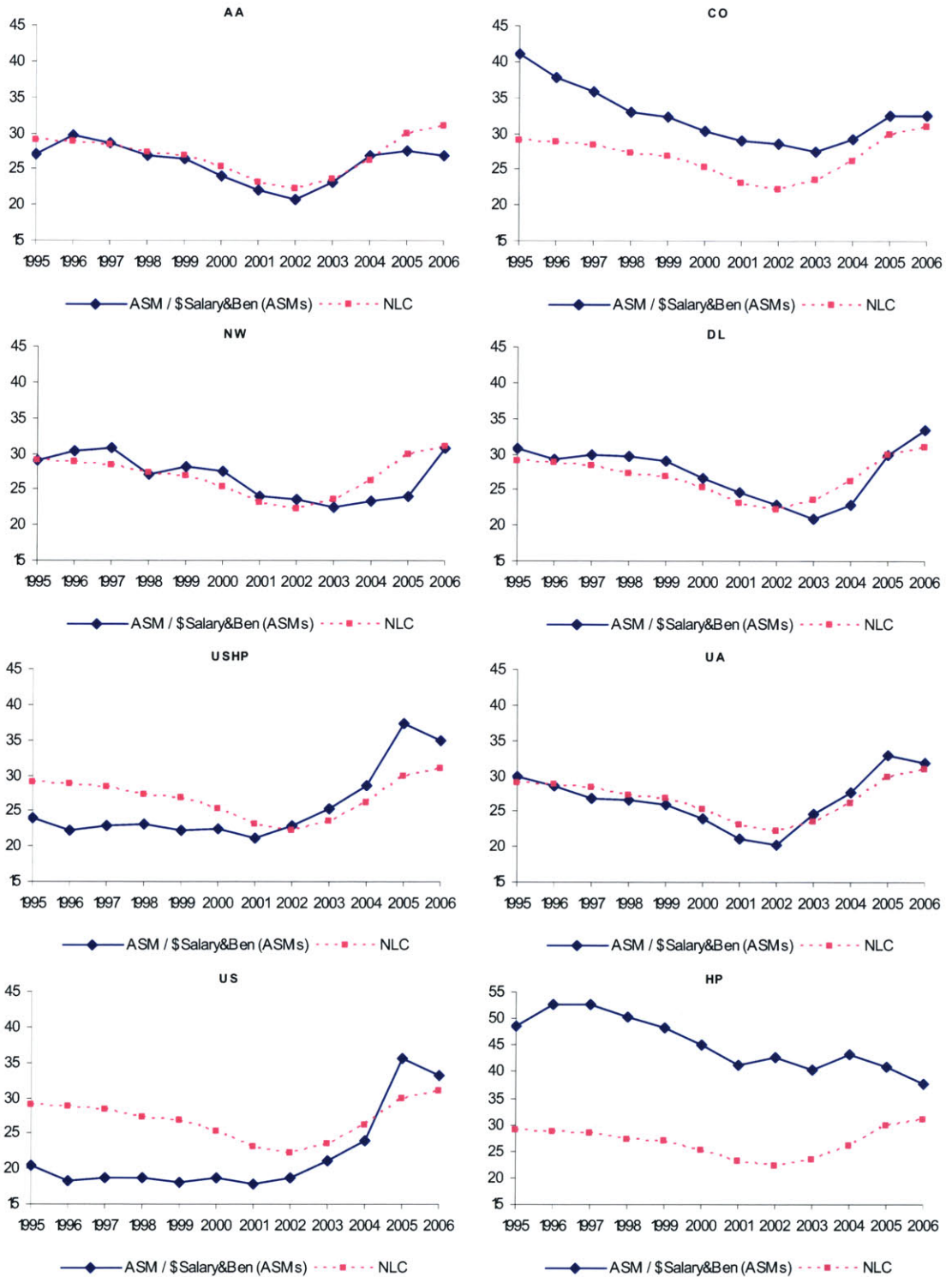


Figure 104 By-carrier Analysis: NLC ASM / \$Salary & Benefits

