Price Competition in the Top US Domestic Markets: Revenues and Yield Premium

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Abstract

Since 2000 the US airline industry has gone through a severe crisis which initiated important changes in the competitive environment of the industry. The economic downturn, the fierce competition between Legacy carriers, the rapid expansion of Low Cost carriers, the soaring fuel prices and the 9/11 attacks are some of the reasons that put many US airlines into a financial crisis. Many of the traditional major US airlines were forced into bankruptcy during the first five years of the decade. That forced Legacy airlines to change their pricing strategies to better match their LCC competitors and stimulate demand.

This thesis concentrates on the pricing and competition between Legacy and low cost carriers in the US domestic markets by analyzing the Top 1000 US domestic markets. A new metric is introduced, the yield index, that compares fares among airlines in specific markets in order to quantify the fares collected by major airlines with respect to their competitors in different segments of the domestic market. Furthermore a quantitative analysis of competition is performed to identify important changes during the years of the crisis.

The average fare gap between Legacy carriers and LCCs that existed in 2000 was shrinking until 2005. The traffic and revenue losses of Legacy carriers combined with the rapid expansion of LCCs have also mitigated the market share difference and revenue difference between Legacy and LCC carriers. Legacy carriers were forced out of numerous domestic markets by new competition. Overall, the average number of competitors in domestic markets has dropped from above three in 2000 to below three in 2006 but the average number of LCCs has increased.

Only four out of six Legacy carriers have held an average yield premium in the Top US domestic markets. On the other hand all Legacy carriers maintained a yield premium in the local markets of their hubs. It was observed however that the yield premium in hub markets decreased during the crisis, and the most financially distressed airlines have had the lowest yield premiums.

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Chapter 1
Introduction

The past decade saw the US airline industry coming through two distinct financial cycles. From 1995 until 2000 the industry followed an up-cycle when the net profits exceeded 15 billion dollars[1] and then from 2000 to 2005 a down-cycle when US airlines lost more than 30 billion dollars[2].

The US airline industry can be segmented in to two distinct categories: the network carriers that operate vast domestic and international network on a hub-and-spoke basis and will be referred, hereafter, as the Legacy carriers, and the low cost carriers that operate mainly point-to-point domestic networks and will be referred as LCCs.

The down-cycle can be attributed to both economic and socio-political facts that govern, respectively, the airline industry and the world community:

- Fierce competition between Legacy carriers
- Rapid growth of LCCs led to air fare reductions and lost market share by Legacy carriers
- Over-capacity of the system since supply of aircraft seats is higher than the respective demand.
- 9/11 terrorist attacks, Iraq war and SARS epidemic reduced air travel demand
- China's and India's industry's rapid development that increased fuel demand.

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[1] R. Doganis, "The Airline Business Second Edition", Routledge, 2006.
[2] ATA, , www.airlines.org, last accessed 03/19/2007.

All above factors have led to significant changes in the airline industry. US Legacy carriers have introduced major cost cut-backs in order to overcome their revenue shortage and diminution of yield- a metric widely used in the industry that shows how much revenue is produced by a passenger carried per mile. The scope of this research is to analyze US airlines revenues and yields. This thesis concentrates on the pricing competition between major Legacy and low cost carriers in the US domestic markets by analyzing the Top 1000 US domestic markets -in terms of daily traffic. A new metric is introduced, the yield index, that compares fares among airlines in specific markets in order to quantify the fares collected by major airlines with respect to their competitors in different segments of the domestic market.

1.1 Recent Forces and Trends of the US Airline Industry

The airline industry has always been characterized by very low profit margins and a cyclic profitability pattern with an, approximately, ten year period; usually five to six years of net profits followed by four to five years of net losses. The last cycle starting in 1995 was the most intense since deregulation in 1978 both during its up side and its downturn. From 1995 until 2000 the total profits for the US airlines exceeded 15 billion dollars, by far the most profitable years since deregulation. In the second part of the cycle from 2001 to 2005 the US airlines reported a total loss of 35 billion dollars. This pattern was followed not only by the US airline industry butin a smaller extent for the global airline industry too.

The competitive environment of the US airline industry and the struggle of airlines to remain profitable are clearly depicted by the low profit margins of the airlines. The airline industry's highest profit margins were observed in the period 1997-1999 when the average was fluctuating between 4.3% and 4.7%; a low value compare to the US business average of, approximately, 6%[3]. It is evident that even during the most profitable period of the airline industry, since Deregulation, airlines had to struggle in order to achieve marginal profits. In 2000, the last profitable year of the US airline industry, the average profit margin dropped to 1.9%. In 2002 the average return on revenue was down to -10%.

[3] ATA, 2007 Economic Report, p. 6.

Although periods of financial instability have been common in the airline industry the tremendous losses of the last 5 years have led to a severe crisis. The profits generated in the period 1995 to 2000 were not adequate for the airlines to withstand the recent down-cycle period. The industry was affected both by economic factors and non-economic circumstances that led to the reduction of both traffic and revenues, which will be discussed in greater detail in the next section. The most severe years for US carriers were 2001 to 2003 and since then the industry is slowly recovering but the total losses were still significant. This crisis mostly hurt the Legacy carriers that have not had a single profitable year from 2000 to 2005.

On the other hand the major LCCs, like Southwest, JetBlue and AirTran, seized the opportunity of travelers' reduced willingness to pay during the crisis and grew significantly both in terms of traffic and revenues, generating profits for most of the five years of the crisis. Several Legacy airlines, though, had to file for bankruptcies and were driven to great cost reductions in order to endure the financial crisis, as will be discussed in a later section.

After five straight years of net losses US airline companies reported net profits of approximately 3 billion dollars[3] in 2006, a sign that the industry might have recovered and airlines will once again return to profitability.

1.1.1 Causes for the Crisis of the Airline Industry

The airline industry follows historically the behavior of the general economy. Businesses with diminishing travel budgets are a critical issue for the industry since business passengers typically pay the highest fares. When the GDP growth slows down, people's income loses value, hence their willingness to pay for air travel drops. Airlines in turn have to reduce their fares in an attempt to stimulate demand and deal with the reduced traffic.

The cyclic behavior of the airline industry is often attributed to the phase lag between aircraft ordering and aircraft delivery. When traffic is growing rapidly during an up-cycle of the industry and airlines have the capital to expand their fleet aircraft orders rise. However, when these aircrafts are delivered after a few years the system is characterized by overcapacity and the

profits go down both because operating costs have increased and the airlines drop their fares to drive demand.

Ticket distribution via traditional travel agents has lost ground to Internet channels, as more than 50% of the tickets in North America are currently sold via the web[4]. Internet distribution, although it reduces the sales and distribution costs for the airlines, leads to a fare transparency that makes travelers more conscious about low fare alternatives in air travel and, hence, reduces their willingness to pay.

The first Low Cost Carriers appeared just after deregulation in 1978. Their innovative and efficient business model offers them a competitive advantage of lower operational costs over Legacy carriers. Their operation is based on secondary airports near major cities, a single aircraft-type fleet, young employees and high aircraft utilization and employee productivity. This allows the LCCs to introduce into the air travel market very low fares and still generate profit. Legacy carriers, in response have to match these fares otherwise they would lose their traffic and market share. Since the mid 90's LCCs have grown very rapidly and have exceeded a market share of 25%[5] within the US domestic markets.

Another important driver to lower yields for most of the US domestic markets is the fierce competition among Legacy carriers themselves in order to capture as much traffic as possible in the US markets. Fares have constantly been decreasing since deregulation in 1978 even before the widespread appearance of LCCs, as it is typically the case with unregulated competitive markets[6]. Figure 1 presents the change in yields over time since deregulation.

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[4] Airline Business, July 2004.
[5] Celia Geslin, "Pricing and competition in US Airline markets: Changes in Air Travel Demand since 2000", MIT Thesis, Dept of Civil and Environmental Engineering, June 2006.
[6] ATA, http://www.airlines.org/economics/finance/PaPricesYield.htm, last access 03/19/2007

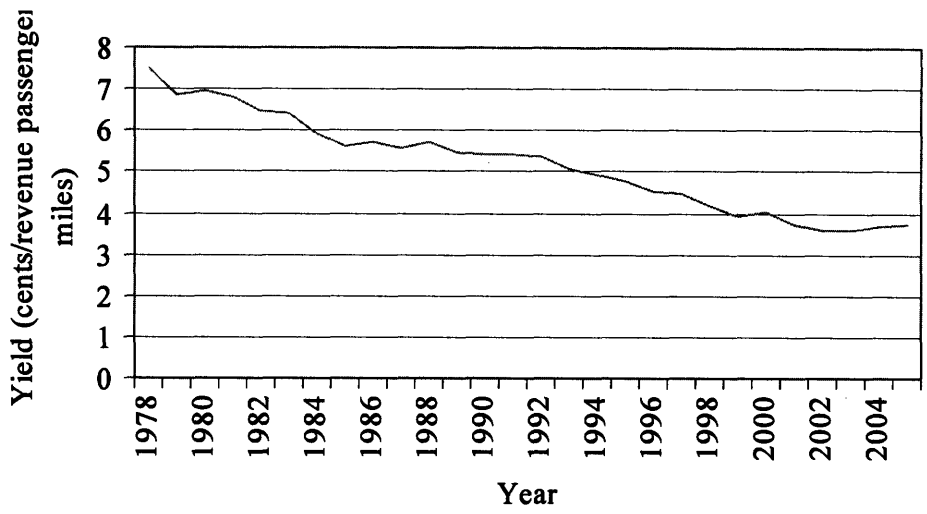

Figure 1: Trend in US Domestic Yield since 1978 Deregulation, in 1978 US cents [Source: ATA, "Annual Passenger Yields: U.S. Airlines"] [6]

Fuel prices played a major role during the industry crisis. Until 2002 fuel prices were still low but since then and especially in 2004 and due to factors such as the Iraq war and the rapid growth of China's industry that lacks of oil resources, fuel prices have skyrocketed making it the highest expenditure for airlines. Figure 2 shows how the average price paid by US airlines for jet fuel changed from 2000 to 2006.

Non-economic facts have played a very important role during the airline industry crisis by making recovery even more difficult for the airlines. The terrorist attacks of 9/11, the fear on future strikes and on SARS epidemic and the Iraq war in 2003 led to huge reductions in demand in 2002 and 2003. Strict security measures and the frequent delays that these cause are a form of inconvenience to the passengers that, also, affects their willingness to fly and are having a particularly negative effect on shorter haul travel.

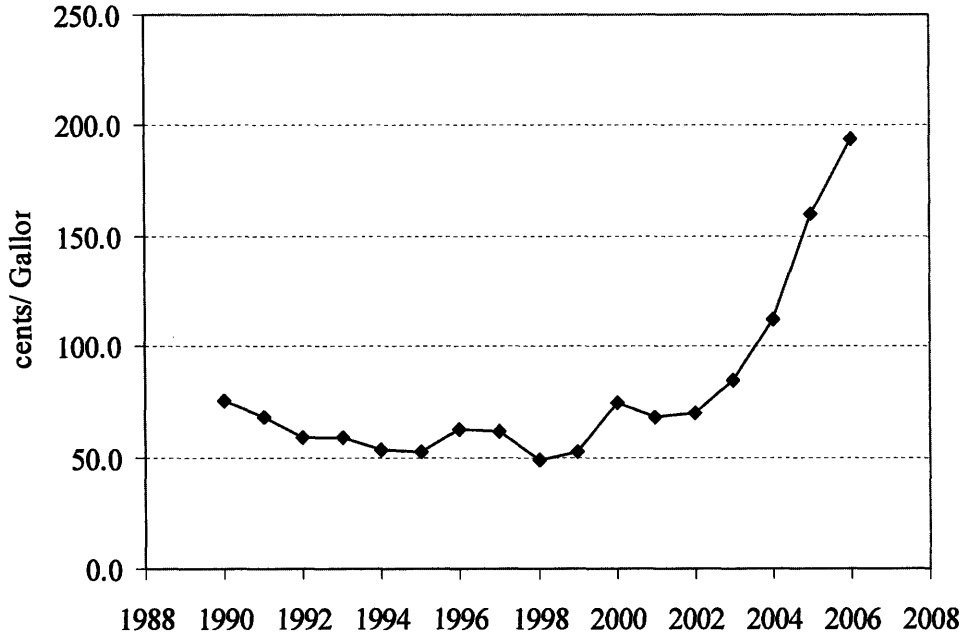

Figure 2: Average Price Paid by US airlines for Jet Fuel, [Source: ATA, "Annual Crude Oil and Jet Fuel Prices"][7].

1.1.2 Enduring the Crisis and Cost Reductions of the Legacy Carriers

Although this thesis will concentrate on the pricing competition between US domestic carriers and the trends in revenues, traffic and average fare for the period 2000-2006 it is important to introduce the "other side of the coin" for the airline companies, their costs. Thus the recent trends of some important cost measures will be discussed briefly.

Losses were so immense for many of the airlines that several were led to bankruptcies during the period of the crisis. American Airlines acquired Trans World Airlines after it went bankrupt in 2001; US Airways and United Airlines filed bankruptcy during the fourth quarter of 2002- the former filing a second time in 2004-, while Delta and Northwest filed Chapter 11 in September 2005. US Airways merged with America West to avoid a second bankruptcy and possible liquidation in 2005. Several Low Cost and Regional carriers went bankrupt too. The

[7] ATA, http://www.airlines.org/economics/energy/Annual+Crude+Oil+and+Jet+Fuel+Prices.htm, last access 03/19/2007

most important ones: Vanguard Airlines in 2002, Hawaiian Airlines in 2003, ATA Airlines in 2004, Aloha Airlines in 2004 and Comair in 2005. Bankruptcies have helped the airlines to restructure, renegotiate employment issues with unions and reduce their personnel. Legacy carriers were thus able to lay off significant numbers of employees and hence reduce their labor costs significantly- which so far have been their major costs.

There is a strategy by most airline companies to increase their average stage length in order to take advantage of the economies of scale. Legacies outsourced many of their operations in short haul markets to regional carriers. The center of attention of Legacy carriers became the International markets where their wide and complex networks become a serious product differentiator against LCCs and where economies of scale are easier to exploit, by traffic consolidation and longer hauls. Legacy carriers try to squeeze out as much revenue as possible from markets where they still have the "upper-hand", that is their hub markets and the markets they still monopolize through aggressive pricing. The employee and aircraft productivity of the Legacy carriers has improved dramatically and, together with the unit costs, are converging towards the LCC levels.

Although LCCs were the only profitable airlines during most years of the industry crisis, Legacy carriers have grasped the opportunity to restructure and redefine their businesses in order to overcome their difficulties and emerge stronger and more competitive against LCCs from the latest airline industry crisis.

1.2 Thesis Objectives and Approach

The main objective of this thesis is to determine the trends in pricing competition in the top US domestic markets for the period 2000-2006. In other words, the goal is to compare the yields of each of the major US carriers to their competitors in each of the US domestic markets that will be analyzed. Furthermore, trends in traffic and revenues for each of the major US carriers are investigated in order to realize the effects of the crisis in the airline industry.

The data source is the Origin and Destination Survey of the US Department of Transportation. The survey includes all origin-destination markets flown by US carriers and presents measures such as the traffic, revenues and stage lengths both aggregate for each of the markets and disaggregate for each airline in a specific market, based on 10 % sample of the airline tickets as reported from carriers with revenues higher than $100 million dollars. Geslin[5] constructed a database of the top 1000 US Domestic Markets in terms of traffic in 2004 and consistently matched these markets for the years 2000 to 2003 and 2005. The database was updated with 2006 data for the purpose of the current thesis.

The aim of the current thesis is to address the following questions:

- Is there any evidence of convergence between the average fare of LCCs and Legacy carriers from 2000 to 2006?
- Which airlines have a yield premium in the Top US domestic markets? Are the Legacy carriers able to maintain a yield premium?
- How is the average fare in a market affected by the presence of Low Cost Carriers and how does this presence affect the yield premium of Legacy Carriers?
- Are there any differences revenues and traffic between markets with significant LCC presence and those with minimal presence for each of the major Legacy carriers?
- How do Legacy carriers perform in terms of fares, revenues and traffic in their hub markets?
- Do Legacy carriers have a yield premium at their hub markets?
- How much has the number of competitors in the Top US markets changed and what portion of it does it come from Low Cost Carriers?
- How much competition do Legacy carriers face in their hub markets? Is it lower or higher than in the non-hub markets? How much have the LCCs intruded the major US domestic hubs?
- How is the yield premium of airlines affected by the number of competitors in a market?
- How does the combination of all these factors (stage length, traffic, hubs, LCC presence and amount of competition) affect the average fare or yield in a market and more specifically how does it affect each of the Legacy carriers separately?

1.3 Thesis Structure

The current thesis is divided into six chapters. After a short introduction on the recent trends in the US airline industry in Chapter 1, a literature review of studies of pricing competition in the airline industry, hub networks, yield premium as well as any relevant economic studies in the area will follow in Chapter 2.

Chapter 3 will present the data that was analyzed during this research. The significance of the data sample will be addressed and finally the metric used to analyze the data (Yield Index) will be defined and explained.

Chapters 4 will deal with an aggregate analysis of the data. Firstly, carriers are separated into two distinct groups, Legacy carriers and LCCs and are analyzed for the whole data sample. The revenue, traffic and market share for each of the major carriers is evaluated for the whole data sample and an analysis on the aggregate yield premium of each airline is performed. Finally, we try to quantify the competition in the top US domestic markets.

Chapter 5 deals with a disaggregate analysis of the data. The markets are segmented in terms of number of competitors, low fare carrier presence, average stage length and hub/non-hub markets and for each of these segmentations a disaggregate analysis for each Legacy carrier is performed.

In Chapter 6 we perform an econometric analysis on the available data in order to estimate how certain factors affect the average yields in the domestic markets and the yields of Legacy Carriers.

Chapter 7 presents a summary of the findings, discusses some of the limitations of the analysis and suggests directions for future research.

Chapter 2
Definitions and Literature Review

In this chapter some metrics and terminology that are extensively used throughout this thesis will be listed and briefly discussed. Furthermore, a literature review is performed based on the subject of this thesis. We will look on previous research on the competitive aspect of the airline industry, especially since deregulation, as well as on studies relevant to the differences between Low Cost and Legacy carriers. Moreover, a reference will be made on studies about point-to-point and hub-and-spoke networks. Most importantly we will explore previous research on the relation of hubs and the pricing power of hub airlines. Finally, similar studies performed on revenue analysis and pricing of airlines will be brought forward.

2.1 Definitions

This thesis uses a terminology widely used in the airline business. It is thus worthwhile to define and explain the most important terms here since they will extensively be used during the literature review that follows:

Revenue Passenger Miles (RPM)

A revenue passenger mile is defined as one revenue generating passenger transported by one mile. It is a measure of the output sold by an airline and can be calculated as the total number of enplanements multiplied by the average stage length, where stage length is the distance flown by an aircraft between two airports.

Average Fare

The average fare is the passenger revenue produced in a market over the total traffic (number of passengers) in this market:

$$Average\,Fare = \frac{Passenger\,\mathrm{Re}venue}{Total\,Traffic}$$

When calculated from the above equation the average fare is weighted with respect to the passengers of each airline so that this equation is equivalent to:

$$Average\,Fare_j = \sum_i Traffic_1 \times Average\,Fare_i$$

where i is an airline serving market j.

Yield

Yield is a very common measure of the revenue quality of an airline. It is defined as the revenue generated (by a flight leg or a market or any set of either of the two like the entire network) divided by the respective revenue passenger miles. In other words yield is the revenue generated by a passenger flown by one mile in the corresponding leg, market or network, or the revenue per unit of output sold per mile:

$$Yield = \frac{Revenue}{Revenue\ Passenger\ Miles}$$

Yield (Fare) Premium

Yield premium has never been universally defined. During this thesis yield premium is defined as the ability of an airline to generate higher yields than the average within a market or across a set of markets while taking into consideration the airline's traffic in these markets. In this thesis we developed a new measure that enabled us to estimate the yield premium of an airline in a set of markets and which we will introduce in section 3.4.

Hub Market

Any market that originates or terminates at the hub of an airline is characterized as a hub market for that airline. For example, the Atlanta to Boston market is a hub market for Delta Airlines but not for US Airways, who also serves the market, since Atlanta is Delta's hub. Also the Boston to Los Angeles market is not a hub market for Delta even if passengers are connecting through a hub of Delta.

Hub Premium

A hub premium similarly to yield (fare) premium is the ability of an airline to receive higher fares than the average fares in its hub markets.

Average Haul

Average haul is the distance traveled by a passenger in one market. If service in a market requires a connection at a hub then the average haul is simply the sum of the distances flown in the two legs that will serve a passenger in this market. As we will later see two airlines might have significantly different average hauls in the same market. This is explained by the fact that one airline might serve the market nonstop while the other by connecting the passengers through its hub.

2.2 Literature Review

Since 1978 Deregulation, when the US airline industry was liberalized and the environment became increasingly competitive, a large number of studies have been performed that examine the price competition between airlines and the effect of the free market on the airline business. Numerous studies have been written, especially, since the emergence of the low cost carriers when pricing competition in the airline business became even fiercer. Early studies were much more descriptive than analytical but as competition in the airline industry grew and econometric theory progressed recent research has become more quantitative. The first years after deregulation most studies tried to analyze the recent impacts of deregulation and forecast the future changes that will occur in the industry. Many of the studies in the late 1980s and early 1990s focused on the attributes of the hub-and-spoke networks and on the issue of economies of scale and only during the past decade has the research expanded to compare the productivity, costs and business models between Low Cost and Legacy carriers.

The first part of the literature review will look at some important studies that have been performed during the past two decades, related to competition and its effects on airline fares as well as more general studies on the operations and pricing strategies of US airlines. Looking at the previous research on airline competition we will be able to show both how the US airline industry has evolved and identify some critical factors that affected this evolution and at the same time to realize how this research provides a new analysis on the pricing competition between US airlines. The final part will be devoted to reviewing studies that were concentrating on airline hubs and their role in the pricing competition between airlines and the yield performance of airlines on their hub markets compared to other markets of their network.

2.2.1 General Studies on Competition

Since Deregulation of the airline industry in 1978 the competition between existing airlines and the emergence of new ones has been driving the yields down by approximately 2%

per year[8]. The yield decline was compensated though by high rises in the demand for air travel, hence higher industry-wide load factors, as well as by the efforts of airlines to become more efficient and thus reduce their costs.

Although the deregulated environment was expected to boost new entrant carriers in the US airline industry a study by Borenstein (1992)[9] has showed that the eight largest firms in 1977 captured 81.1% of the total domestic RPMs while in 1990 the market share had gone up to 90.5%.

Borestein (1992)[9] has also tried to quantify the effect of competition on the price levels of a market. He found that in 1990 airlines in monopoly markets offered on average 8% higher fares than in duopoly markets which in turn had 8% higher fares than markets with three competitors. Earlier studies, like Baumol et al (1982)[10] argued that the threat of potential competition may lead to a reduction of the fares offered by an operator in a market, otherwise known as the theory of contestability –a major argument in favor of the Deregulation of the airline industry. However, Morrison and Winston (1987)[11] found that actual competition in a market reduces the fares significantly, contradicting the theory of contestability that expected the fares to be low enough before the entry of a new competitor in a market. According to their findings potential competition has in the best case one third the impact on price levels that actual competition has.

Morrison and Winston (1990)[12] addressed the effect of competition on airline pricing. Performing a regression analysis they showed that the impact of the number of competitors on lower fares was stable during the decade following deregulation. They also found that, although the number of effective competitors at a national level fell from 8.7 in 1978 to 7.7 in 1988, the number of competitors at the market level has increased from 1.5 to 1.9 during the same period. Although these numbers have probably increased significantly since then (since many more airline are now operating in the US domestic markets), no study has attempted to quantify the average amount of competition that a carrier faces in the US domestic markets. This is being

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[8] M. Franke, *Competition between Network Carriers and Low-cost Carriers: Retreat Battle or Breakthrough to a New Level of Efficiency*, Journal of Air Transport Management, 15, 21, 2004.
[9] S. Borenstein, *The Evolution of US Airline Competition, Journal of Economic Perspectives*, 6, 2, Spring 1992.
[10] W. Baumol et al, *Contestable Markets and the Theory of Industrial Structure*, New York: Harcourt Brace Jovanovih, 1982.
[11] S. Morrison, C. Winston, *Empirical Implications and Tests of the Contestability Hypothesis*, Journal of Law and Economics, Vol. 30, October 1987.
[12] S. Morrison; C. Winston, *The Dynamics of Airline Pricing and Competition*, The American Economic Review, Vol. 80, No. 2, May 1990.

addressed by the current research for the top 1000 US domestic markets and will be presented in Chapters 4 and 5 of this thesis.

There are many factors in the airline business that can affect the pricing strategy of the airlines. A study by the General Accounting Office (1991)[13], tried to analyze how different competitive conditions affect the prices an airline applies in a market. In summary it was found that an airline is more likely to apply higher fares when:

- One of the airports in a market is slot constrained or highly congested.
- The airline is code sharing with a regional carrier
- The airline obtains a high market share.

Furthermore, the higher the operating costs of the lowest cost carrier in the market the higher the average fare on that market will be.

The US Department of Transportation (DOT) releases quarterly a "Domestic Airline Fare Consumer Report"[14] that includes the total traffic and average fare for each of the Top 1000 US Domestic markets. It also includes a fare premium calculation for each city in the Top 1000 US Domestic markets. The DOT defines fare premium as the average fare in a market compared to the average fare in all other markets that are comparable in terms of density and traffic[15]. In DOT's reports, though, all markets of a city are treated as one single market, by deriving the average haul and the average fare across all markets that include service to this city. By calculating the overall average fare premium in a city, rather than the premium in a market, the fare premium in many of the city's markets may be significantly over- or underestimated. Furthermore, the report does not look into the fare premium of the carriers operating in each market. This thesis calculates the yield premium of each airline in each of the Top 1000 US domestic markets in order to realize which airlines and in what markets they effectively charge higher prices than the market average.

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[13] General Accounting Office, *Airline Competition: Effects of Airline Market Concentration and Barriers to Entry*, April 1991, Report to Congressional Requesters.
[14] US DOT, *Domestic Airline Fare Consumer Report*, Quarterly Report, http://ostpxweb.dot.gov/aviation.
[15] US DOT, *Fare Premiums by City*, www.ostpxweb.ost.dot.gov/aviation/domestic-competition/sf983.pdf, 2001.

2.2.2 Hub-and-Spoke and Point-to-Point Networks

The expansion of hub-and-spoke networks was an indirect product of the deregulated environment in the US airline industry. Although before the 1978 Deregulation Act some carriers operated hub-and-spoke networks (while others just linear point to point networks), it was shortly after Deregulation that the economic benefits of the hub-and-spoke networks were increasingly realized. The percentage of trips above 1500 miles that involved a connection via a hub increased from 42% in 1978 to 52% in 1990[9]. Since then, hub-and-spoking is a fundamental characteristic of operations of Legacy carriers.

The main characteristic of a hub-and-spoke network is load consolidation. Each flight into or out of the hub of an airline carries passengers to multiple destinations who will connect or have connected at the airline's hub. The airline is thus able to serve a greater number of markets with the same number of flights, hence, increasing its average load factor. With the hub-and-spoke network it is more justifiable to serve small cities with low demand, since with one flight the airline may serve passengers form that city to multiple destinations. Furthermore with the same size of fleet an airline can offer a higher frequency schedule. Most major hubs of the US airlines are located in central cities of the country. As it will be discussed in a later section, airlines greatly benefit from their dominance in local markets to and from their hub. On the other hand, operation of hub-and-spoke networks is much more costly than point-to-point networks.

Point-to-point networks are characteristic of LCC operations, although there are LCCs that extensively operate through hubs, like AirTran through its Atlanta hub. These networks are much simpler and hence incur fewer costs to the airlines operating them. Since load consolidation is not possible with a point-to-point network LCCs typically focus on dense markets where there is enough traffic to justify service. Hence, it is expected that the database of the Top 1000 US domestic markets, in terms of traffic, that is analyzed during this thesis will include most of the US domestic traffic served by low cost carriers.

2.2.3 Low Cost and Legacy Carriers

Many studies have tried to analyze and compare the different business models of LCCs and Legacy carriers. The first carrier that implemented the low cost model was Southwest Airlines in the early 70s and was followed by many new entrant carriers over the following two decade. The fundamental advantage of LCCs is that they can offer very low, one-way fares while still generating large profit due to their very low unit costs and high productivities[16]. The emergence of LCCs increased the demand for air travel dramatically since they provided cheap service to people who would have otherwise never considered traveling. Thus, LCCs benefited not only by absorbing a significant market share of the existing traffic but, also, by stimulating traffic based on the price elastic behavior of consumers to air travel. Southwest was the first and until the mid 90s one of the few airlines that achieved to took advantage of the free market to compete with the Legacy carriers. The LCC model only started to spread significantly and becoming more successful in the early 90s.

On the other hand, Legacy carriers immediately benefited from the deregulated environment. Fares in markets with high demand dropped while in markets with low demand, which during the regulated era had been subsidized, service was reduced and prices were increased to compensate for the low traffic. The dominance of legacy carriers generated high barriers to entry to other airlines. This was achieved mainly through aggressive pricing that lowered the yield in a market below a level that made the market unprofitable, frequent flyer programs that increased consumers' willingness to pay and booking incentives to travel agents to promote Legacy carrier service. Furthermore, over-congested and slot constrained airports together with long term gate leases to the large carriers intensified the entry barriers and created a worry that the deregulated environment was becoming less competitive than envisioned, as suggested by a testimony of the General Accounting Office (1998)[17]. During the 1980s many of the new entrant airlines either went bankrupt, merged with or were acquired by the large carriers of the time. Legacy carriers' dominance reached its peak during the up cycle of the airline industry in the mid to late 1990s.

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[16] G. Tsoukalas, *"Convergence in the US Airline Industry: A Unit Cost and Productivity Analysis"*, MIT Thesis, Dept of Aeronautics and Astronautics, August 2007.

[17] General Accounting Office, *Airline Competition: Barriers to Entry Continue in Some Domestic Markets*, Testimony Before the Subcommittee on Transportation, March 1998.

Early on in the deregulation era airlines realized that they can benefit from the liberalized market and hence increase their profits by offering fares to consumers according to their willingness to pay. In other words, they would profit from business passengers who are less sensitive to price by offering them high fares, while increase their load factors by offering low prices to consumers who would otherwise not fly. This strategy was achieved via differential pricing which offers different fares for the same itineraries based on different restrictions. Restrictions in in-flight amenities, refundability, advanced booking and minimum stay requirements enable the airlines to identify between high and low willingness to pay passengers, apply the fares accordingly and, thus, generate more profit. With the widespread appearance of LCCs, though, which offered simply structured, one-way low fares the complex fare structures of Legacy carriers started to lose their effectiveness[18].

Furthermore, consumer's reduced willingness to pay due to the existence of lower fares (offered by LCCs), has forced Legacy carriers in most cases to reduce their fares and overall lose revenue. The impact of LCCs on pricing and reduction of yields and revenues becomes evident from the findings of Morrison (2001)[19]. He tried to model the impact of Southwest Airlines on the fares of other airlines that fly: between airport pairs that WN serves, between adjacent airport pairs to the ones that WN serves that serve the same markets, as well as to other markets where the fares are reduced because of the threat of potential competition from WN. He estimated that approximately $12.9 billion have been saved from air travel budgets in 1998 (20% of the total US domestic revenue) only due to the existence of Southwest in the US domestic markets.

According to a report by the Department of Transportation (2003)[20] that focused on new entrant low cost airlines, the rapid expansion of LCCs started early in 1993. In this study it was observed that, although Southwest had so far aimed at short haul dense markets, the new wave of LCC entries penetrated in markets of all distances. The DOT report tried to estimate the full effect of LCCs' fares on the average fares of the industry as well as on the domestic traffic during the airline industry's greatest up-cycle in the mid 1990s. During this period the Legacy carriers not only were not harmed by their new entrant LCC competitors but they benefited greatly from the increased load factors that the low fares generated, so that the new type of competition and the

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[18] M. Tretheway, *Distortions of Airline Revenues: why the network airline business model is broken*, Journal of Air Transport Management, 3, 14, 2004.
[19] S. Morrison, Actual, *Adjacent and Potential Competition: Estimating the Full Effect of Southwest Airlines*, Journal of Transport Economics and Policy, 35, 2, May 2001.
[20] US Department of Transportation, *Low Cost Airline Service Revolution*, www.dot.gov, Summer 2003

co-existence of Low Cost and Legacy carriers in the airline industry benefited both the consumers and most of the carriers. In the report, though, the concern of how this new competitive environment would affect the carriers during industry's next down-cycle is correctly expressed.

During the period that this thesis examines (2000-2006) the US domestic airline industry changed its form mainly because of the rapid increase of LCCs' market share and the aim of the Legacy carriers to restructure. Legacy carriers lost many of their monopoly markets and their dominance has been challenged. LCCs efficient business models and the reduced barriers to entry since the late 1990s, has led to an increasing competition out of which LCCs seem to come more profitable since the start of this decade.

Tretheway (2004)[18] makes a comparative study between the Low Cost Carrier model and the Legacy carrier model, which he refers to as the Full Network Service Carrier model. He states that in 2000 LCCs served 24% of the total domestic passengers while generating the 11% of the total domestic passenger revenues. He argues that because of the rapid expansion of LCCs, their high profitability and large number of aircraft orders, the Legacy carriers will continue to lose market share, which will eventually drop to around 40 to 50% in the US domestic markets, which based on the analysis performed in this thesis this has proven to be an inaccurate prediction. In this thesis it will be shown how these numbers have changed in the Top 1000 US domestic markets (which generate a very large proportion of the total domestic traffic) since 2000 and, especially, what was the situation in 2006, when most Legacy carriers have restructured and, most importantly, have overcome the industry crisis.

2.2.4 Pricing Competition and the Industry Crisis

As described in the introduction of this thesis, during the period 2000 to 2004 the airline industry lapsed into the greatest crisis of its history. The effects of fierce competition and the intense crisis in the US domestic markets are clearly depicted in the findings of Geslin (2005)[5]. She performed an aggregate analysis of the Top 1000 US domestic markets in order to observe trends in average fares, revenues and demand for air travel for the time period 2000 to 2005. She found that the average fare and passenger revenues dropped by 16% and 17%, respectively, since 2000, while traffic dropped during the peak period of the crisis but recovered by 2004.

One of the most important characteristics of the period that the current thesis examines is the financial instability of many airlines caused by the crisis, which in many cases led the airlines to file Chapter 11 for bankruptcy. Hofer et al (2005)[21] attempt to correlate the financial distress of an airline to the prices it applies. They used data of the Top 1000 US domestic markets for the years 1992 and 2002, during which the industry was under serious financial crisis, to model the pricing strategies of airlines that were operating under Chapter 11 provisions of the bankruptcy code. Hofer found that financially distressed airlines have reduced their fares before filing for bankruptcy and in most cases reduced even further during bankruptcy. Based on his results he concluded that financially distressed airlines are more aggressive in their pricing strategies mainly for two reasons:

- Bankrupt airlines usually have lower costs due to the protection from Chapter 11, hence are able to offer lower fares and still generate profit.
- Travelers' willingness to pay for transportation service by a financially unstable airline drops hence the airline has to reduce its prices in order to regain demand.

A similar study had been performed earlier by Busse (2002)[22] that, in addition, suggested that financially distressed companies discount future returns more heavily than short term returns and thus are more likely to price aggressively.

2.2.5 Market Segmentation

Airline fares differ substantially between high and low density markets, an impact, as explained in section 2.2.3, of the free airline market. In order to further investigate the above statement, Bitzan and Chi (2006)[23] segmented the US domestic markets into two categories: small and rural communities below 300,000 citizens and large communities above 300,000 citizens. They estimated that the average air fare for serving the small communities is 11% higher than that of large communities and the attributed the difference to the following reasons:

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[21] C. Hofer et al, *Financial Distress and US Airline Fares*, Journal of Transport Economics and Policy, 39, 3, September 2005.

[22] M. Busse, *Firm Financial Conditions and Airline Price Wars*, The RAND Journal of Economics, 33, 2, Summer 2002.

[23] J. Bitzan, J. Chi, *Higher Airfares to Small and Medium Sized Communities- Costly Service r Market Power*, Journal of Transportation Economics and Policy, 40, 3, September 2006

- Service to lower communities is more costly mainly primarily because of shorter average stage lengths and moreover because of low load factors and smaller aircraft sizes.
- Airlines that serve small communities have increased market power due to lower competition caused by the low density of these markets.

Geslin (2005)[5] also calculated the average fare and total passengers and revenues for the period 2000-2004 for the following distinct market segmentations:

- Short, medium and long haul markets
- High and low LCC market share
- Hub and non-hub markets
- Competition level

For these three categories however she only provided the nationwide industry trends and performed a minimal disaggregate (i.e. per carrier) analysis. The current thesis evaluates the same metrics for the same market segments for each major US carrier (explained in more detail in Chapter 3) and repeats some of the statistics performed by Geslin but for a longer period—2000 to 2006—, hence including in the analysis the first year when the industry has supposedly overcame the crisis. Furthermore the yield premium of airlines is analyzed for these same segmentations. Pricing strategies and airline's performance (market share and passenger revenue) can be compared between airlines in order to better realize the overall domestic strategy and performance of each of the major US airlines. Furthermore, we will observe how (and if) known practices of specific airlines, such as Continental's strong position in the New York markets or United's attention towards transcontinental markets, are reflected on their yields, traffic and revenues.

2.2.6 Hub Premium

Although hub operation has been proven costly for legacy carriers, no airline, even during its worst financial distress, has abandoned its hub-and-spoke network structure. There have been, however, attempts to dehub the least efficient hub networks. As Borenstein (1992)[9] aptly comments:

"..., hub-and-spoke networks are not just a source of increased production efficiency (for the airlines)*; they are also associated with airport concentration and dominance by one or... two airlines. This airport dominance ensures a degree of protection from competition and control over price that... has significantly altered airlines' strategies in the deregulated industry."*

Many studies have attempted to analyze the effect that a hub operation has on the air fares of an airline's hub markets[24]. Borenstein (1989)[25] found that prices charged by the airlines at their hub markets are higher than other similar (in terms of distance and traffic) markets of their networks. He then moved on to model the price of an airline as a function of many factors, such as frequency of service, average haul, size of aircraft and average load factor. He estimated the relationship between price and these factors based on data from major airline hub operations, including: TWA at St Louis, Northwest at Minneapolis, US at Pittsburgh, American at Dallas, United at Chicago O'Hare and Delta at Atlanta. Based on his results he was able to identify the most critical factors that affect the fares in the hub markets, presented in ranking order here:

- Market shares of the hub carrier both at a specific hub market and on an aggregate level at the endpoint airports of the market.
- Average Haul of the market
- Load Factor
- Frequency of service

Airlines in their hubs typically obtain very high market share on local markets, which gives the market power to apply higher fares. Borenstein (1989) attempted to speculate possible reasons for airline's dominance in their hub markets:

- Loyal customers gained by frequent flyer programs
- Increased traffic through travel agent commission override programs which guaranteed bonuses to travel agents generating a specific amount of revenues for an airline.
- Airlines' service at their hub markets is usually better than their competitors mainly because of higher frequencies and more alternatives routes and thus it is more attractive to travelers.

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[24] The term "hub markets" has been defined at the beginning of this chapter.
[25] S. Bernstein, *Hubs and High Fares: Dominance and Market Power in the U.S. Airline Industry*, The RAND Journal of Economics, 20, 3, Autumn 1989.

- Airport level entry barriers to competition because of high congestion and slot and gate constraints.

The situation in the airline industry, of course, has changed since then. Most domestic bookings are done online, through an airline's own website or at web-based travel agents. Hence, the impact of traditional travel agents on the hub market power of an airline should not be any more significant. Moreover, new carriers in the past decade penetrated most of the domestic markets hence the legacy airlines no longer enjoy the luxury of monopolizing their hub markets.

A report by the DOT (2001)[26] analyzed the fares in the US domestic hub markets. It compares the fares in hub markets which are dominated by legacy carriers to the fares in hub markets where there is significant LCC competition. It was found that passengers pay 41% more in the former and the difference is even greater in the short haul hub markets. This report however, only analyzes the average fare across the hub markets and does not explicitly look into the airlines serving these markets and thus it does not estimate the hub premium of dominating airlines.

The most recent study on hub premiums was performed by Lee and Luengo-Prado (2005)[27]. They defined hub premium "*as the ability of a given network airline to charge passengers in the same fare category more per mile in markets to and from its hubs than on otherwise similar markets throughout the remainder of its network*". The undoubtable advantage of their research compared to older ones is the fact that it accounts for the passengers' mix; that is they separated the passengers into leisure and business passengers and they performed their analysis based on that separation. Legacy carriers attribute the fact that average fares on their hub markets are higher than their non-hub ones to the higher number of unrestricted passengers (high fare, business passengers) that fly locally to and from their hubs. Unrestricted fares can be as much as ten times higher than restricted coach class fares and thus even a small increase in the number of unrestricted passengers may significantly increase the average fare in a market. One more study,

[26] US Department of Transportation, *Dominated Hub Fares*, Domestic Aviation Competition Series, January 2001.
[27] D. Lee, M. J. Luengo-Prado, *The impact of Passenger Mix on Reported "Hub Premiums" in the U.S. Airline Indusrty*, Southern Economic Journal, 72, 2, 2005.

by Gordon and Jenkins (2000)[28], addressed the effect of passenger mix on hub premium but only concentrated on the analysis of Northwest Airlines.

As we have seen so far many studies have addressed the issue of high fares in the hub markets of an airline but all of them have analyzed the problem by comparing the fares in the hub markets to other similar non-hub markets. The current thesis attempts to compare the fares that a hub airline applies at its hub markets to the fares offered by all other airlines serving the same markets. This analysis is important because since the beginning of the decade many LCCs have penetrated into legacy airlines' hubs increasing the competition in the hub markets. It is hence interesting to observe how (and if) the fare gap between the hub airline and its competitors has changed wit the prevalence of LCCs. All major hubs of the Legacy airlines will be examined in order to see how their pricing strategies have changed during the industry crisis at their hub markets. For the scope of this thesis we defined the hub premium as the ability of an airline to generate higher yields in its hub market compared to its competitors. For this reason a new metric is introduced, the Yield Index, which is defined in Chapter 3.4.

[28] R. Gordon, D. Jenkins, *Hub and Spoke Pricing in the Northwest Airlines Domestic System,* Department of Economics, Northwestern University, 2000.

Chapter 3
Data Presentation and Methodology

The aim of this chapter is to familiarize the reader with the data set analyzed and methodology used in this thesis. Hence, firstly, the data set will be presented by pointing out explicitly the data included on the set. Then, two major issues concerning the data analyzed will be presented, namely the source of the data and how the data has been collected. Furthermore, the size of the data set, its significance and its limitations will be addressed. Finally, the key metric used in the data analysis—the Yield Index—will be defined and how it was applied to the data set will be discussed.

For all terminology used in this Chapter refer to Section 2.1 Definitions.

3.1 The Database

The database used for the analysis that was performed for this thesis includes data for a large number of US domestic Origin and Destination markets. It is vital here to define the term Origin-Destination market, which will be referred hereafter as an O-D market or more often as just a market. An O-D market refers to the pair of cities from where a passenger originated his trip to where the passenger was ultimately destined. An O-D market does not differentiate between passengers with the same origin and destination cities but with different itineraries. Hence, a passenger originating from city "A" with final destination city "B" who is served by a non-stop flight between the two cities belongs to the same O-D market as a passenger originating from "A" with final destination "B" who is served by a connecting flight through city "C". On the other hand a flight leg refers to the pair of cities from where an airplane took-off and where was next landed.