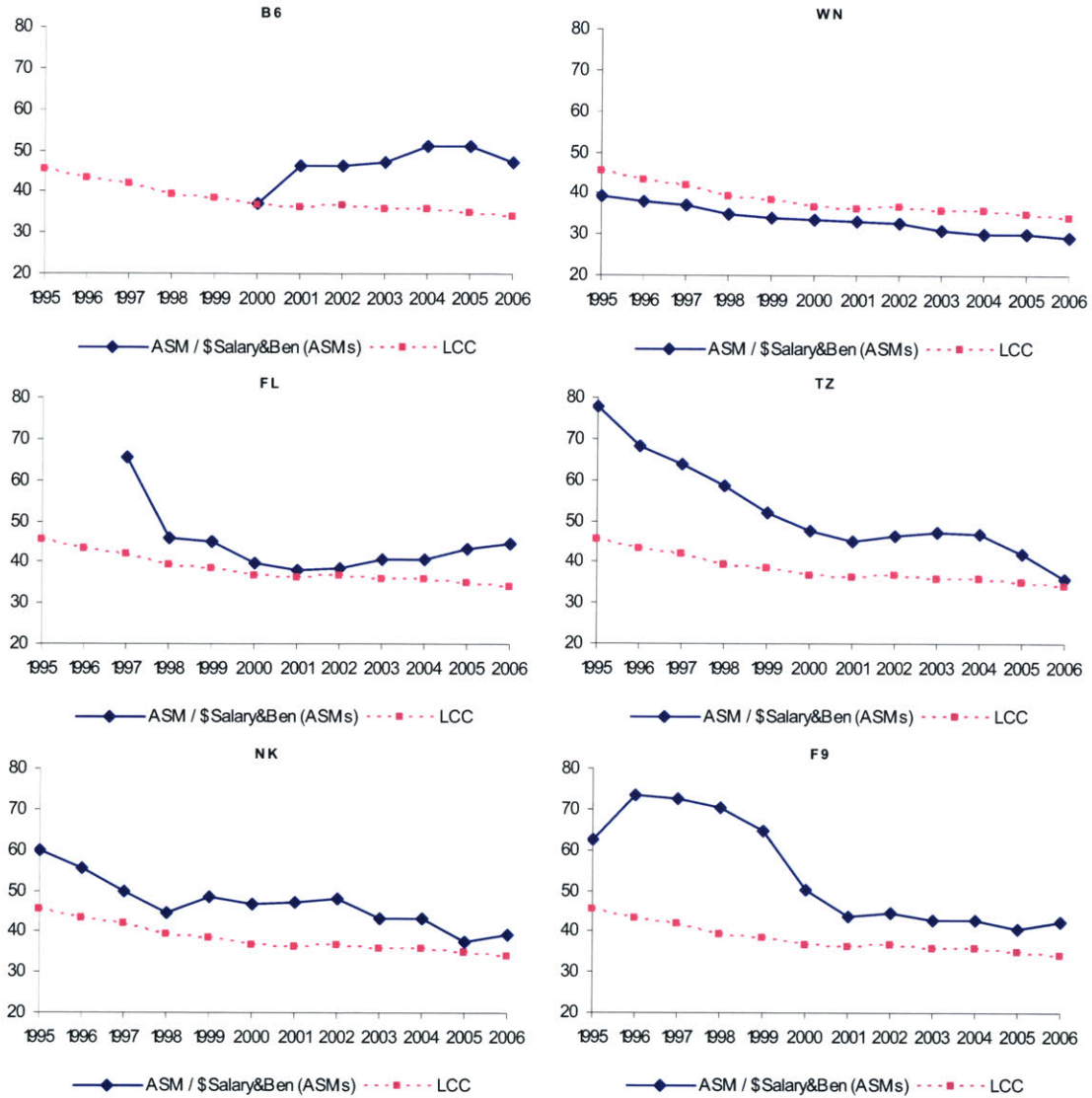


Figure 105 By-carrier Analysis: LCC ASM / \$Salary & Benefits