Pricing competition between airlines is at the level of an O-D market. Airlines flying the same O-D market are in direct competition with each other; even though some airlines may offer non-stop service while others only connecting service. Airlines serving an O-D market are, thus, targeting the same passengers irrespective of the number of flight legs with which each airline serves the market.

In the database analyzed in this research one O-D market incorporates all airports in the vicinity of both the originating and the destination city. For example, the New York, NY – Washington DC market includes passengers traveling from LaGuardia, John F. Kennedy or Newark Liberty International Airports to Dulles or Ronald Reagan International Airports. This way, different airport choices within a metropolitan area for passenger flying between two cities are considered as part of the same market. Two airlines, thus, directly compete if they fly at different airports of the same metropolitan area.

All data in the database is given on a per day each way basis (PDEW). In other words, a single O-D market incorporates both passenger flow directions between the city pair. Hence, the number of passengers flying daily in each direction of the city pair are added and then divided by two in order to get the PDEW traffic in the O-D market.

The database includes 856 US domestic O-D markets and their corresponding data for the years 2000 through 2006. Geslin[5] created the database by first looking at the top 1000 US domestic O-D markets—in terms of traffic—in the year 2004. These markets were matched to the top 1000 US domestic markets of the years 2000 to 2003 and 2005. In other words, any 2004 market that was not included in the top 1000 markets of any of the other years was not included in the database. The result was that 856 out of the top 1000 appeared every year from 2000 to 2005 in the top 1000 markets. For the purpose of the current research the database was expanded to 2006 data, by including the same 856 markets with 2006 data. Only 16 out of 856 markets do not appear in the Top 1000 US O-D markets in 2006; 7 out of the 16 "missing" markets are New Orleans's markets which lost a huge amount of traffic after the Katrina hurricane in 2005. It is important to mention that all of these 16 markets are very close to the Top 1000 markets; most of the markets were ranking higher than 1150th in terms of PDEW traffic and just the smallest one ranking as low as 1,424th. Hence, by including these 16 markets in the database won't lead to inconsistent results or significant "noise" in the statistics. Throughout this Thesis the 856 markets included in the database will be referred as *Sample Markets*.

The database includes the following set of information:

- For each O-D market:
  - Aggregate PDEW Passengers and Passenger Revenues
  - Average Yield and Average Haul
  - The airlines operating in this O-D market
- For any airline serving the O-D market:
  - PDEW Passengers and Passenger Revenues
  - Market Share
  - Average Yield and Haul

Figure 3 presents a sample O-D market drawn from the database for a given year.

Markets Rank	*Market / Carrier*	*Non-Stop Mileage*	*PDEW Pax*	*PDEW Revenue*	*% Market Share*	*Avg. Yield*	*Avg. Haul*	*Year*	*City1*	*City2*	*Code*	*Sort*	*Item*	*City1*	*City2*
1	Fort Lauderdale FL	1,068	5,181.9	582,858.6	100.00	10.46	1,075	20060	+FF	+NY	+FF +NY	1	Total	Fort Lauderdale FL	New York/Newark NY
1	Jet Blue	1,068	2,296.1	264,599.5	44.31	10.77	1,070	20060	+FF	+NY	+FF +NY	2	B6	Fort Lauderdale FL	New York/Newark NY
1	Delta Air Lines	1,068	998.7	105,259.6	19.27	9.75	1,081	20060	+FF	+NY	+FF +NY	2	DL	Fort Lauderdale FL	New York/Newark NY
1	Continental Airlines	1,068	963.9	114,828.3	18.60	11.17	1,067	20060	+FF	+NY	+FF +NY	2	CO	Fort Lauderdale FL	New York/Newark NY
1	Spirit Air Lines	1,068	515.0	53,176.3	9.94	9.60	1,076	20060	+FF	+NY	+FF +NY	2	NK	Fort Lauderdale FL	New York/Newark NY
1	Other Locals	1,068	404.4	44,048.5	7.80	9.83	1,108	20060	+FF	+NY	+FF +NY	3	Other	Fort Lauderdale FL	New York/Newark NY
1	Off-line Connects	1,068	3.8	946.4	0.08	0.00	1,075	20060	+FF	+NY	+FF +NY	4	Offline	Fort Lauderdale FL	New York/Newark NY

Figure 3: Sample database O-D market Fort Lauderdale, FL – New York, NY in 2006.

A threshold market share of 5% is set in every O-D market for an airline to be included explicitly in the database. All airlines with market shares below 5% are included in the subcategory "Other Locals", as per Figure 3. Although this limits the database to fewer listed airlines per market it still does not affect significantly the type of analysis performed during this research. The minor effect of this limitation is further proved by the fact that "Other Locals" rarely obtain a significant market share; in 80% of the O-D markets in 2005 "Other Locals" have a market share below 10%, while there is no market where "Other Locals" obtain more than 22%. Hence, this group of airlines plays a minor competitive role in the market. Figure 4 includes the airlines that are explicitly included in the database for all years from 2000 through 2006.

Legacy Airlines		Low Cost Carriers		Others	
American Airlines	AA	Airtran/Frontier	FL	Alaska Airlines	AS
Continental Airlines	CO	America West Airlines	HP	Allegiant Air	G4
Delta Air Lines	DL	American Trans Air	TZ	Aloha Airlines	AQ
Northwest Airlines	NW	Frontier Airlines	F9	Chautauqua	RP
Trans World Airlines	TW	Independence Air	DH	Hawaian	HA
United Airlines	UA	Jet Blue	B6	Legend	LC
US Airways	US	National Airlines	N7	Midway Airlines	JI
		Pro Air Services	P9	Midwest Express Airlines	YX
		Southwest Airlines	WN	USAir Shuttle	TB
		Spirit Air Lines	NK		
		Sun Country Airlines	SY		
		Vanguard	NJ		

Figure 4: List of U.S. carriers that are included in the database

This thesis concentrates primarily on the analysis of six Legacy carriers and three LCCs, namely: American Airlines, Continental Airlines, Delta Airlines, Northwest Airlines, United Airlines, US Airways, Airtran/Frontier, JetBlue and Southwest. These will be referred, hereafter, as the Major airlines.

3.2 Data Source

The primary data source for this research comes from the Origin and Destination Survey (0&D Survey) performed by the US Department of Transportation (DOT) in collaboration with

the domestic airlines and the Air Transport Association. All "Large" U.S. scheduled passenger air carriers certificated by the Federal Aviation Administration (FAA) report to the US DOT for the O&D Survey. Airlines report data for the 10% of their ticket coupons so that the survey represents a 10% sample of the tickets issued, both for domestic and international markets[29]. The reported data includes the fare of the ticket, the number of passengers per ticket and the itinerary of the passengers' trip. The US DOT processes this data to incorporate the distance of travel per ticket as well as the O-D market for which the ticket was issued[30].

Data Base Products, Inc receives the processed data from the US DOT and produces a commercial product called O&D Plus. The product is distributed on a CD or DVD-ROM and includes a quarterly summary of all the domestic and international origin and destination markets flown by U.S. certified carriers. O&D Plus distinguishes between the two directions inside an origin and destination market. In other words data is provided separately for passengers flying in one direction of a market and those flying in the opposite direction.

There are two limitations on O&D survey's data. Any airline only operating aircrafts with capacity less than 60 seats may not participate on the survey. This limitation is of minor importance since these carriers obtain a very small market share in any of the top 1000 O-D markets analyzed and, moreover, as discussed in section 3.1, in the database created any airlines with a market share below 5% are not explicitly listed in the market summary.

The second, more important limitation is that there is no distinction between different fare structures in the O&D survey. This fact does not allow this research to distinguish between leisure and business passengers, and, more general, between different air travel products. Hence, the analysis on the price competition between airlines in the Sample Markets is limited to the average fares collected by the airlines in each market.

[29] Data Base Products, "O&D Plus Regulations Manual", www.airlinedata.com.
[30] Data Base Products, "O&D Plus Operations Manual", www.airlinedata.com.

3.3 Data Sample Size

In order to realize the size of our market sample, it is worth comparing the total daily output — RPMs— and revenues in the Sample Markets for each of the nine US domestic airlines, which are primarily examined in this thesis, to their corresponding total domestic RPMs and passenger revenues. In order to perform this analysis the data for the total domestic traffic and passenger revenue were extracted from Form 41, another database from DOT available from Data Base Products, Inc, which is based on data reported by FAA certified airlines. Figure 5 and Figure 6 present this comparison for the year 2005. The results were similar for any year since 2000.

Observing the two graphs, it becomes evident that for most carriers both the output and the revenues in the Sample Markets are more than 50% of their total domestic values. The percentage of total domestic RPMs that comes from the Sample Markets ranges from 39 for Northwest to 71 for Southwest, while for the revenues the percentage ranges from 41 to 76, respectively for the same two airlines. On an aggregate level these nine airlines produce 60.5% of their domestic revenue and output 56.5% of their domestic RPMs in the Sample Markets. It is worth noting that for all airlines in the Sample Markets the revenue percentage is much higher than the RPM percentage, a fact that may be attributed to higher average fares in the Sample Markets for markets of similar length and demand. This can be justified when looking at the yield equation presented in chapter 2.1; a higher yield is the result of either higher revenues, lower RPMs or both.

Finally, it can be concluded that, due to the fact that the percentages of airlines' revenues and RPMs in the Sample Markets are mostly above 50% of their respective total domestic values, the statistics and trends of the airlines in the Sample Markets that are analyzed in this research may lead to important conclusions about an airline's overall performance in terms of pricing and competition in the US domestic markets.

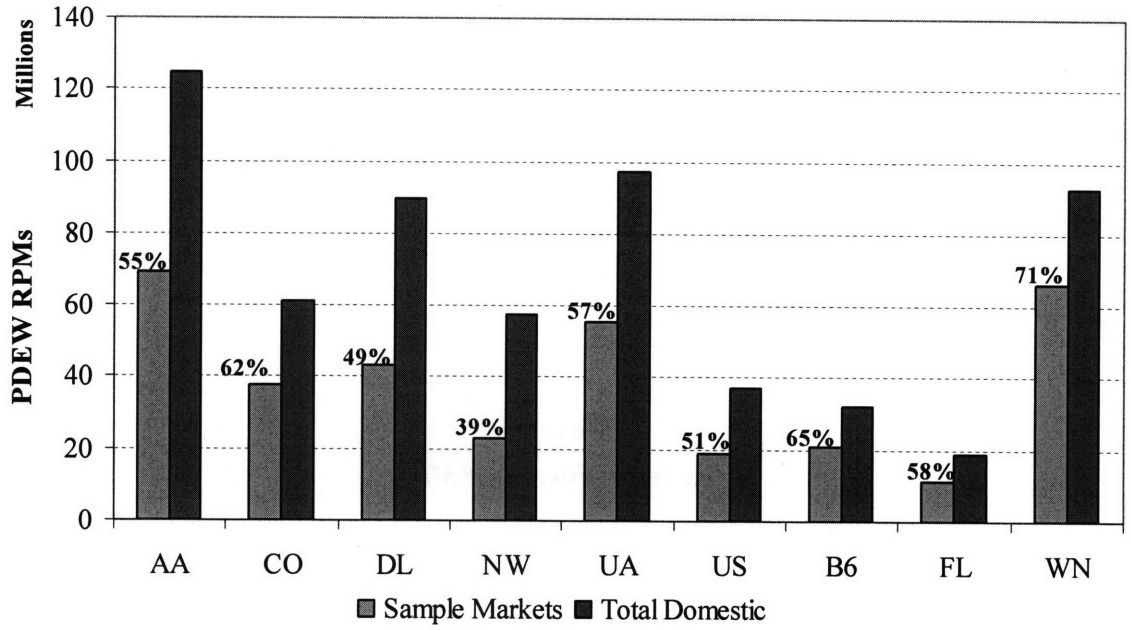

Figure 5: PDEW RPMs per Legacy carrier in the Sample Markets as a percentage of their total PDEW domestic RPM in 2006.

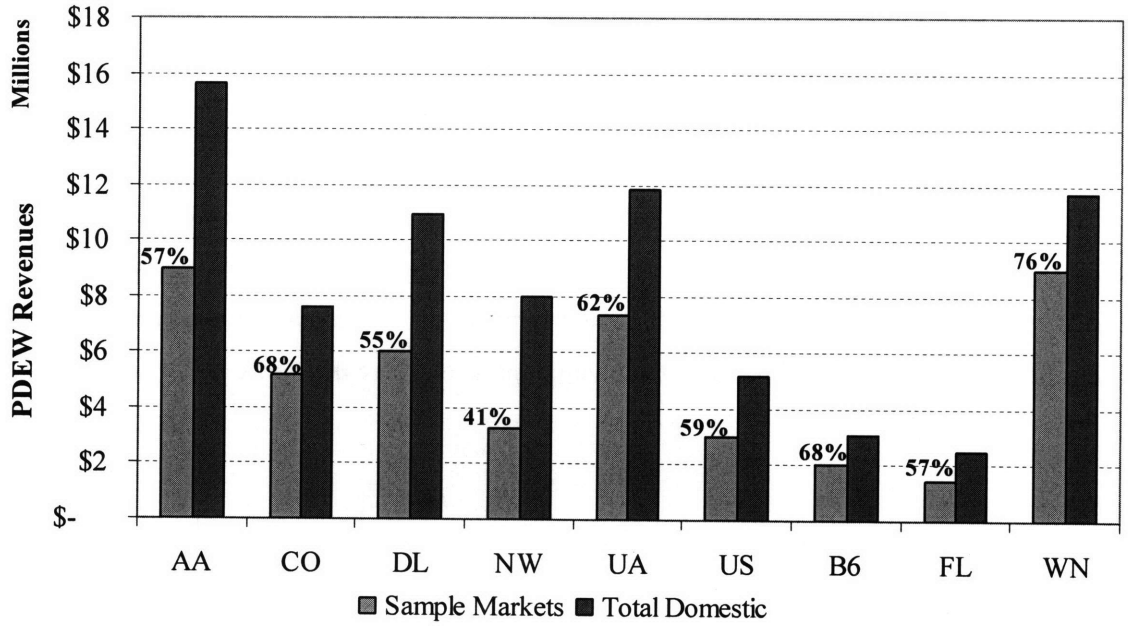

Figure 6: PDEW Revenues per Legacy carrier in the Sample Markets as a percentage of their total PDEW domestic Revenues in 2006.

3.4 The Yield Index

The main objective of this thesis is to identify which airlines have the yield premium, as defined in Section 2.1, in the Top US Domestic markets and in different segments of this market set. Hence, the aim is to compare the average yield for each of the major carriers in various segments of the Top 856 markets to the average yield across these markets. For this purpose the metric yield index is introduced:

$$Yield = \frac{Revenue}{Revenue\ Passenger\ Miles} \qquad \text{Equation 1}$$

$$\text{Yield Index } YI_{i,j} = \frac{Yield\ of\ Airline\ i\ in\ Market\ j}{Average\ Yield\ in\ Market\ j} \qquad \text{Equation 2}$$

In other words, the yield index states by what percentage is an airline's yield different from the average yield in a market. The average yield in a market is simply the total revenue generated by all airlines in the market over the total revenue passenger miles in the market:

$$Average\ Yield\ in\ Market\ j = \frac{Total\ Revenue}{(Total\ Traffic)\cdot(Average\ Haul)} \qquad \text{Equation 3}$$

In order to calculate the yield index of an airline across many markets a weighted average is used. An airline's yield index in each market of the set to be analyzed is weighted by the airline's traffic in this market. This way, the yield comparison within markets where an airline's traffic is high becomes "more important" than within markets where the traffic is low. Hence:

$$\text{Average Weighted } YI_{i,j}\ \overline{YI}_i = \frac{\sum_{j \in S} YI_{i,j} \cdot Traffic_{i,j}}{\sum_{j \in S} Traffic_{i,j}} \qquad \text{Equation 4}$$

where S is the set of markets across which the average yield index for airline i has to be determined, j is a specific market of the set and $Traffic_{i,j}$ is airline's i total traffic in market j.

In general, the average weighted yield index enables us to compare the yield of an airline within a set of O-D markets with the same characteristics, such as the markets that originate from an airline's hub or the markets with high presence of low cost carriers, to the average yield of all airlines in the same set of markets. This way direct comparison between the yields of different airlines can be made within a specific set of markets. Furthermore, the ability, or inability, of an airline to generate higher yields than its competitors within a set of markets is easily quantifiable.

3.5 Segmentation of the Data Set

In this research the Sample Markets have been segmented to different categories within which the $\overline{YI}$ for each of the nine major airlines is calculated for all years from 2000 to 2006. These categories are:

- The Sample Markets in overall
- Sample Markets segmented according to the number of airlines serving each market
- Short, medium and long haul O-D markets
- O-D markets with low and markets with high LCC presence
- Hub markets for each airline, meaning the O-D markets where one of the two cities of the market is a hub of the specific airline.

Chapter 4 will present the analysis for the first category, which will be referred as the aggregate analysis, while Chapter 5 will present analysis for the other three categories which will be referred as the disaggregate analysis.

Chapter 4
Analysis on Pricing and Competition in the Top US Markets

This Chapter includes statistics across all markets of the data sample. Firstly, changes in traffic, revenues and average fare will be observed on an aggregate level—market level—for the period 2000 to 2006. Furthermore, an analysis of the same metrics will be performed grouping the airlines into Legacy and Low Cost carriers, in order to identify performance and output differences between these two distinct business models and most importantly to observe how their fare differential has changed over the years.

In the second part of this chapter, the analysis will be further segregated, to the airline level. Each one of the nine major US carriers will be considered separately trying to identify significant changes of airline metrics and compare how each airline responded to the increasing competition and the industry crisis. Moreover, the competition that each legacy carriers faces on average in the Sample Markets will be quantified and a first attempt will be made to correlate it with the respective carrier's observed trends in traffic and average fare.

Finally, the yield index for most of the major airlines will be presented from 2000 to 2006 to spot which airlines have an overall yield premium in the top US domestic markers.

4.1 Aggregate Trends

As mentioned in earlier Chapters, the period 2000 to 2006 includes one of the worst crises of the US airline industry. The effect of the crisis on the revenues and traffic across all US airlines in the domestic markets is clearly depicted on Figure 7. Starting from 2000, which for most airlines is the last year of profits until 2006, both revenues and traffic take a huge fall for a two year period and by the end of 2002 the lowest values of the period 2000-2006 are marked. Traffic dropped by 11.0% from 2000 to 2002 but the rate of revenue loss was much greater; by 2002 airlines were generating 22.8% less revenue than in 2000. This large difference between the rate of decrease of traffic and the rate at which revenue dropped is appointed to the large decrease of the average fare across the Top 1000 markets. Observing Figure 8, the average fare was dropping by approximately 7% per year from 2000 to 2002. One very important reason for the reduction of the average fare was the rapid expansion of Low Cost carriers, the fares of which had to be matched by the Legacy carriers. An additional reason for the fare reduction is the lost traffic caused by the political and social events of the period 2001-2002 (as explained in Chapter 1) that forced the airlines to reduce their fares in order to attract back the lost traffic.

By 2003 the domestic airline industry started recovering both in terms of traffic and revenues; again though the traffic recovered much faster than the revenues. The passengers moved per day each way in the Sample Markets in 2005 exceeded the 2000 levels and in 2006 the traffic was up by 5.5%. However, revenues in the Sample Markets in 2006 still remained below the 2000 levels, but for the first time in six years legacy carriers reported profits. The restructuring of airlines the last few years has reduced their costs tremendously so that profits were once again achieved despite their reduced revenues.

Three consecutive years of reduction in average fare since 2000 resulted in the lowest average fare observed in the Sample Markets—$124.00 in 2004. Since then, though, average fare has been constantly increasing. In 2006 the average fare saw its greatest rise, by 8.1% from the 2005 but it still remained at much lower levels than in 2000—almost $12 lower (-7.9%).

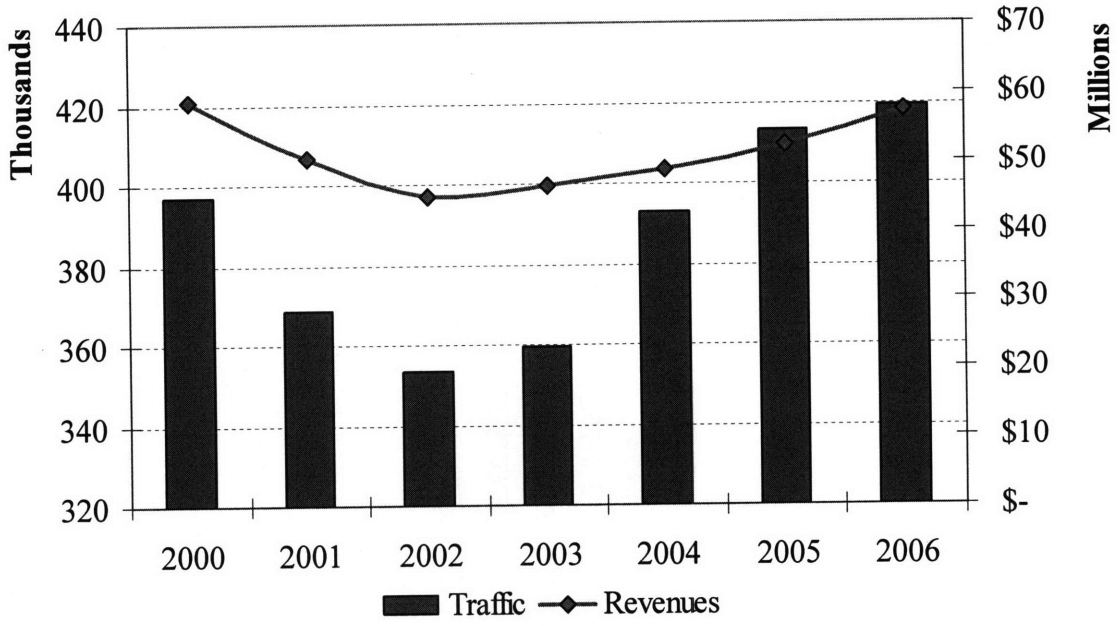

Figure 7: Total PDEW Traffic and Revenues in Sample Markets from 2000 to 2006

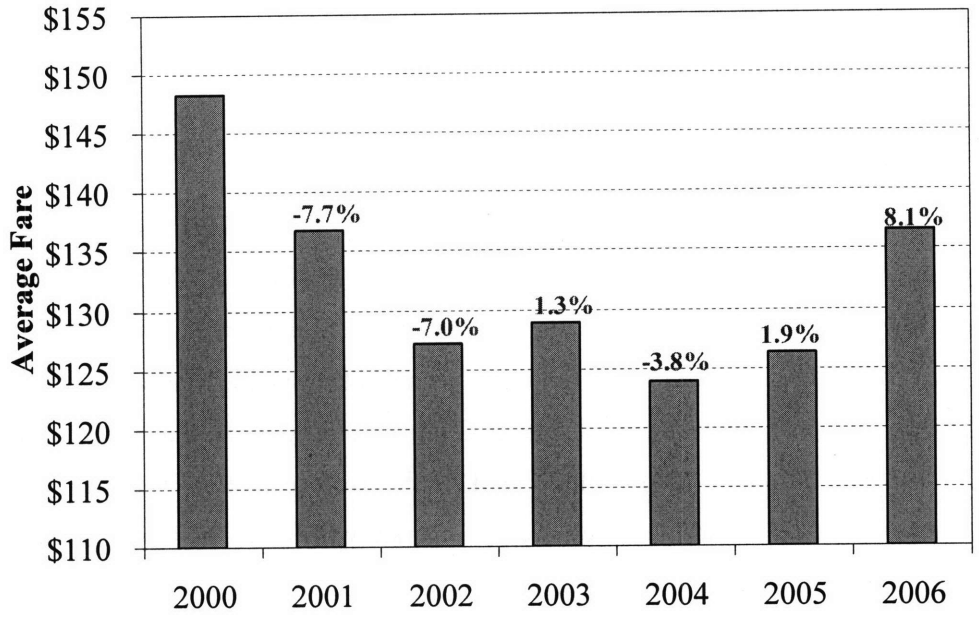

Figure 8: Average Market Fare in Sample Markets from 2000 to 2006 (percentages signify the relative drop from the previous year)

It is worth pointing out that only a little more than half of the Sample Markets saw a average fare reduction from 2000 to 2006— 460 markets in contrast to 397 markets that had an increase in average fare. Looking at the distribution of the percentage change of fare from 2000 to 2006, Figure 9, it is evident that most of the markets are within the range of -30% to +20%.

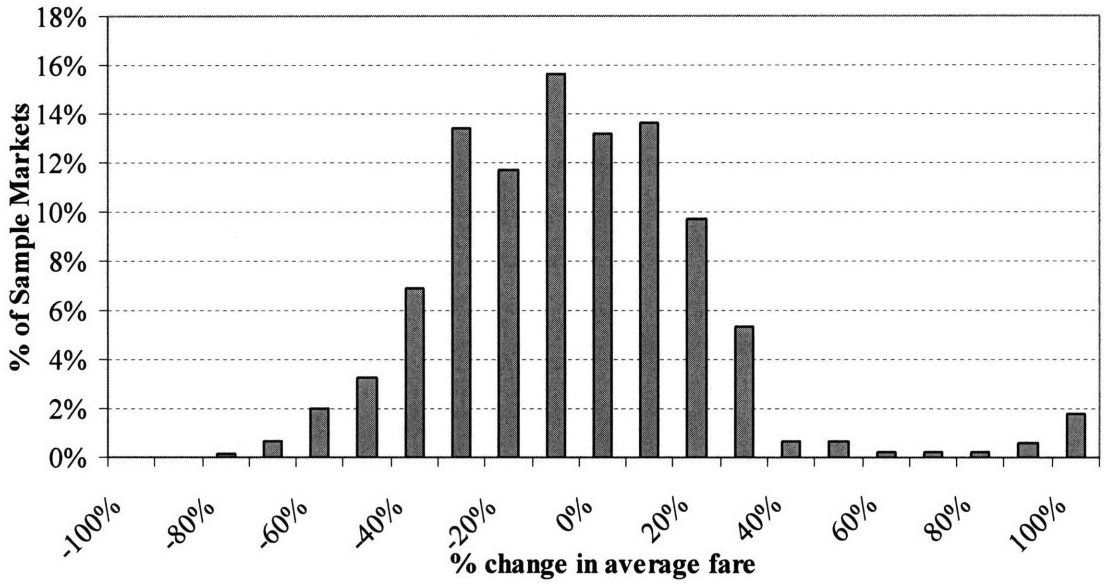

Figure 9: Distribution of Percentage Change in Average Fare between 2000 and 2006 in the Sample Markets

In 2000 there were 573 markets out of the Top 856 (66.9%) that had at least one LCC serving each market. By 2006 673 markets were served by an LCC (78.5%). Out of the 460 markets that had a lower fare in 2006 than in 2000, 106 markets were not served by an LCC in 2000 but had at least one LCC introduced in the following years. In the Sample Markets, 134 that were not served by an LCC in 2000 had at least one LCC introduced by 2006; that leads to the conclusion that in 79.1% (106 out of 134) of these markets the average fare has dropped. The relationship between average yield and LCC presence on a market will further be investigated in chapter 6 where a regression analysis is performed.

As the metrics presented here are further explored for each airline separately and at the same time for different market segmentations and, moreover, as the analysis on competition will be performed, greater background will be provided to better explain the trends that were just discussed.

4.2 A Comparison between Low Cost Carriers and Legacy Carriers

As a first step, in order to identify the differences in pricing, traffic and revenue alterations between legacy and low cost carriers and see how each type of carrier responded to the airline crisis, two groups were formed with six representative carriers from each business model on each group. In the Legacy Group were included the only six US legacy (or network carriers) while the LCC group consists of the six LCCs with the highest traffic in 2005 (this year was chosen because when the analysis was started the 2006 data were not yet available). The following table summarizes the carriers included in each group:

Legacy Carriers Group		*LCC Group*	
American Airlines	AA	Airtran/Frontier	FL
Continental Airlines	CO	America West Airlines	HP
Delta Air Lines	DL	Frontier Airlines	F9
Northwest Airlines	NW	Jet Blue	B6
United Airlines	UA	Southwest Airlines	WN
US Airways	US	Spirit Air Lines	NK

Table 1: Legacy Carriers an LCC Groups

Three figures are shown in the next page that compare side-by-side the two groups in terms of PDEW passengers, revenues and average fare in the Top 856 Markets.

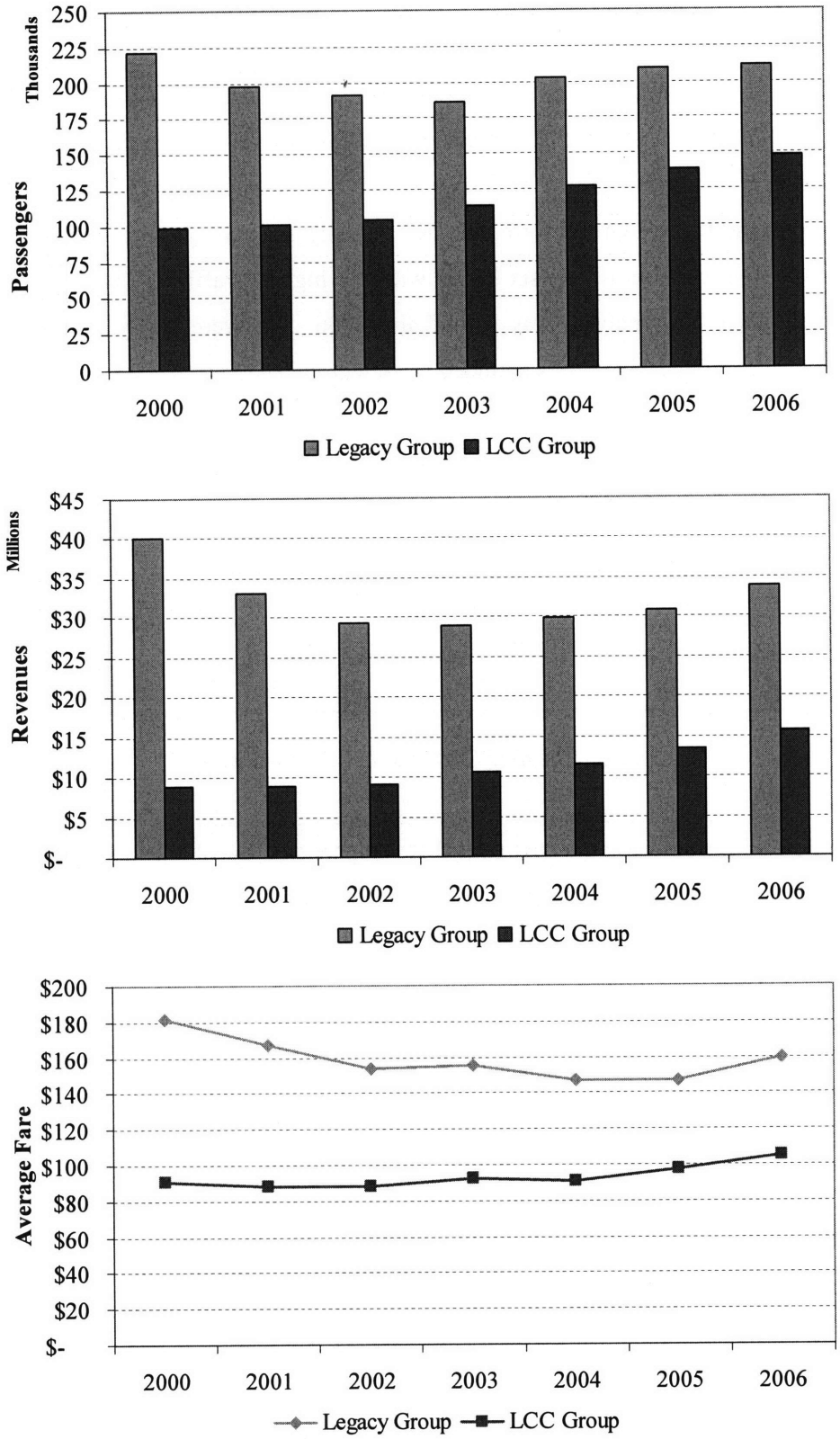

Figure 10: Time Series of Traffic, Revenues and Average Fare of the Legacy Carriers and the LCC Group.

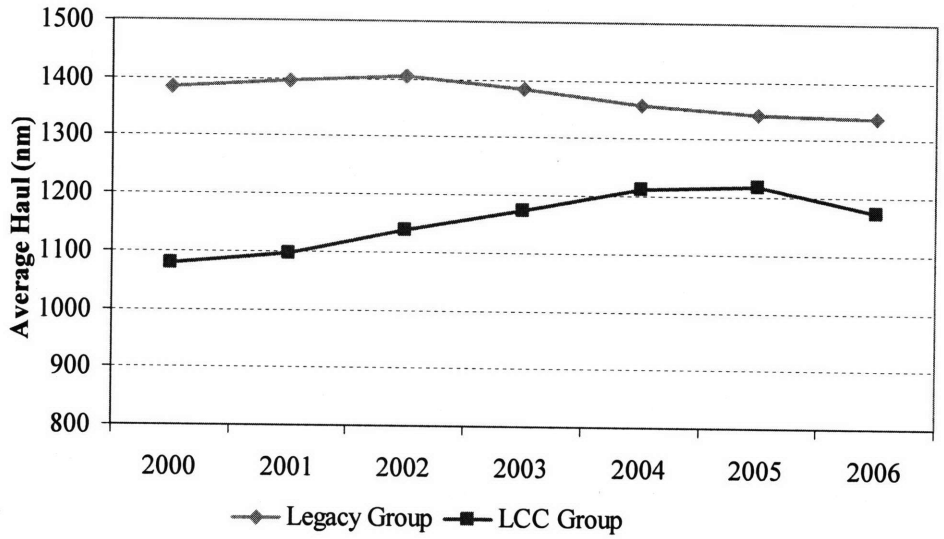

Figure 11: Time Series of Average Haul of the Legacy Carriers and the LCC Group.

The first thing to point out when looking at the figures of revenues and traffic is that Legacy airlines follow the same pattern with the aggregate Figure 7; that is, a continuous loss of both traffic and revenues up to 2003 and a significant recovery since then, however, at levels lower than in 2000. On the other hand, LCCs have marked a continuous growth, by expanding their networks, both in terms of revenues and traffic, and have significantly reduced the gap with the Legacy carriers. By 2006 LCC achieved a much larger market share in the Sample Markets than in 2000—much closer to the Legacy Carriers' market share in 2006. The market share of the Legacy carriers group has dropped from 56% in 2000 to 50% in 2006 and the respective for the LCC group has raised from 25% to 37%. The following table, Table 2, presents the absolute differences between the Legacy and the LCC group from 2000 to 2006 in PDEW traffic and revenues.

Legacy - LCC Gap	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Traffic	123,114	96,876	87,337	71,933	76,070	70,814	56,458
Revenue (in millions)	$31.2	$24.2	$20.3	$18.4	$18.3	$17.4	$18.2

Table 2: Relative Revenues and Traffic between the Legacy and LCC group

The effect of the expansion of LCC's networks is apparent in Figure 11, where the average haul increases almost steadily every year. A very interesting observation is that although in 2006

average haul for LCCs dropped their average fare went up, a fact that implies that increases in average fare are not entirely dependent upon the introduction of longer markets in their networks. On the other hand, a reduction in the average haul of Legacy carriers is observed in Figure 11. As it will be shown in the next section Legacy carriers have moved out of many of the Sample Markets. Hence, it can be concluded that Legacy Carriers have withdrew more from long haul markets than from short haul ones. This trend starts at the midst of airline industry's crisis in 2003 when Legacy Carriers started redefining and restructuring their businesses.

The most important observation in the above figures is the pattern of the average fare. Until 2005 the average fare of the Legacy carriers in the Sample Markets was decreasing; starting from above $180 in 2000 to reach $147 by 2005. LCCs on the contrary, continuously saw their average fares increase but it always remained below $100. This steady increase on average fare can mainly be explained by the fact that all LCCs have been expanding their networks during the period 2000 to 2006 so that their average stage length increased, which in turn clearly leads to higher average fares. In 2006 both groups had had higher average fares compared to the previous year. Legacy carriers, most probably, taking advantage of the recovered traffic in 2005, their restructured businesses as well as an improved economic health were able to apply higher fares in the Sample Markets they served. Hence, after marking the smallest average gap in 2005— $50—, in 2006 the gap was up again at $59.

In 2000 Legacy carriers were applying on average almost double the fares of their LCC competitors, but by 2006 the gap has closed by 35%. LCCs saw their fares increasing by 11% in this seven year period (for the first time above $100) while Legacy carriers, due to increased competition and the industry crisis, received 12% lower fares in 2006 than in 2000. The following table summarizes the relative fares between the Legacy Carrier and LCC group:

	2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Average Fare Gap	$90	$79	$66	$63	$56	$50	$59
Legacy/LCC Fare	2.0	1.9	1.7	1.7	1.6	1.5	1.6

Table 3: Relative Average Fares of the Legacy and the LCC Group

Overall, relating to the figures presented in the previous section, it is evident that the main drivers of trends in the industry are the Legacy carriers, and this is due to the huge size of their networks and hence their large participation in Sample Markets.

4.3 Analysis per Carrier

As mentioned earlier, the research will be expanded to analyzing revenues, traffic and average fare for each one of the major US carriers; the six legacy carriers and the three LCCs with the highest traffic in 2006—Southwest, JetBlue and AirTran. Furthermore, the change on the number of markets that these airlines serve from 2000 to 2006 will be investigated, as well as changes in their average haul. In the following pages Figure 12 and Figure 13 present the aforementioned metrics.

In Figure 12 it is worth pointing out that WN is, by far, the airline with the highest traffic in the Sample markets followed by AA in 2006. The latter is the Legacy carrier with the largest increase in traffic in this period and the sole Legacy with an increase in revenues. As mentioned in Chapter 1, AA acquired TWA in 2001, which was a very large carrier with a fleet of 190 aircrafts that served 101 Sample markets in 2001; in 2002 AA served 46 more markets than in 2001 and only then started moving out of markets. Hence the augmentation of AA can partially be explained by the acquisition of TWA. Together with UA they are the only Legacy airlines that served more Sample markets by 2006.

Another important remark is that the three LCCs investigated in depth have seen an increase in all five categories presented in Figure 12 and Figure 13 from 2000 to 2006. All three LCCs have shown a much larger increase in revenues than in traffic and that is due to their increase in average fare. B6 is the carrier with the highest relative increases in all five categories. B6 started operations in 1999 and in 2000 was still very small but has expanded with tremendous rates and by serving 9 Sample markets in 2000 it has expanded to 60 Sample markets in 2006, 24 of which were first introduced in its network in 2006, thus by this year serving almost as many passengers as NW—the smallest Legacy carrier in the Sample Markets.

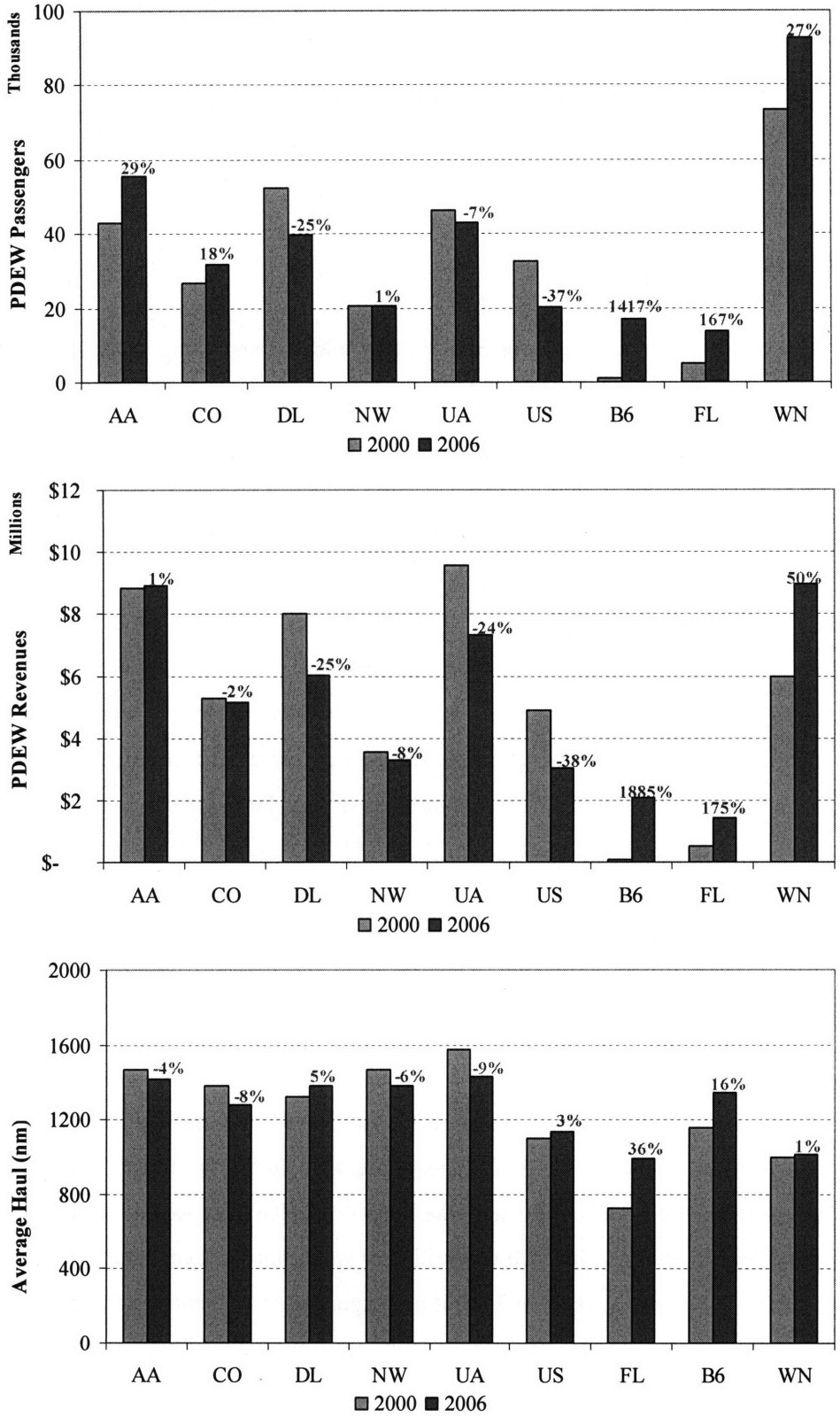

Figure 12: PDEW Traffic, Revenues and Average Haul for each of the Major carriers in the Sample Markets for years 2000 and 2006.