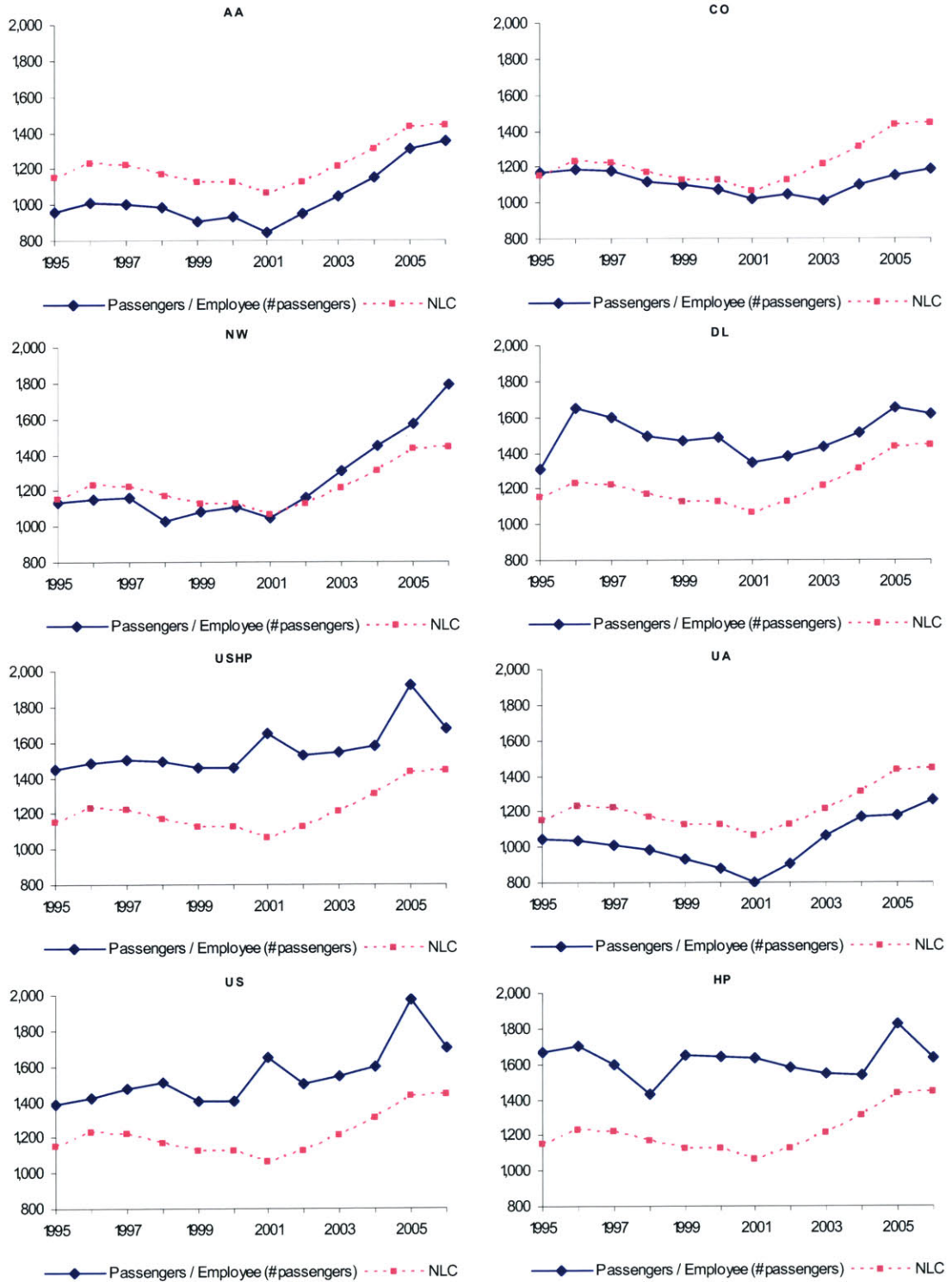


Figure 106 By-carrier Analysis: NLC passengers / employee