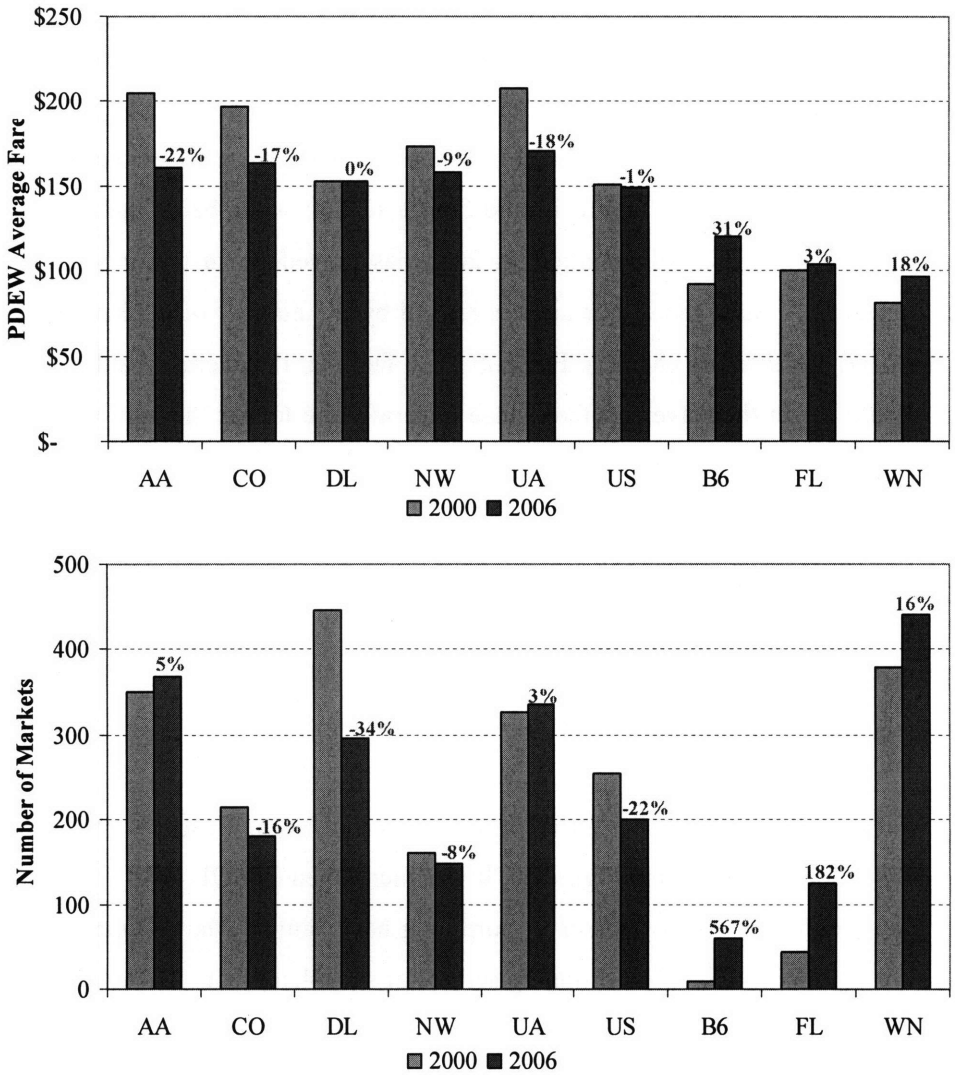

Figure 13: Average Fare and Market Participation for the Major carriers in the Sample Markets for 2000 and 2006

WN, although it has been operating in the US domestic markets since 1971, still achieved a huge expansion of its point-to-point network from 2000 to 2006 and has moved into the first place in terms of Sample markets served.

The hit in revenues experienced by the Legacy carriers that was observed in Figure 10, can be seen again when looking each Legacy carrier individually. DL, UA and US suffered immense revenue losses during the seven year period; the latter generating 38% less revenue by 2006. All three airlines have filed for bankruptcy at least once between 2001 and 2006 and the reason is clearly depicted in Figure 12. When looking at the graphs of traffic and average fare DL and US,

which faced the biggest sock in revenue generation, they are the only Legacy airlines whose reduced revenues are primarily the consequence of their traffic loss and not the reduction of their average fare. Their traffic loss is a result of terminating service in 150 Sample markets for DL and 50 for US most of which were short haul markets; hence the increase of their average haul from 2000 to 2006, as depicted in Figure 12 and Figure 13. DL while being the airline with the highest participation in the Sample Markets in 2000 has moved down to forth place in 2006 (Figures in Appendix A show the Major airlines ranked by the number of markets they serve in 2000 and 2006 and the absolute change). Evidently, the fact that the average haul of DL and US increases it should affect their average fare, since generally the longer the haul the greatest the applied fare.

AA, CO, NW and UA, on the other hand, have had a significant reduction on their average fares in order to match their LCC competitors. Again here the reduction of average fare can be partially correlated to the decrease of their average haul, although the relative decrease in average fare is much larger than the relative increase of the average haul.

It is worth mentioning the two different strategies that Legacy carriers chose during the crisis, that are clear on Figure 12 and Figure 13. It was mentioned that DL and US have increased their average haul either by starting to serve more long haul Sample Markets either by offering direct service or via their hubs, or by dropping service at short-haul markets. Another reason for an increased average haul is that an airline might move from direct service to connecting service through its hub for a specific market hence increase the haul of that airline in this market. This will also lead to a reduced average fare since connecting service can be cheaper than direct service in a market due to the inconvenience the connection causes to a passenger. On the other hand AA, CO, NW and UA have decreased their average haul probably by trying to concentrate on the markets that can be served via their hubs and thus dropping long haul direct services. However, it is important to emphasize that it is not clear if these observed trends are merely a coincidence—since only a portion of the total US domestic markets is examined—, an actual strategy of the airlines, or different competitive circumstances that have forced Legacy carriers to act variably.

4.4 A Quantitative Analysis of Competition

Since the early 1990s many new airlines have emerged into the US domestic markets, when the US airline industry was flourishing. By 2000, however, the situation changed. Traffic and revenues in the industry started to decline and many airlines struggled to generate even marginal profits. As it was described in Chapter 1 many airlines were forced to bankruptcy while many others disappeared. Some airlines, especially LCCs like WN, B6 and Fl, have taken the opportunity to expand their networks and increase their market share over Legacy carriers (as described in Chapters 4.2 and 4.3). This unstable environment has led to significant changes in the competition and more specifically in the number of airlines competing in each market. It should be reiterated here that in the Sample Markets are only included airlines that get at least 5% market share in each market they participate in. In this section, hence, the number of effective competitors on each Sample market is calculated and then the average number of effective competitors per market as well as the average number of effective competitors that each Legacy carrier faces in the Sample markets they serve is derived; the word effective refers to the fact that airlines with less than 5% market share are excluded from the data set but it will often be dropped hereafter.

4.4.1 Aggregate Competition

Year	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Mean Competition	3.22	3.26	3.20	3.17	3.13	3.06	2.95

Table 4: Average Number of Effective Competitors in Sample Markets from 2000 to 2006

Since 2000 the average number of effective competitors has been decreasing in the Sample Markets with the exception of 2001, as it can be seen in

Table *4*. Airlines were forced by the reduced traffic levels, as presented in Figure 7 earlier, to move out of many markets in Top 1000. In 2006, the average number of competitors per market has fallen for the first time under 3 competitors per market and has dropped since 2000 by 8.2%.

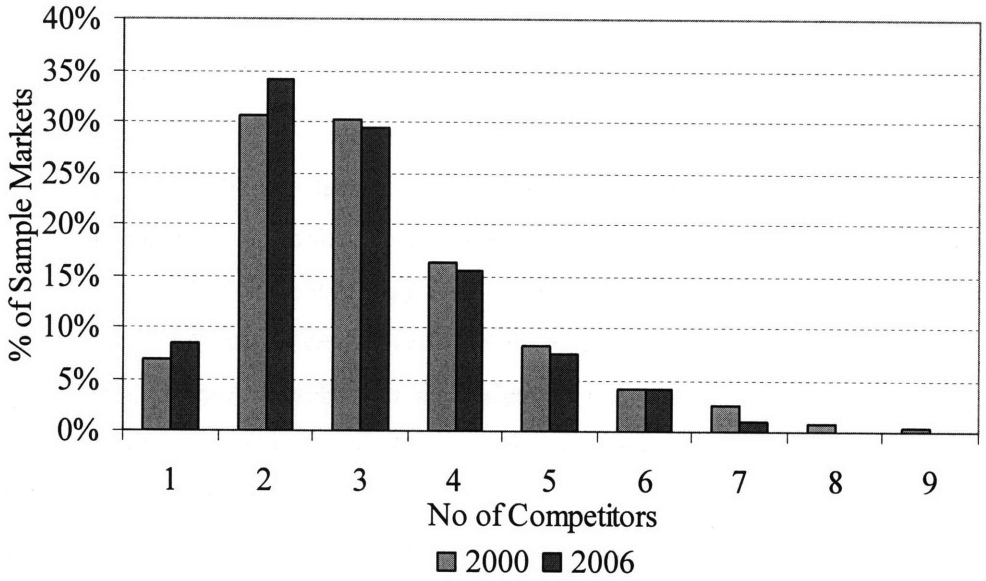

Figure 14: Distribution of the Number of Competitors in the Sample Markets for 2000 and 2006.

A very interesting fact can be observed in Figure 14 that relates to what was just presented. In 2006 there are more monopoly and duopoly markets in the Top 1000 than in 2000 and many less with 3 or more effective competitors. Approximately 35% of the Sample Markets had only two competitors in 2006 and there are no markets any more with as many as eight and nine competitors. In the 1990s many new-coming airlines tried to break the monopoly of the Legacy carriers in some US domestic markets. However, the response of Legacies to new entrant carriers in order to maintain their market share by matching the new entrant's fares, has forced many of their competitors to withdraw from their markets after a few years (even months occasionally) of unprofitable operations. This may provide an explanation on why monopoly markets are up again by 2006. Many of the monopoly sample markets are Legacies' hub markets, a fact that shows how important are hubs for the Legacy carriers and how more effectively they can maintain their power there.

4.4.2 Competition per Carrier

Moving from the aggregate competition in the Sample Markets, an analysis was further performed on the competition level that each Legacy Carrier has been facing and how it changed throughout the period 2000 to 2006. Looking at Table 5, DL and US are the only airlines for

which the average number of carriers they compete with has increased through the years. Although both airlines in 2000 were facing the lowest number of competitors, by 2006 DL and US were the second and third highest in terms of number of carriers they compete against. This result is even more interesting when combined with the fact that these two airlines moved out of the most sample markets during this period; hence most probably had to exit markets with up to three competitors and not markets with high airline concentration.

On the other hand all other four airlines saw the average number of competitors drop, with CO taking the lead with a -18.2% change in 7 years. All four were facing more than three competitors on average per year in 2000 but steadily moved below three and by 2006 close to 2.6. In 2002 a significant reduction in the number of competitors can be observed for all six Legacy airlines and this can be attributed to the acquisition of TWA by AA; hence each having to face one less Legacy airline. Of course, the competition was still there but not in the face of two airlines but in the face of one, AA; hence the only airline to actually benefit of the reduced number of competitors was AA.

The standard deviation around the mean number of competitors has been decreasing through the years for all six Legacy Carriers. This means that the distribution of the number of competitors is more concentrated around its average value and hence that Legacy carriers serve many less markets with many competitors, so that in most of their markets have either two or three competitors.

	AA		*CO*		*DL*		*NW*		*UA*		*US*	
Year	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
2000	3.07	1.57	3.17	1.70	2.77	1.58	3.27	1.95	3.12	1.56	2.57	1.69
2001	3.05	1.46	3.17	1.58	2.85	1.53	3.31	1.85	3.09	1.47	2.66	1.61
2002	2.87	1.35	2.95	1.51	2.73	1.43	3.27	1.71	3.04	1.36	2.62	1.45
2003	2.78	1.34	2.86	1.51	2.70	1.39	3.13	1.55	2.90	1.33	2.60	1.40
2004	2.76	1.39	2.80	1.49	2.65	1.45	3.03	1.59	2.86	1.33	2.66	1.33
2005	2.58	1.41	2.75	1.54	2.67	1.49	2.71	1.66	2.76	1.33	2.45	1.33
2006	2.57	1.38	2.59	1.43	2.79	1.42	2.87	1.46	2.68	1.30	2.71	1.33
2000 -2006 % change	-16.4%		-18.2%		0.5%		-12.1%		-14.1%		5.3%	

Table 5: Mean Number of Effective Competitors in the Sample Markets and the Respective Standard Deviation for each Legacy Carrier from 2000 to 2006.

Figure 15 presents the average number of competitors per Legacy carrier in the Sample Markets for the years 2000 and 2006 but, also, broken down by the type of the competing airline as categorized in Figure 4. It is clear that the decreased exposure to competition is attributable to the decreased participation by other Legacy carriers, which comes as a result of the Legacy carriers moving out of a significant number of Sample markets. In contrast the number of LCC competitors has increased by 2006 and is very close to one airline per market on average (above one for DL and NW). NW faces the highest number of Legacy competitors both in 2000 and in 2006 while the largest drop at number of Legacy competitors is observed for CO. Finally, from Figure 15 becomes evident how small is the presence of "Other" Carriers in the Top US Domestic Markets.

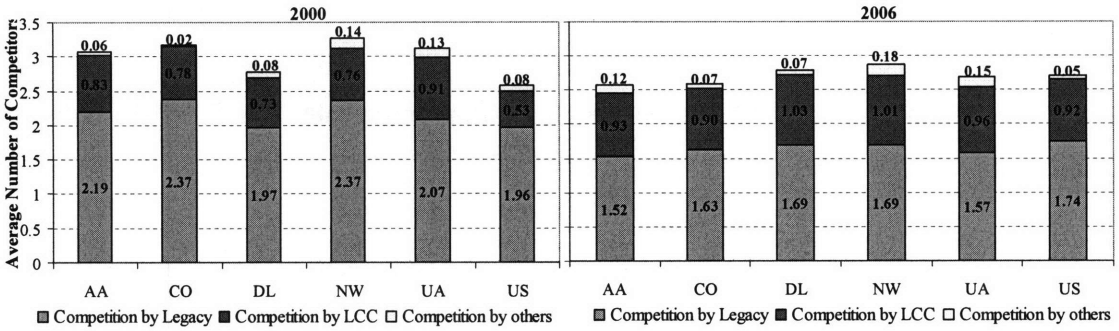

Figure 15: Mean Number of Effective Competitors for each Legacy Carrier Broken Down by Type of Competing Airline for 2000 and 2006.

A very important conclusion suggested by the findings presented so far is that the crisis of the Legacy carriers came not only as a result of the competition against LCCs but most importantly as a result of the fierce competition between Legacy airlines themselves. Legacy airlines were able to recover with the LCC competition increased but with a significant reduction on the exposure to other competing Legacy carriers.

4.5 The Aggregate Yield Index

For the purpose of identifying the fares that airlines receive in the markets they serve relatively to the fares of competing airlines in the same markets while taking into account the traffic of each airline in each market, as explained in Section 3.4 the metric Average Weighted Yield Index, $\overline{YI}$, was developed. Using $\overline{YI}$ it will be possible to identify which airlines have the

Yield Premium (or Fare Premium) in the Sample Markets. In this preliminary analysis all monopoly markets were excluded. The reasoning behind this approach is that the Yield Index of an airline in a monopoly market is by definition equal to 1 since the average yield in that market will always be equal to the monopolizing airline's yield. Figure 16 and Figure 17 illustrate the average weighted yield index for six Legacy Carriers, seven LCCs and two Other Carriers.

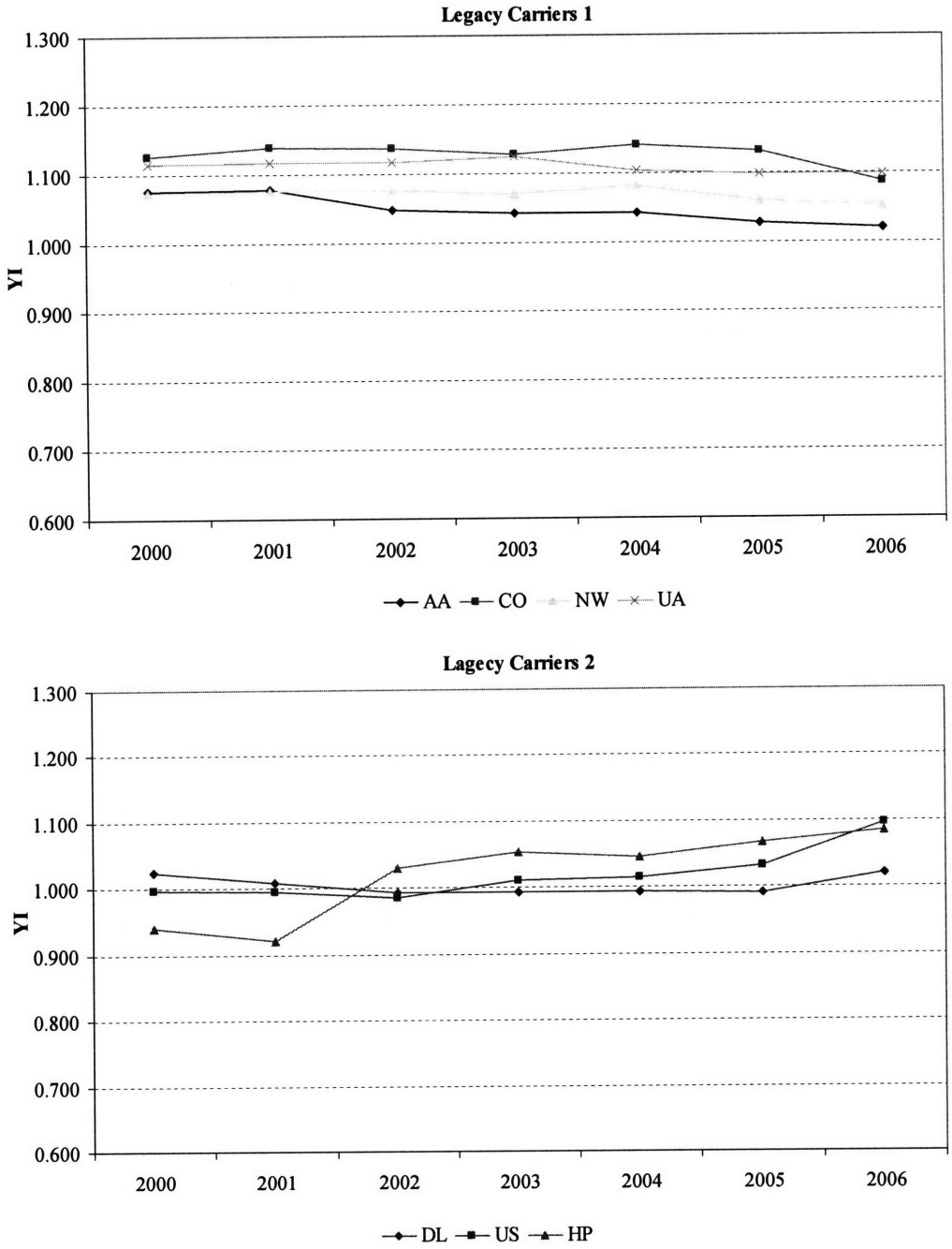

Figure 16: Time Series of the Average Weighted Yield Index for Legacy Carriers (including HP) in the Sample Markets

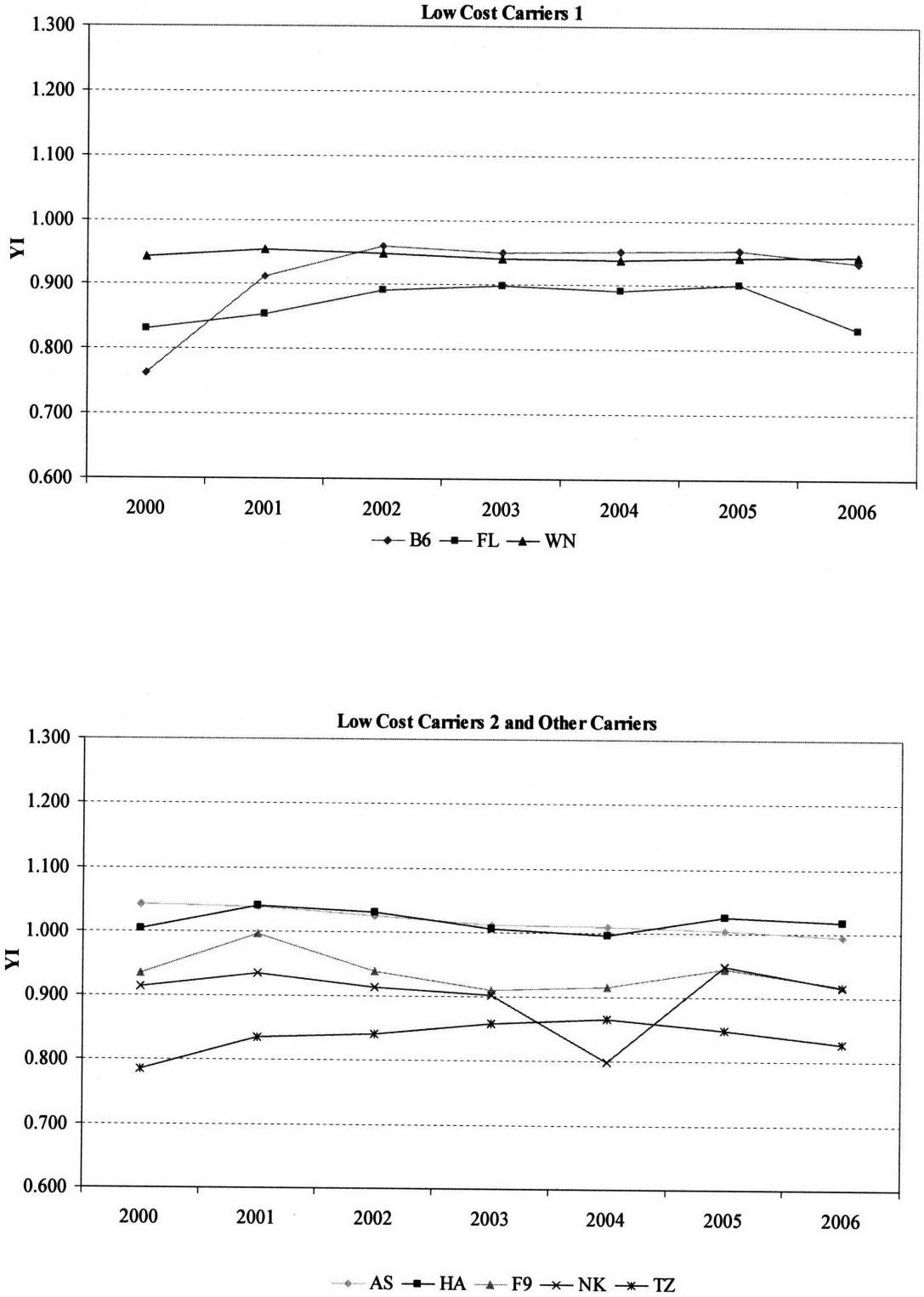

Figure 17: Time Series of the Average Weighted Yield Index for LCCs and Other Carriers in the Sample Markets.

CO, which has been the most stable and economically healthy Legacy carrier during the period of the crisis and one of the two Legacies that did not file for bankruptcy, is shown in Figure 16 to maintain the highest yield premium in the Sample markets it serves, by obtaining on average almost 15% higher fares than its competitors and only in 2006 dropping below 1.1; that was achieved even though the average fare of CO has went down by 18% and without hurting its traffic since CO had the largest increase in traffic from all Legacy carriers (Figure 12 and Figure 13).

It can be observed that, the—as perceived in the airline industry—group of healthier Legacy carriers, AA, CO, NW and UA have a yield premium in the Sample Markets, since all four maintain a $\overline{YI}$ above 1 for the period 2000 to 2006. However, AA has been, steadily, losing its yield premium and by 2006 was collecting fares only slightly above the market's average.

HP was graphed together with US due to their merger in 2005 and also because it is unclear whether HP is a true LCC. Looking at graph *"Legacy Carriers 2"*, with the exception of years 2000 and 2001, HP on average collects higher fares than its competition in the Sample Markets and its $\overline{YI}$ has been steadily increasing. US and DL are the only Legacy carriers that in many of the years of the period examined were not able to obtain a yield premium. US from 2000 to 2002 was receiving fares close and below the average market fares but has been improving since 2002 and maintained a $\overline{YI}$ above 1 from 2003 to 2006; this improvement may be related to the fact that US chose to move out of Sample Markets where it could not apply higher fares without losing its market share (Figure 13). DL is the worst performer among the Legacy carriers in terms of $\overline{YI}$; from 2002 until 2005 DL had fares below the market average and was able to improve and once again regain a yield premium only after it went bankrupt in 2005.

LCCs in Figure 17 prove once again why they are also called Low Fare Carriers. It is impressive how WN's $\overline{YI}$ remains almost stable throughout the years and it signifies that WN applies constantly around 5% lower fares than the average in the market ($\overline{YI}_{WN} \approx 0.95$); here it is proved once more why WN is the most stable and most profitable airline of the US airline industry. B6 follows the exact same pattern as WN since 2002. Years 2000 and 2001 are not characteristic of B6's fare strategy since it only operated in very few markets at that time (Figure 13). FL's $\overline{YI}$ has been moving closer to average from 2000 to 2002, then stabilized at around 0.9

for four years but in 2006 dropped below 0.85, which means that in 2006 FL's fares on average where more than 15% lower than the average market fares and the Sample markets it competes. TZ is the airline with the lowest $\overline{YI}$ in the Sample Markets, while both NK and F9 follow the same trend as all other LCCs and have a $\overline{YI}$ below 1 for all years since 2000.

Finally, AS and HA—the two companies that were categorized in Figure 4 as "Other Carriers"— prove here why they can not be called as pure LCCs. Both carriers obtained fares higher than the market average for all years except in 2004 for HA and 2006 for AS; the latter steadily dropping since 2000 from almost 1.05 at approximately 0.99 in 2006.

In this chapter, the general trends of airlines' $\overline{YI}$ in the Top US Domestic Markets were presented. In the next Chapter , the $\overline{YI}$ of the major carriers will be computed for different segments of the Sample Markets in order to identify how the yield premium of airlines is affected by different market characteristics.

4.6 Summary

The US airline industry has entered and, probably, exited its down-cycle during the period examined in this Thesis. It was shown how the total PDEW traffic and revenue generated in the Sample Markets went down in the first years of this decade but started recovering since 2003. The average fare that a traveler paid in the Sample Markets has dropped by 8% during the seven year period, 2000-2006.

The main findings of the analysis that has been presented so far are:

- The average fare gap between Legacy carriers and LCCs has closed tremendously as Legacies tried to match the fares of the competition. Traffic and revenue losses of Legacy carriers combined with the rapid expansion of LCCs have, also, mitigated the market share difference and revenue difference between Legacy and LCC carriers.

- DL and US experienced the biggest decline in revenues and traffic in the Sample Markets by moving out of a combined 205 markets. Their average fare did not decreased as much as it did for AA, CO, NW and UA whose fares reductions ranged from -9 to -22%. AA was the only Legacy airline to generate higher revenues in the Sample Markets in 2006 than in 2000.

- LCCs—B6, FL and WN—have grew tremendously during this period but they saw theirs fares going up (ranging from 3% to 31%), combined with an increase in their average haul.

- The average number of effective competitors per market has dropped by 8.2% in the Sample Markets, so that in 2006 there are on average less than three competitors per market. The number of effective competitors per market that Legacy carriers face decreased, with the exception of DL and US, but the exposure to LCCs has gone up.

- Overall, Legacy airlines were able to recover with the LCC competition being increased but with a significant reduction in the exposure to other competing Legacy carriers.

- CO has the highest $\overline{YI}$ in the Sample Markets and together with AA, NW and UA are the only airlines that consistently have shown a yield premium on the markets they serve. DL and

US collected fares below the average market fare for most of the years between 2000 and 2006, while HP— although often considered a Low Fare Carrier—applies higher fares than its competitors since 2002. Finally, all LCCs apply at least 5% lower fares on average than the competition while WN has the most stable $\overline{YI}$ than any other carrier in the Sample Markets.

Chapter 5
Extended Analysis on Yield Premiums

This Chapter looks at the trends of the Yield Index of the major US carriers in different segments of the data set. First, the Sample Markets are segmented according to the number of competitors that serve each market. Then, the markets are differentiated based on the aggregate Market Share of the Low Cost Carriers on each market. [The third segmentation is related to the average haul of each market, so that the data set is segmented into long-, medium- and short-haul markets, but the results of this analysis are included in Appendix II.]

The most important analysis of this Chapter looks at the $\overline{YI}$ of the Legacy Carriers in their Hub Markets, as defined in Chapter 3, by analyzing 15 different domestic hubs. Here, the analysis is expanded to include revenues, traffic, average fare and market share per carrier per set of hub markets in order to see how they differ from the aggregate results, and thus to better understand the importance of hubs to the Legacy Carriers' networks. Also, the number of effective competitors will be presented in order to compare it to the results of Chapter 4 and identify differences in competition between hub and non-hub markets.

Refer to Chapter 2 for the definition of hub markets and yield and hub premium that will be used extensively in this section.

5.1 Segmentation by the Number of Competitors per Market

As discussed earlier in Section 4.5, the average weighted yield index of an airline in a monopoly market is always 1.0. It is evident that $\overline{YI}$ of an airline at a market depends on the airline's market share, since the closer to 100% the airline's market share is, the closer its $\overline{YI}$ will be to 1.0. On this ground it was decided to segment the Sample Markets according to the number of airlines serving each market[31]. On average, the more competitors in a market the smaller will be the traffic share of each competitor. Hence the data set was divided into markets with two, three and four or more competitors. This division was chosen so that its set has approximately the same number of markets; Figure 14 shows the distribution of the number of airlines serving a market in the data set.

Table 6 illustrates the market and revenue share of each major US carrier in each of the three segmentations of the data set[32], while Figure 18, Figure 19 and Figure 20 present the Average Weighted Yield Index of these airlines in each segment.

In markets with two competing airlines it can be observed in Figure 18 that AA, CO, NW and UA are very closely packed at just below 1.10. For CO and UA the higher number of competitors in the markets they serve, the higher is the yield premium that these two airlines have; in contrast to AA for which exactly the opposite holds. CO again, stands out as the leading carrier in terms of yield premium in the Sample Markets.

As far as DL and US are concerned, their highest $\overline{YI}$ is observed in the markets that they compete against just one airline for almost all years. DL's high $\overline{YI}$ in 2006 can related to the fact that its revenue share in this group of markets is much greater than its market share. In markets with three competitors both airlines have a marginal yield premium. The most important point of comes from graph c, where it may be observed that DL receives much lower fares than its competitors in markets where it's competing against at least three airlines and, with the exception of 2006, has been constantly losing ground. On the other hand, US has had a $\overline{YI}$ below 1 until

[31] Note that airlines with less than 5% market share in a specific market are excluded from the database.
[32] In bold characters are some statistics that stand out both positively and negatively.

2002 but has been growing since then, so that in 2006 its yield index is comparable to CO's and UA's.

Finally, it is again remarkable how stable WN's $\overline{YI}$ is over the years and ranges from 0.9 to 0.98 depending on the number of competing carriers, Figure 20. Surprisingly when B6 is competing with just one airline it collects on average higher fares than that airline. The sharp rise of B6's $\overline{YI}$ in Graphs b and c from 2000 to 2006 can be attributed to the fact that in 2000 B6 had just emerged in the industry and it took around two years to stabilize in the markets. Irrespective to the number of competitors, FL has had the same pricing strategy, which led to the collection of at least 10% lower fares than the average.

a) Market Share

	2 Competitors			*3 Competitors*			*4 or more Competitors*		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*	*2000*	*2006*	*% Change*
AA	36.2%	48.3%	**33.4%**	30.0%	32.1%	7.0%	19.5%	19.0%	-2.4%
CO	36.9%	47.7%	29.4%	28.1%	35.7%	27.3%	21.1%	21.3%	0.9%
DL	51.4%	**58.0%**	12.8%	28.5%	35.7%	25.5%	19.7%	19.7%	0.0%
NW	60.7%	54.0%	-11.0%	45.9%	**46.7%**	1.7%	23.7%	**29.1%**	23.0%
UA	44.4%	37.1%	-16.3%	31.3%	27.3%	**-12.5%**	23.2%	21.4%	-7.6%
US	45.9%	**31.1%**	**-32.3%**	36.8%	28.8%	-21.7%	18.3%	23.6%	28.8%
B6	-	**61.9%**	-	27.0%	35.1%	**30.1%**	14.4%	**28.6%**	**99.3%**
FL	33.9%	31.0%	-8.5%	15.1%	19.4%	28.8%	12.3%	**14.0%**	13.3%
WN	61.4%	**60.6%**	-1.4%	39.1%	**36.1%**	-7.6%	22.5%	26.3%	16.8%
HP	22.7%	**22.0%**	-3.3%	17.7%	19.4%	9.9%	17.7%	17.2%	-3.0%

b) Revenue Share

	2 Competitors			*3 Competitors*			*4 or more Competitors*		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*	*2000*	*2006*	*% Change*
AA	39.6%	51.0%	**28.8%**	34.7%	34.1%	-1.6%	23.3%	20.1%	-13.7%
CO	41.2%	49.5%	20.1%	32.7%	38.9%	19.2%	22.9%	23.4%	2.1%
DL	54.0%	**64.9%**	20.2%	27.6%	**39.2%**	**42.0%**	17.3%	17.8%	2.8%
NW	63.9%	56.6%	-11.5%	49.3%	**50.9%**	3.3%	21.9%	**27.3%**	24.5%
UA	50.6%	42.9%	-15.2%	35.3%	29.8%	-15.4%	28.3%	24.2%	-14.6%
US	47.6%	34.6%	**-27.4%**	35.9%	28.6%	**-20.3%**	17.8%	**25.6%**	**44.2%**
B6	-	**65.0%**	-	12.6%	29.9%	**138.3%**	11.4%	24.4%	**114.1%**
FL	30.0%	**24.7%**	-17.7%	11.8%	**14.5%**	22.4%	8.7%	**11.3%**	29.7%
WN	55.1%	54.2%	-1.6%	30.9%	29.7%	-3.8%	17.1%	22.5%	31.2%
HP	18.6%	23.4%	**25.8%**	14.5%	19.4%	34.2%	15.1%	19.0%	25.3%

Table 6: Market and Revenue Share of the Major US Carriers in the Sample Markets Segmented by the Number of Competing Airlines per Market.

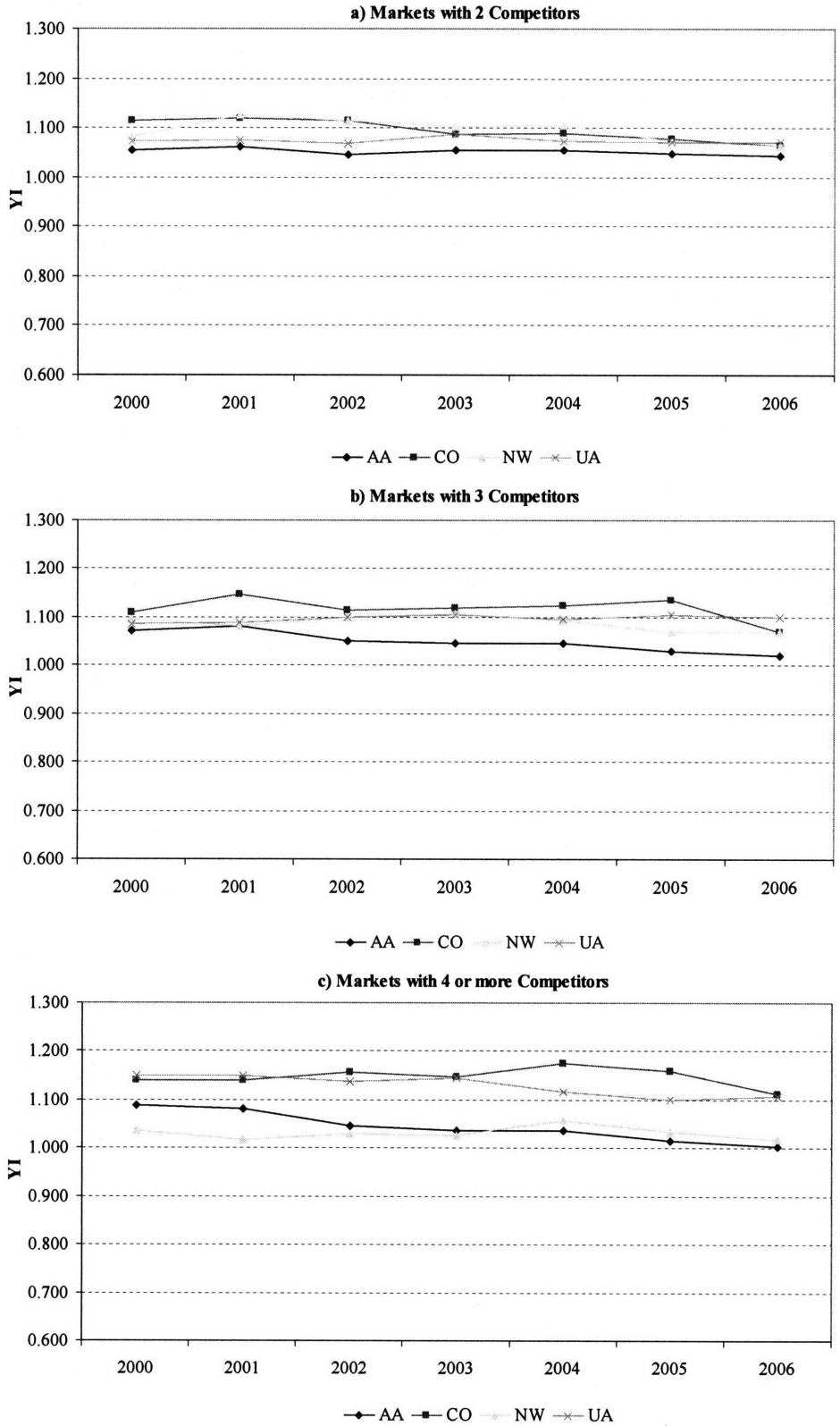

Figure 18: Time Series of the Average Weighted Yield Index for AA, CO, NW and UA in Sample Markets with a) Two, b) Three and c) Four or more Competitors.

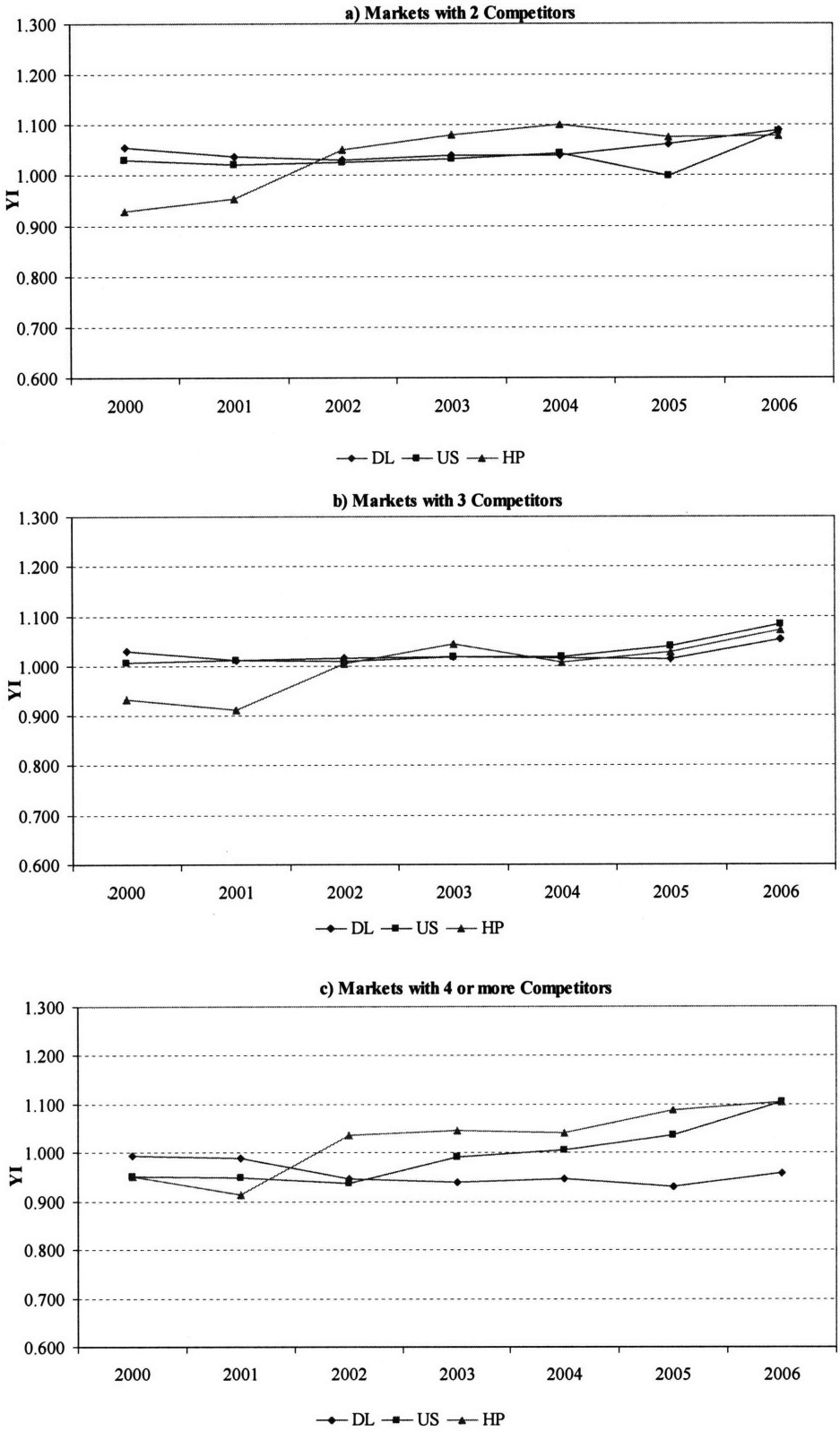

Figure 19: Time Series of the Average Weighted Yield Index for DL, US and HP in Sample Markets with a) Two, b) Three and c) Four or more Competitors.

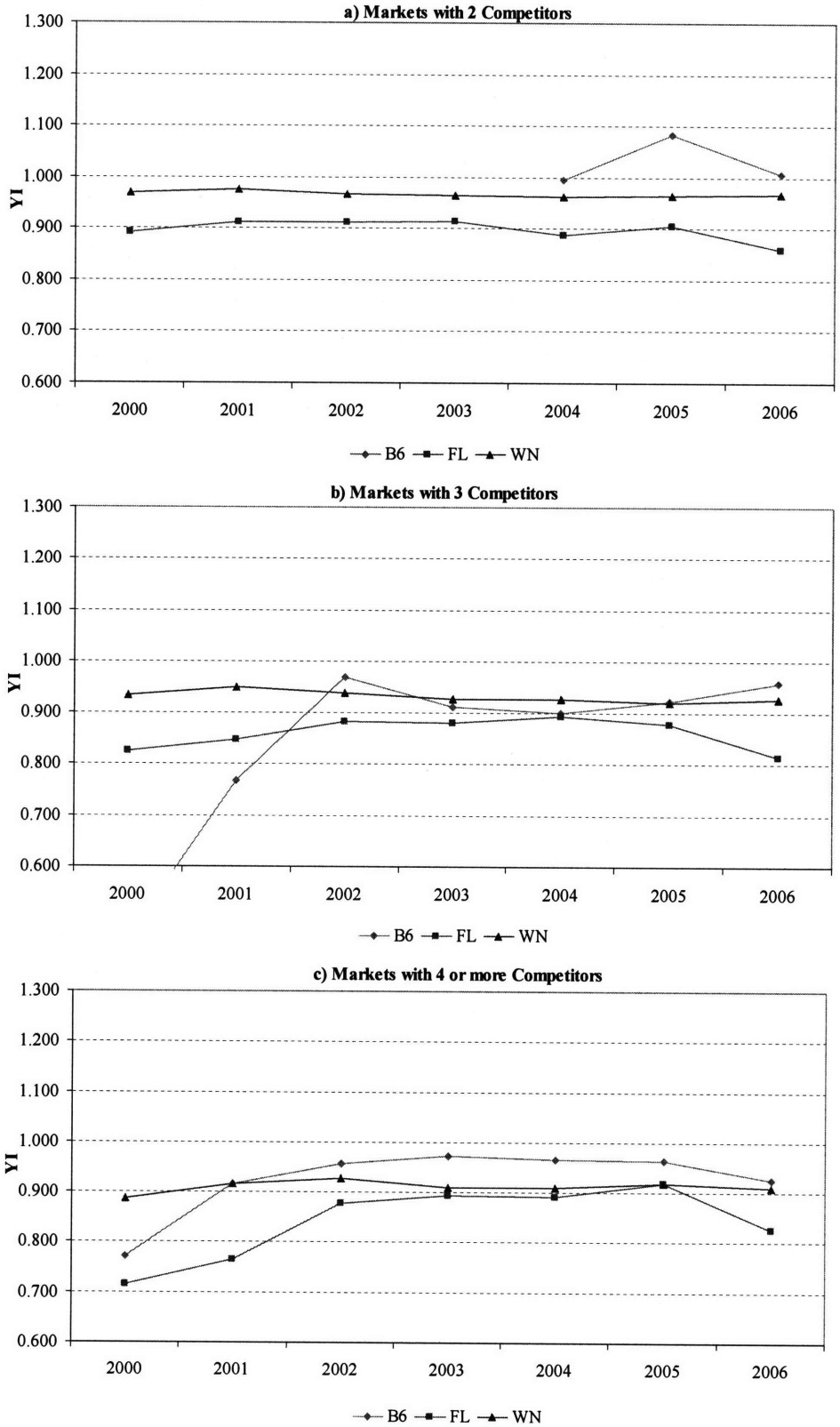

Figure 20: Time Series of the Average Weighted Yield Index for B6, FL and WN in Sample Markets with a) Two, b) Three and c) Four or more Competitors.