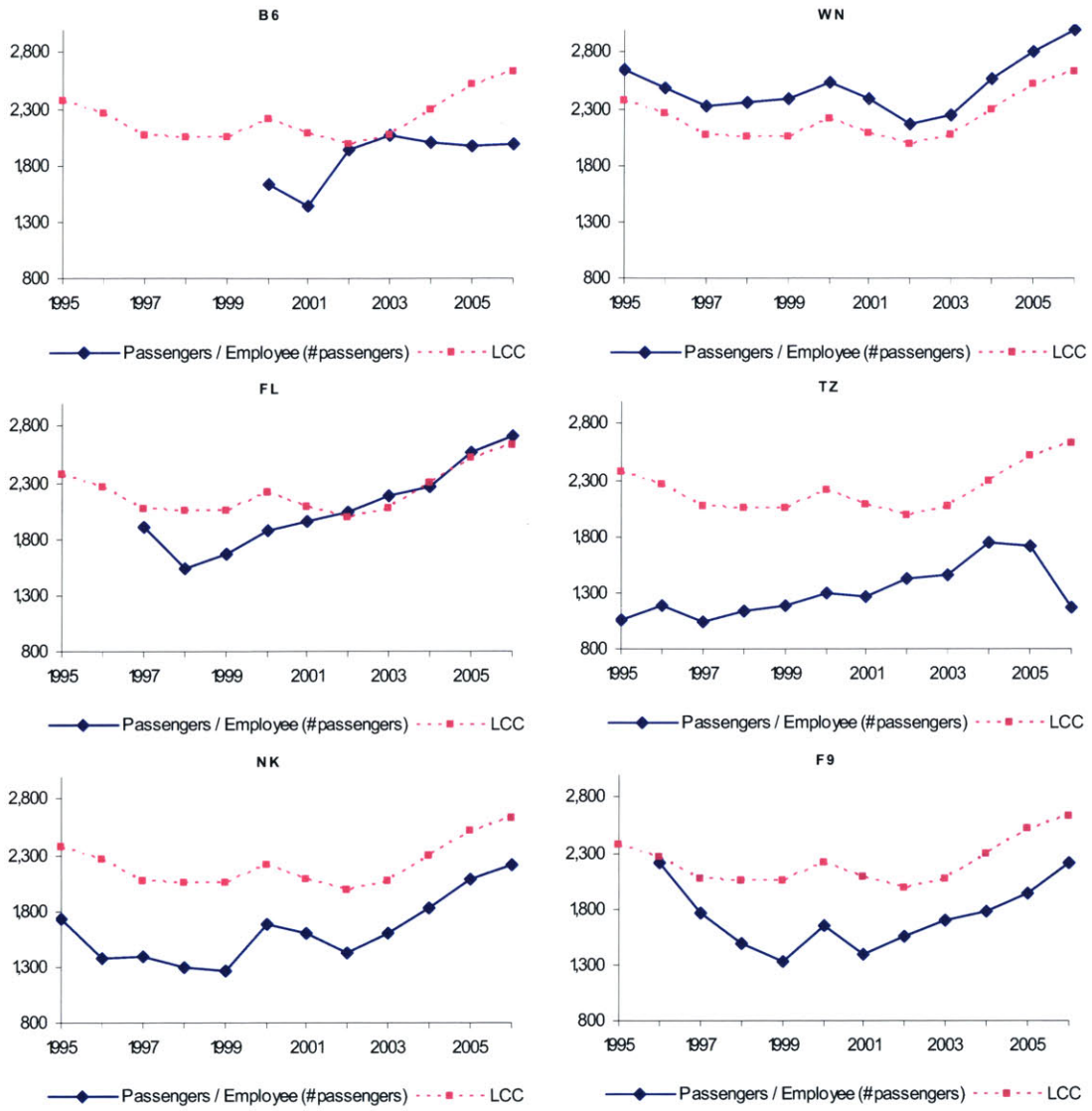


Figure 107 LCC passengers / employee

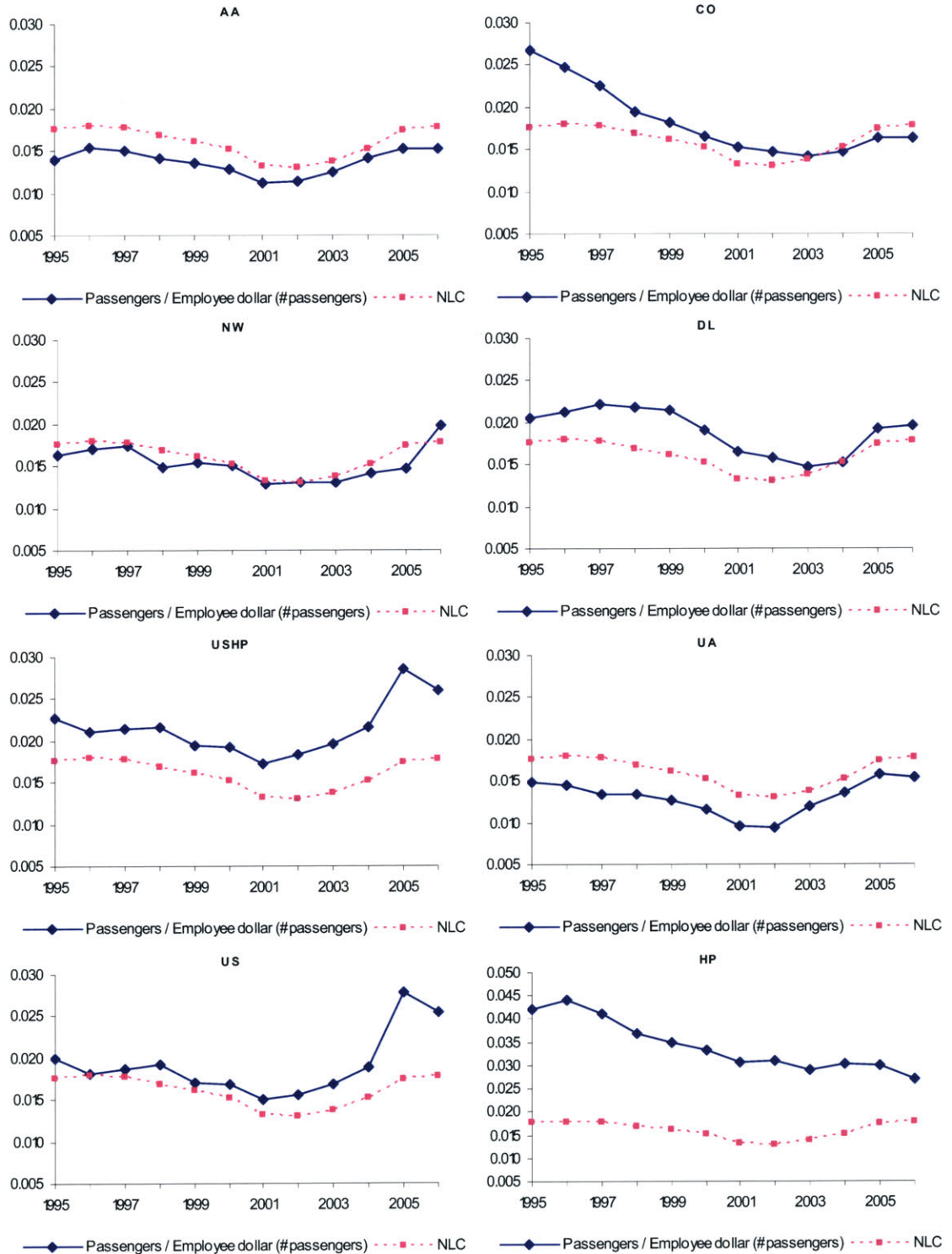