5.2 Segmentation by LCC Presence

Another analysis of the data set is produced when segmenting the markets based on the LCCs market share per market. In markets where LCC presence is very low Legacy carriers basically compete against each other and it is very interesting to observe the differences in yield indices between the airlines. Moreover, it is worth observing how markets penetrated by LCCs differ in terms of fares from those where LCCs are not present.

A threshold markets share of 10% was chosen that separates the markets with significant LCC presence and these without. The reason is that there are only very few markets in the data set with no Low Cost Carriers serving them; hence a segmentation based on just the presence of an LCC and not of the market share would have led to a comparison between two completely different sized sets. In 2000 there were 523 markets with at least 10% of their traffic being moved by LCCs while only 333 markets served almost entirely by Legacy carriers—the numbers have changed in 2006 to 620 and 236 markets respectively.

Figure 21 illustrates the average fare and average haul in the two segments of the Sample Markets. As expected the average fare is much higher in markets with minor LCC presence and this is not only due to the absence of LCCs, that as has been already shown in earlier sections receive lower fares than their Legacy competitors, but also because the markets with minor LCC presence have a higher average haul. The reason for the latter observation is that LCC mainly operate short-haul, point-to-point networks and thus are serving fewer long haul markets than Legacy carriers that connect their passengers via their hubs. Average haul has been increasing since some LCCs have started to offer connecting service—e.g. AirTran through Atlanta and Southwest through Chicago Midlands—or added long haul direct service—e.g. JetBlue has significantly grown its network since 2000.

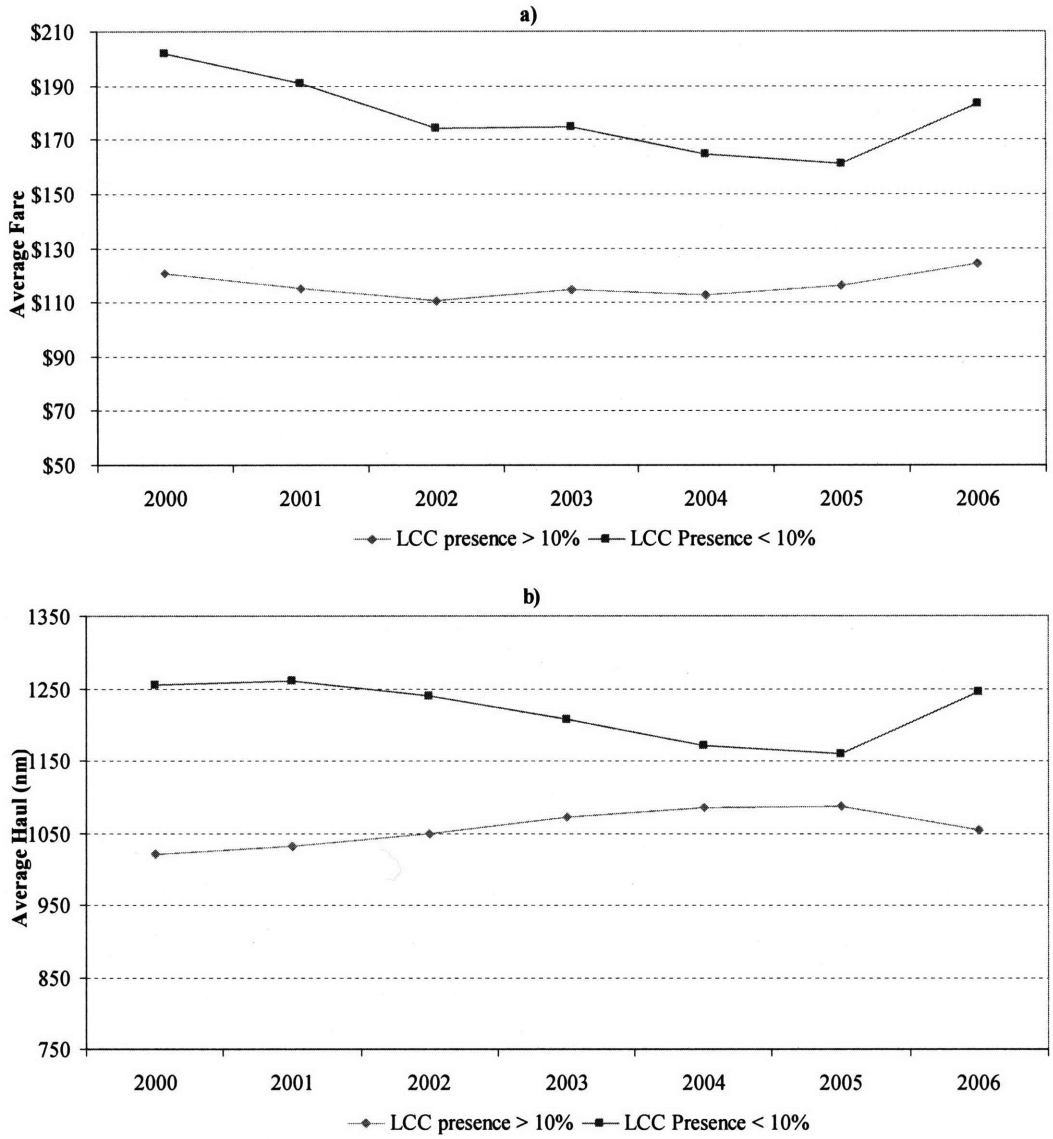

Figure 21: Comparison of a) the Average Fare and b) the Average Haul of Sample Markets with Low and High LCC Market Share.

Table 7 presents the changes in market and revenue share of the Legacy carriers in the two segments of the Sample Markets. The only airlines that achieved to increase their market share at markets with significant LCC presence are AA and CO but only CO has also increased its revenue share. On the other hand at markets where Legacy carriers compete primarily with each other only DL and US have lost in market share—by losing almost half of their market share in 7 years. AA stands out as the airline that gained the highest share during this period, by almost doubling its market share at the markets with minor LCC presence.

a) LCC Presence > 10%

	Market Share			*Revenue Share*		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
AA	8.3%	9.1%	9.6%	11.1%	10.2%	-8.5%
CO	4.6%	6.0%	30.0%	6.1%	7.2%	18.0%
DL	10.2%	9.2%	-9.9%	11.5%	10.5%	-8.9%
NW	4.9%	4.7%	-3.5%	6.6%	5.6%	-14.8%
UA	10.6%	9.0%	-15.6%	15.1%	11.0%	-26.8%
US	4.1%	3.8%	-6.6%	4.0%	4.2%	4.0%

b) LCC Precence < 10%

	Market Share			*Revenue Share*		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
AA	15.9%	29.4%	85.4%	19.6%	29.8%	52.0%
CO	11.0%	13.5%	22.8%	12.3%	13.8%	11.8%
DL	19.0%	10.2%	-46.3%	16.1%	10.8%	-33.0%
NW	5.7%	5.8%	1.9%	5.4%	6.0%	11.2%
UA	13.6%	15.1%	11.0%	17.7%	17.3%	-2.5%
US	16.1%	9.0%	-44.4%	13.3%	8.2%	-38.2%

Table 7: Market and Revenue Share of the Legacy Carriers in the Sample Markets Segmented by LCC Market Share.

Figure 22 illustrates the average weighted yield index in markets with high and low LCC presence. CO again stands out as the airline that collects the highest fares compared to its competitors for almost all years from 2000 to 2006, while US shows the highest improvement from 2002 onwards both in markets with high and low LCC presence. As expected in markets with high LCC presence Legacy carriers have a higher $\overline{YI}$ than in markets with low LCC presence since LCCs on average collect lower fares than Legacy carriers, as can be seen from the results in Figure 22 with the only exception being NW.

DL is the only Legacy carrier that has a $\overline{YI}$ below 1.0 for every year in the period of study at the markets where it only competes with Legacy carriers. In other words DL when is competing against Legacy carriers only always receives lower fares than the competition (around 3% lower than the average) and even so it can not maintain neither its market nor its revenue share, as observed in Table 7.

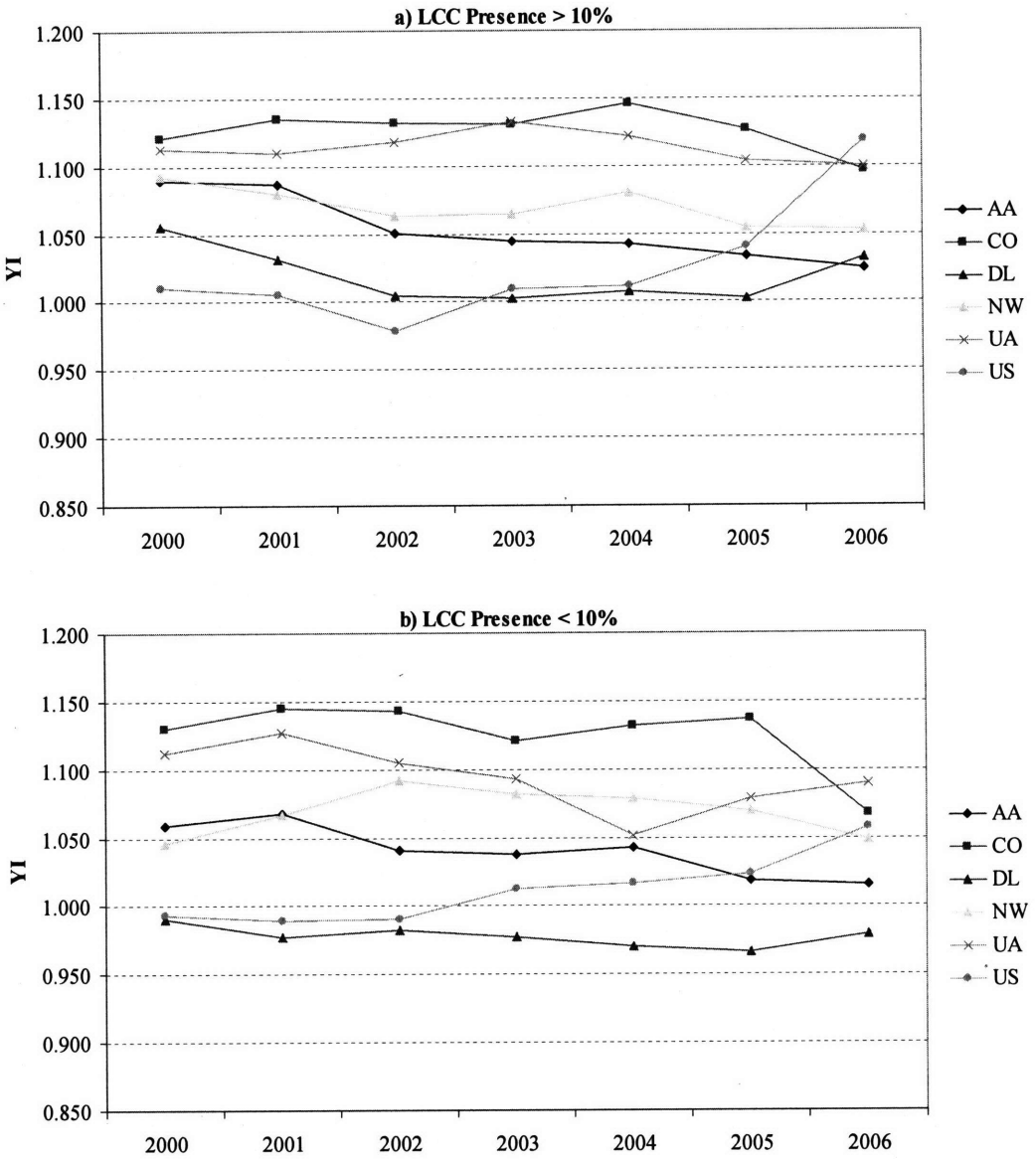

Figure 22: Time Series of Average Weighted Yield Index for the Legacy Carriers in Sample Markets where the aggregate Market Share of LCCs is a) above 10% and b) below 10%.

5.3 Hub Markets Analysis

In this final section of this Chapter, an analysis is performed on the hub markets of the six Legacy Carriers. As it was presented in the literature review in Chapter 2 hubs are very often associated with significant fare premiums for airlines in their respective hub markets. Chapter 2 includes definitions for a hub market, yield premium and hub premium that will be used extensively in this section.

The following table presents the airports that were considered as domestic hubs for the Legacy Carriers and were used for the analysis of the fare (or yield) premiums in hub markets in the Top US Domestic Markets. The source of the data was Aviation Daily[33] and the airports were selected according to their daily connecting ratio. In this research, the three largest hub airports for each Legacy Carrier were selected for the analysis. American Airlines is the only exception with only two hubs being included in the analysis because its third largest hub, St. Louis, was a result of the TWA acquisition by AA in 2001 so that the first year that first with data for St. Louis local markets with AA being the hub airline is 2002. Hub airports with a high connecting ratio but with very high proportion of international departures, like Miami (AA) and New York J.F. Kennedy (DL), were not included in the analysis because airlines utilize them for international connections which are out of the scope of this research.

[33] S. Lott, *Connecting Passengers Key to Defining 'Hubs'* Aviation Daily, 12/06/2006, pp 5-8, McGraw-Hill.

Hub Airport	*Hub Airline*	*Connecting Ratio*	*Daily Departures*
Dallas/ Fort Worth	American Airlines	68.6%	757
Chicago O'Hare	American Airlines	56.3%	490
Houston	Continental Airlines	66.2%	689
New York Newark	Continental Airlines	32.2%	396
Cleveland	Continental Airlines	42.2%	216
Atlanta	Delta Air Lines	79.1%	968
Cincinatti	Delta Air Lines	76.4%	376
Salt Lake City	Delta Air Lines	68.4%	309
Detroit	Northwest Airlies	68.0%	478
Minneapolis/ St. Paul	Northwest Airlies	66.1%	440
Memphis	Northwest Airlies	82.9%	218
Chicago O'Hare	United Airlines	61.7%	608
Denver	United Airlines	65.2%	411
Charlotte	US Airways	82.9%	538
Philadelphia	US Airways	57.9%	432
Pittsburgh	US Airways	46.8%	156

Table 8: Major Domestic Hubs in the US sorted by Legacy Carrier[33].

5.3.1 Initial Analysis on the Hub Markets

As a preliminary step, an aggregate analysis was performed in the hub markets of the Sample. The following three graphs, in Figure 23, present the traffic and revenues that are generated each day each way both at the hub markets of each of the six Legacy Carriers and the non-hub markets that each Legacy Carrier serves as well as the average fare that the Legacy Carriers receive. Out of the total 856 markets that form the data set, there are 580 hub markets of at least one Legacy Carrier in 2006; hence approximately 68% of the Sample Markets are hub markets of a Legacy carrier.

This difference between the number of hub and non-hub markets is evident in both the revenue and traffic graphs of Figure 23. One important fact to point out from these graphs is that Legacy Carriers were hurt both in their hub and their non-hub markets during the industry crisis, but since 2003 have recovered only in their hub markets. Hence, by 2006 the PDEW revenue generated in the hub markets by the "hubbing" airlines is

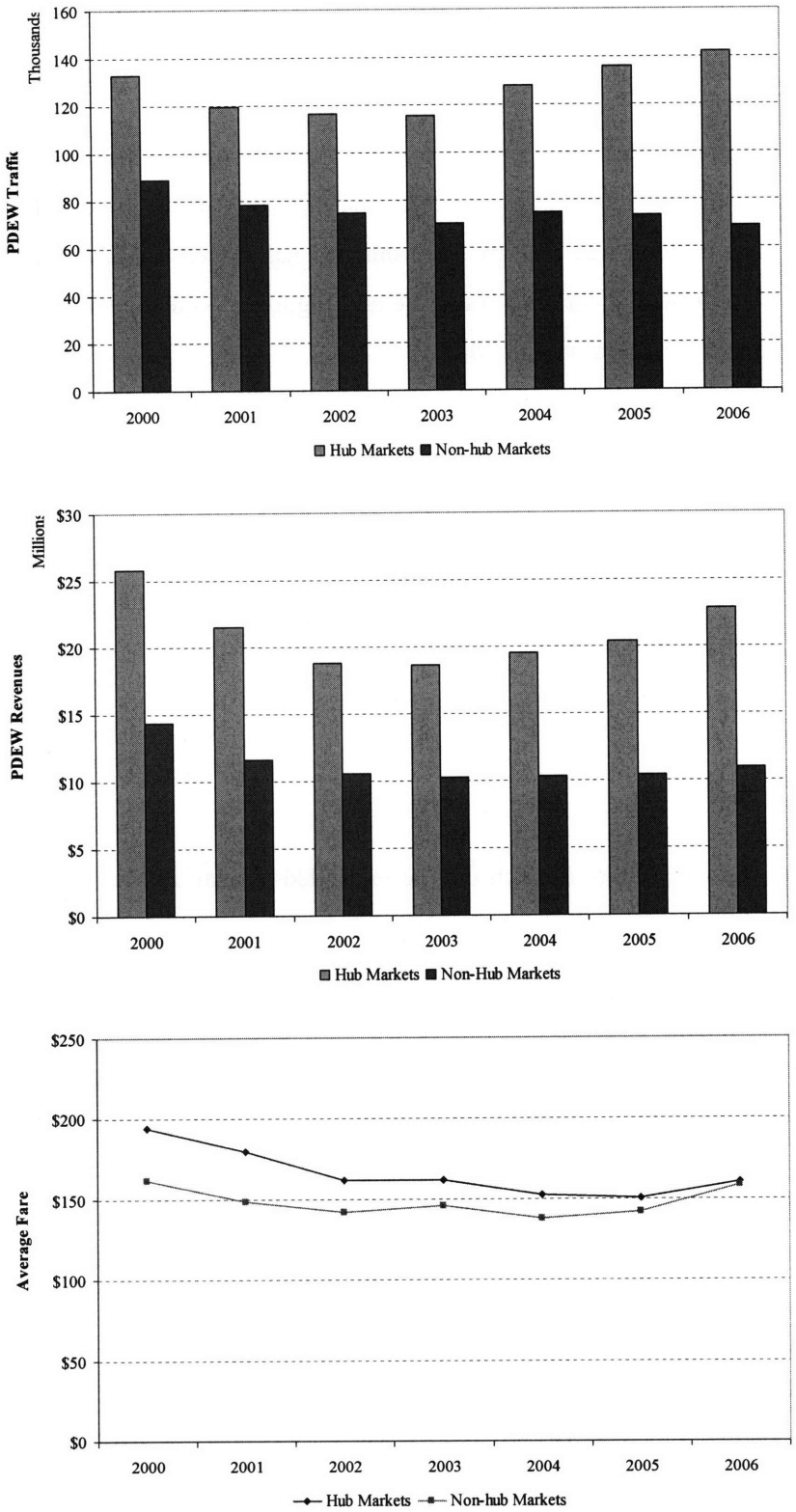

Figure 23: Total PDEW Traffic, Revenues and Average Fare Generated in all Hub Markets by the Respective Hub Airlines.

almost double than that generated in the non-hub markets, while the traffic is more than twice higher—having exceeded the 2000 levels.

Finally, the average fares that airlines receive at their hub markets have declined in 7 years by 17.3%. Although the difference in average fare that Legacy carriers collected from their hub and non-hub markets in 2000 was $32, by 2006 this gap has closed to $2. Again here it can be seen— as it was also presented earlier in Figure 8 and Figure 10— that average fares constantly dropped until 2005 and increased only in 2006.

Overall, Figure 23 helps to point out that hubs are very important for the Legacy carriers not only for offering a large network via connections but also by giving them the power to be the drivers at the local hub markets. This is why, a recovery is observed primarily in the hub markets of the data set but not at the non-hub markets.

5.3.2 Analysis per Hub

As mentioned earlier the research will be expanded to analyze yield premium and other metrics on the local markets of 17 US domestic hubs. In this section the results of this analysis are presented by Legacy Carrier and by hub. In Section 3.4 the Yield Index equations were first introduced. Here below it will be shown how these equations were used to compute the Average Weighted Yield Index, $\overline{YI}$, for the hub markets of each of the Legacy Carriers' hubs:

$$\overline{YI}_i = \frac{\sum_{j \in S} YI_{i,j} \cdot Traffic_{i,j}}{\sum_{j \in S} Traffic_{i,j}},$$

where j is a market out of a set S of Hub Markets served by airline i. The set S consists of Sample Markets whose either origin or destination is a specific hub airport of airline i. So, for example, AA's Yield index in Dallas/ Fort Worth, DFW, local markets is given by:

$$\overline{YI}_{AA} = \frac{\sum_{j \in DFW\ markets} YI_{AA,j} \cdot Traffic_{AA,j}}{\sum_{j \in DFW\ markets} Traffic_{AA,j}}.$$

In the figures of Yield Index that follow, Figure 24 to Figure 29, the scale is kept the same in all graphs so that the comparison between hubs of different airlines is clearer. Also, in all graphs the "brown" line represents the $\overline{YI}$ of the corresponding airline across the whole set of Sample Markets (as presented in Chapter 4), while the "blue" line represents the $\overline{YI}$ of that airline in its non-hub markets. In addition, for each Legacy carrier analyzed the changes in traffic, revenue, average fare and market share for each set of Sample markets are included.