Figure 108 NLC passengers / employee dollar

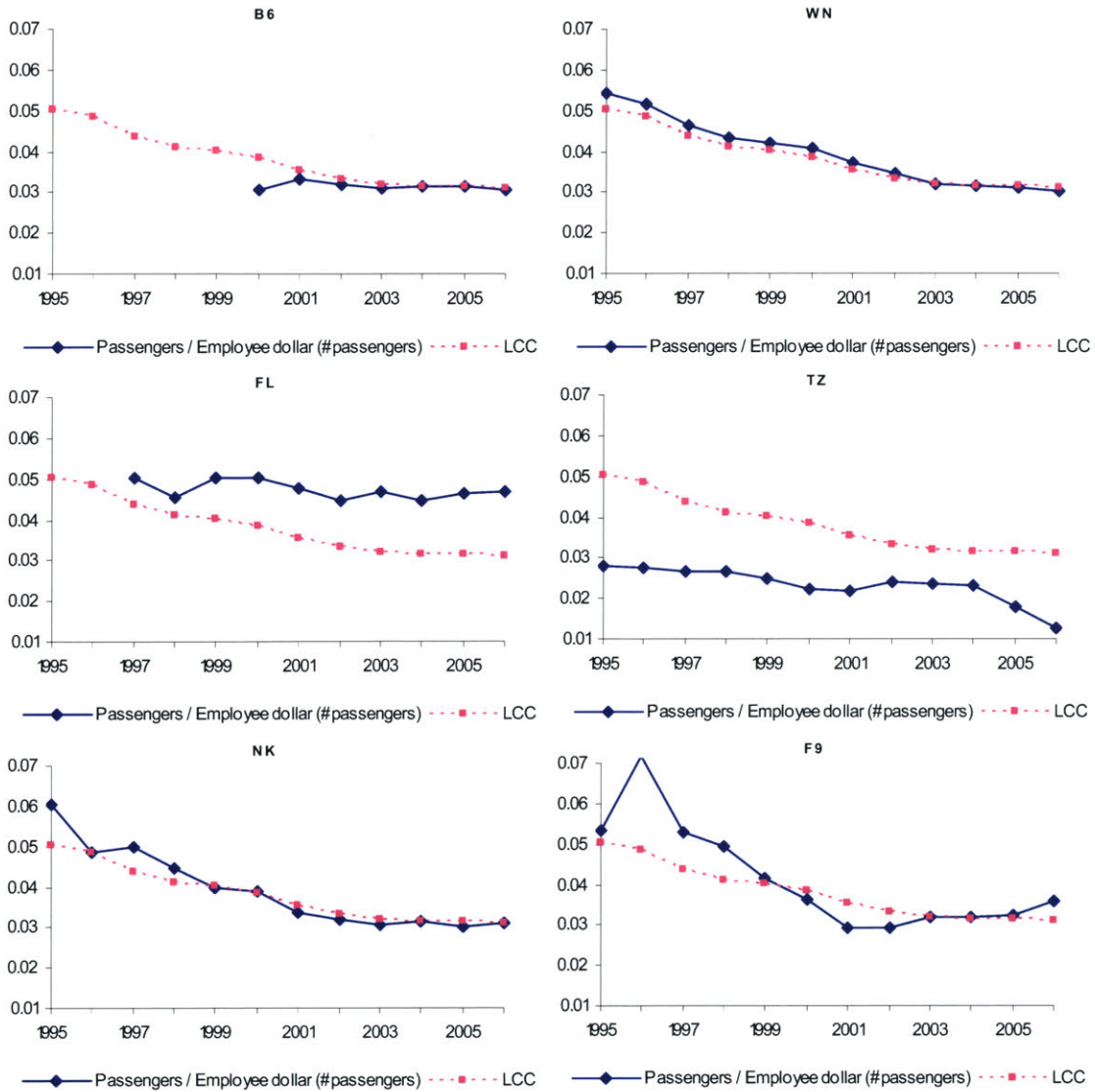


Figure 109 LCC passengers / employee dollar



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