American Airlines

Table 9 and Figure 24 summarize the results of the hub analysis for American Airlines. The two hubs investigated are Chicago O'Hare and Dallas Fort Worth, which include 61 Sample Markets each (in 2006) while AA's set of non-hub markets consists of 235 Sample Markets (in 2006)—the highest number of non-hub markets served by any Legacy carrier. The first thing to point out in AA's hub markets analysis is the huge increase in traffic both at its hub and at its non-hub markets from 2000 to 2006 that was also accompanied by a significant increase in market share. Both increases most probably are the result of the TWA acquisition in 2001, but in the case of Chicago there are 7 more Sample Markets served by AA in 2006 than in 2000. However, AA has one of the lowest market shares in a set of hub markets (Dallas Fort Worth, 28% in 2006) that were analyzed in this thesis. In its Chicago O'Hare hub AA shows the largest decrease in the average fare collected (-30%) than any other Legacy carrier in its hub markets. On the other hand AA has the highest market share in the non-hub markets of any Legacy airline (22% in 2006). Another important remark is that the average fare that AA receives in its two sets of hub markets has dropped much faster than did in AA's non-hub markets and that might provide an explanation for the higher increase in market share in AA's hub markets (assuming that demand is, at least, partially driven by fares).

In terms of $\overline{YI}$, it may observed that although AA has a yield premium in all sets of markets, this premium has been decreasing rapidly. The reduction in average fares has led to lower yield indices, which means that by 2006 the fares that AA is collecting in both sets of hub

markets are closer to those collected by AA's competitors; so for example in the Dallas/ Fort Worth markets AA was receiving more than 13% higher fares than the average in 2000 but by 2006 only 7% higher. In the case of non-hub markets it can be observed that since 2005 AA has been collecting lower fares than its competitors.

Continental Airlines

The three hubs that were used for analyzing Continental's hub performance are Cleveland, Houston and New York/ Newark with 21, 51 and 66 corresponding hub-markets respectively while there are only 45 non-hub Sample Markets served by CO. Looking at Table 10, Houston has seen a huge increase in PDEW traffic (39%) and it is the only set of hub markets with a higher revenue generation in 2006 than in 2000. The fact that CO moved out of 36 non-hub markets by 2006 is depicted in the 45% decrease of traffic in that set of markets. CO together with AA are the only Legacy airlines with an increased market share in all four sets of Sample markets presented in Table 10. New York's local markets account for more than 50% of the total revenues generated in the Sample Markets by CO and although these are some of the busiest markets in the US with a large number of competitors, still CO has achieved a huge increase in market share from 2000 to 2006 (+11 percentage points).

Observing Figure 25, CO has the largest yield premium observed in this analysis in its New York hub reaching almost 1.195 in 2004. Since then though $\overline{YI}$ has dropped down to 1.105 by 2006—as a result of CO collecting 21% lower fares in its New York markets in 2006 than in 2000. In both Houston and Cleveland hubs CO has seen its $\overline{YI}$ to go down much earlier and, interestingly, the yield indices there are lower than the overall yield index of CO (an effect of the high revenue and traffic generated in the New York hub). The effect of the increased average fare in CO's non-hub markets is clearly shown in CO's $\overline{YI}$ at its non hub markets which in 2005 has moved to above 1.0 and by 2006 has even exceeded the $\overline{YI}$ in Cleveland local markets.

Delta Air Lines

Delta's hubs that were included in the analysis of hub premiums are Atlanta (54 markets), Cincinnati (14 markets) and Salt Lake City (27 markets); also, DL served in 2006 201 non-hub

Sample Markets. One important thing to point out from Table 11 is that DL is the only carrier that has lost traffic in all four sets of markets and especially in Cincinnati and the non-hub markets. The result of that loss was an important reduction in DL's market share. DL's market share in its Atlanta hub is the highest observed in the analysis although Airtran uses Atlanta as its own hub and hence serves most of the Sample Markets that DL also serves. It is, also, worth pointing out that the average fare that DL collects from its Cincinnati hub markets is the highest average fare from all sets of hub markets presented in this analysis in 2006. The increase of the average fare in Cincinnati may explain partially the 10% loss of market share of at these markets.

The fact that DL has such a high market share in its Atlanta markets means that the average fare in these markets is very close to DL's average fare at the same markets. This is why DL's yield premium in Atlanta is only slightly above 1 (Figure 26). Also DL primarily competes in most of the Atlanta markets with Airtran which a low fare carrier and hence receives lower fares than DL. Still though $\overline{YI}$ has always been above 1.05 and has been increasing since 2004. It is also important to mention that although DL's $\overline{YI}$ in all three hubs has been steadily decreasing up to 2005, in 2006—the year after DL has filed for bankruptcy—DL improves its $\overline{YI}$ in all three hubs and at its non-hub markets. Cincinnati shows the lowest $\overline{YI}$ of all other Legacy hubs in 2005 and 2006. Overall, DL's $\overline{YI}$ for all three hubs has been ranging from 1.04 to 1.10 from 2000 to 2006 and is one of the lowest observed among the Legacy carriers.

Northwest Airlines

For Northwest Airlines the three hubs investigated are Detroit, Memphis and Minneapolis/ St. Paul that include 32, 7 and 36 Sample Markets respectively. There are also 74 non-hub Sample Markets served by NW. In these latter markets NW shows the highest gain in market share from 2000 to 2006 than any other Legacy carrier, as demonstrated by Table 12. The average fare that NW collects at its Memphis local markets shows the largest increase than any other hub in the industry (+12%) a fact that also reflects NW's yield index in its Memphis markets, which, as may be seen in Figure 27, has been increasing since 2000 except in 2006; in 2005 NW was collecting 12.5% higher average fares than the competition.

NW had had by far the lowest $\overline{YI}$ in its non-hub markets up to 2004, marking its lowest value in 2002 when NW was receiving on average 13.5% lower fares than its competitors. In Minneapolis/ St Paul, NW largest domestic hub, maintains a yield premium throughout the years, which however has been decreasing for most of the years so that by 2006 $\overline{YI}$ is close to 1.06.

United Airlines

The three hubs that were used for analyzing United Airline's hub performance are Chicago O'Hare, Denver and Washington DC that include 64, 46 and 43 local Sample Markets respectively, while there are 186 non-hub Sample Markets served by UA. United is just the second Legacy carrier (after AA) that shows a reduction on the average fares it receives in all three hubs and at its non-hub markets. In the Washington DC hub markets UA's traffic goes up by 40% but the revenues increase only slightly and that is explained by the huge reduction of the average fare in these markets. In 2000 Washington DC markets had the highest average fare ($265) but by 2006 it has gone down by almost 30%. This huge fare drop had also had a significant effect on UA's yield premium in the Washington DC local markets. It is evident from Figure 28, that since 2003 the $\overline{YI}$ in Washington DC has dropped considerably—from 1.155 in 2003 to 1.080 in 2006.

It is worth mentioning that both AA and UA have gained market share in the local markets of Chicago O'Hare which both airlines use as their hub even though they are competing in exactly the same markets. The fact that UA obtains higher fares than AA—together with the fact that AA's fares drop more rapidly than UA's fares in Chicago—explains why the $\overline{YI}$ graph of UA in Chicago is much high than the respective graph of AA. In other words, UA has been receiving at least 12% higher fares than the average in the Chicago markets, while AA's $\overline{YI}$ is always below 1.12 and in 2006 as low as 1.03. The fact that AA's fares are lower than UA's can explain why AA's traffic has increased much more than UA's.

Overall UA is the only Legacy carrier, which in any year of the period investigated had a $\overline{YI}$ above 1.0 in all of its hub markets and at its non-hub markets. Also, with the exception of Washington DC, UA's Yield Index seems to be the most stable over the years with very small variations. Finally, together with CO, UA is the only airline that has two sets of hub markets constantly above 1.12—Chicago O'Hare and Denver.

US Airways

US Airways' hubs that were included in the analysis of hub premiums are Charlotte (18 markets), Philadelphia (33 markets) and Pittsburgh (16 markets)—so that US is the airline with the fewest hub markets in our Sample. Also, US served in 2006 135 non-hub Sample Markets. As illustrated by Table 14, at these latter set of markets US collected 20% higher fares in 2006 than in 2000 (the largest increase among the Legacy carriers) and one explanation maybe that US has moved since 2000 out of 53 non-hub markets which probably were short haul markets or just markets were US showed weakness on receiving high fares. This latter argument can be more justifiable when looking at Figure 29. The Yield Index at the non-hub markets rises sharply since 2002.

Another interesting point is that US shows tremendous losses in market share in all three hubs and at its non-hub markets; US and DL, which were the two weakest airlines as discussed previously are the only carriers which lose market share in all sets of markets. Surprisingly, this market loss is also accompanied with a large decrease in the average fares collected by US. The fact that US has tried to move out of its Pittsburgh hub and put more emphasis on Philadelphia is depicted by the 30% reduced traffic in Pittsburgh markets. An interesting fact though is that the market share of US in Philadelphia markets has dropped more than it did in Pittsburgh markets but that can be explained if it is assumed that US primarily terminates service at markets that doesn't dominate in order to move hub operations from Pittsburgh. This can also be an explanation of why Pittsburgh has the highest $\overline{YI}$ from all other US hubs.

As far as the yield index of US is concerned, it shows the largest improvement than any other airline in all three hubs—especially in Philadelphia and Pittsburgh $\overline{YI}$ rises since 2002 from very close to 1.0 at above 1.1. Hence, although US's fares have seen a large drop, the average fares in the markets that US serves must have dropped even more sharply. It seems that the two bankruptcies that US has filed have helped to improve its yield premium; a small increase of the $\overline{YI}$ can first be observed after the first bankruptcy in 2002 and then a much greater increase after the second bankruptcy in 2004. Of course it shouldn't be forgotten that the higher the market share of US, the closer the average fare of a market to US's average fare at that market, so an increase of the yield index when market share is lost should be expected, but not as high as that illustrated by Figure 29.

(a)

	Traffic			Revenues		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
Chicago O'Hare	10,679	13,754	29%	$2,088,398	$1,883,060	-10%
Dallas/ Fort Worth	13,405	17,015	27%	$3,095,514	$2,954,858	-5%
Non-hub Markets	19,857	25,988	31%	$3,883,317	$4,258,926	10%

(b)

	Average Fare			Market Share		
	2000	*2006*	*% Change*	*2000*	*2006*	*Change*
Chicago O'Hare	$196	$137	-30%	43%	54%	11.1
Dallas/ Fort Worth	$231	$174	-25%	24%	28%	3.8
Non-hub Markets	$196	$164	-16%	20%	22%	2.2

Table 9: Absolute and Relative Changes in (a) PDEW Traffic and Revenue and (b) Average Fare and Market Share on all Hub and Non-Hub Markets of American Airlines.

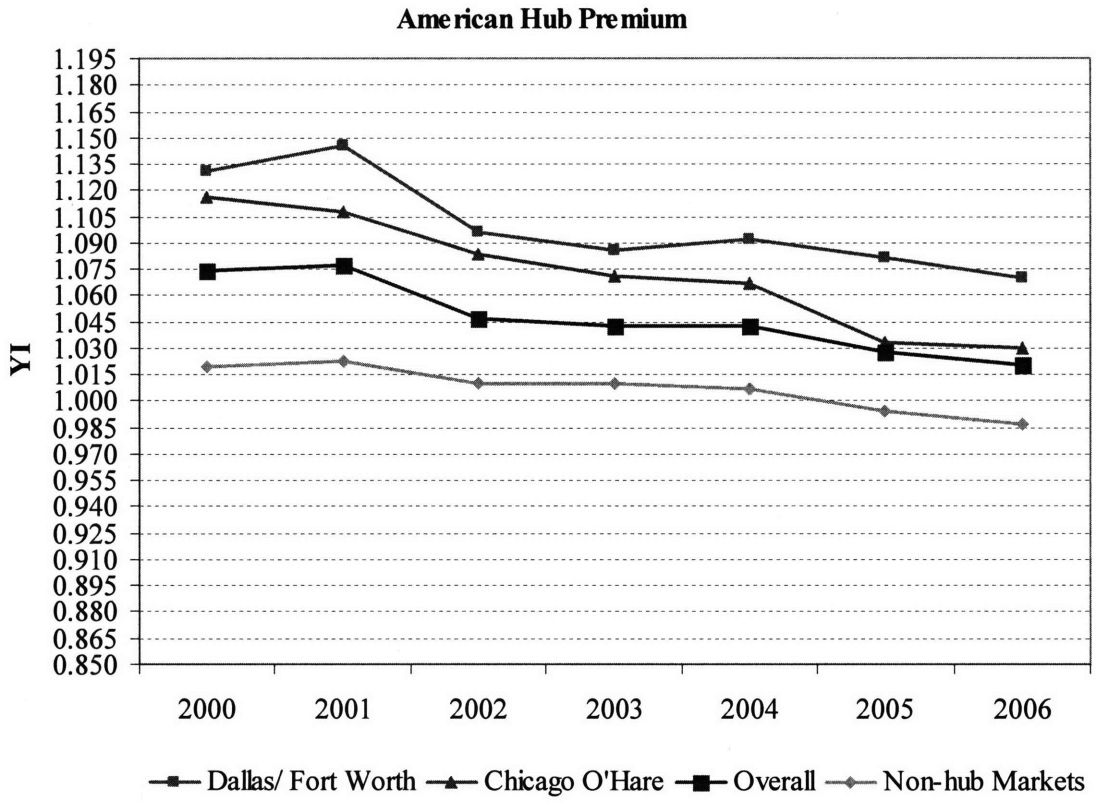

Figure 24: Time Series of Average Weighted Yield Index in American Airline's Hub and Non-Hub Markets.

(a)

	Traffic			Revenues		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
Cleveland	3,547	3,900	10%	$613,346	$558,743	-9%
Houston	8,262	11,521	39%	$1,655,604	$1,816,010	10%
New York	14,776	17,224	17%	$3,166,855	$2,975,187	-6%
Non-hub Markets	1,780	983	-45%	$290,947	$180,765	-38%

(b)

	Average Fare			Market Share		
	2000	*2006*	*% Change*	*2000*	*2006*	*Change*
Cleveland	$173	$143	-17%	23%	24%	0.9
Houston	$200	$158	-21%	51%	57%	6.3
New York	$214	$173	-19%	41%	52%	11.5
Non-hub Markets	$163	$184	13%	9%	11%	1.5

Table 10: Absolute and Relative Changes in (a) PDEW Traffic and Revenue and (b) Average Fare and Market Share on all Hub and Non-Hub Markets of Continental Airlines

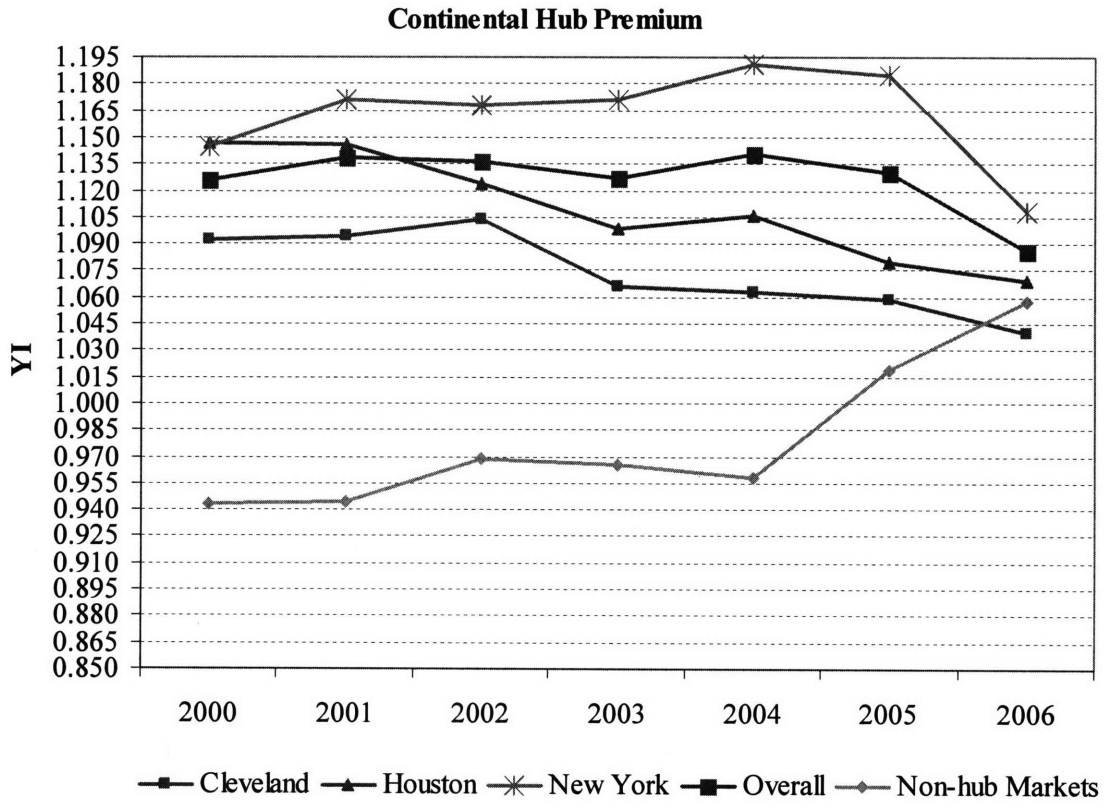

Figure 25: Time Series of Average Weighted Yield Index in Continental Airline's Hub and Non-Hub Markets.

(a)

	Traffic			Revenues		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
Atlanta	19,544	17,016	-13%	$3,305,876	$2,833,703	-14%
Cincinnati	2,465	1,842	-25%	$522,375	$413,540	-21%
Salt Lake City	4,576	4,164	-9%	$628,681	$629,205	0%
Non-hub Markets	26,415	16,899	-36%	$3,671,746	$2,253,629	-39%

(b)

	Average Fare			Market Share		
	2000	*2006*	*% Change*	*2000*	*2006*	*Change*
Atlanta	$169	$167	-2%	75%	73%	-2.6
Cincinnati	$212	$225	6%	62%	56%	-5.9
Salt Lake City	$137	$151	10%	53%	45%	-7.3
Non-hub Markets	$139	$133	-4%	18%	18%	-0.8

Table 11: Absolute and Relative Changes in (a) PDEW Traffic and Revenue and (b) Average Fare and Market Share on all Hub and Non-Hub Markets of Delta Air Lines.

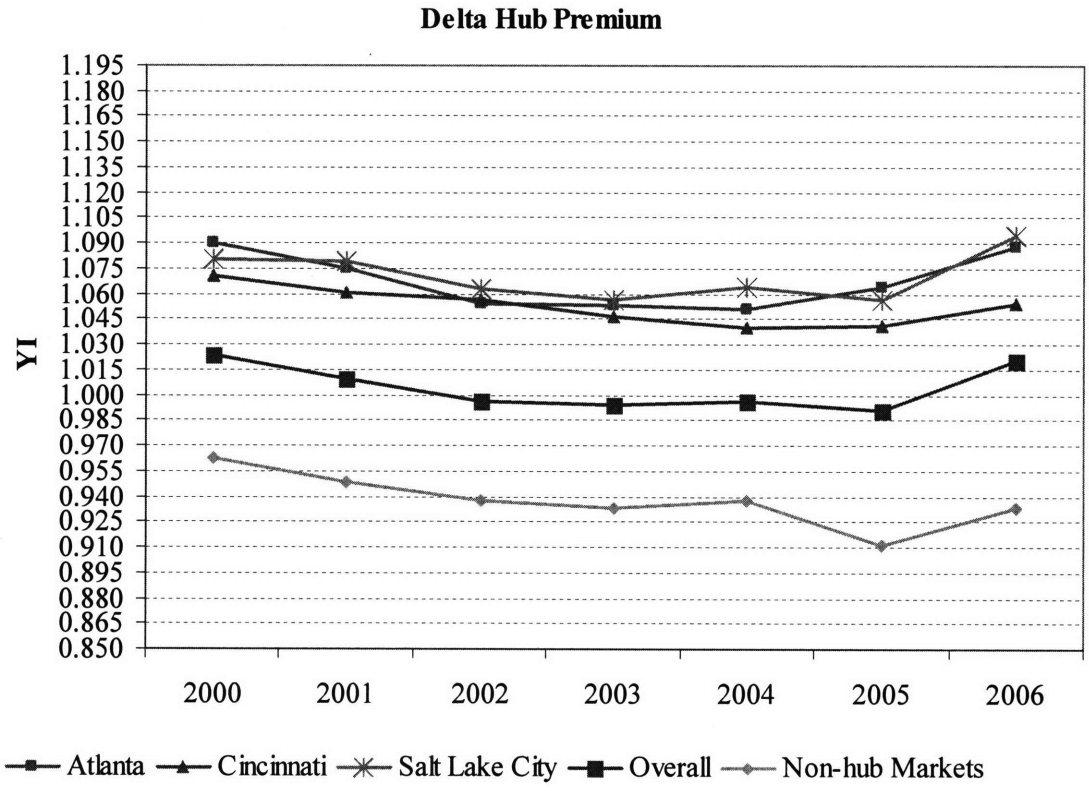

Figure 26: Time Series of Average Weighted Yield Index in Delta Air Line's Hub and Non-Hub Markets.

(a)

	Traffic			Revenues		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
Detroit	8,490	8,416	-1%	$1,361,215	$1,224,871	-10%
Memphis	828	704	-15%	$148,321	$141,718	-4%
Minneapolis/ St. Paul	9,368	9,176	-2%	$1,747,807	$1,576,270	-10%
Non-hub Markets	2,199	2,725	24%	$371,822	$403,707	9%

(b)

	Average Fare			Market Share		
	2000	*2006*	*% Change*	*2000*	*2006*	*Change*
Detroit	$160	$146	-9%	44%	42%	-2.1
Memphis	$179	$201	12%	55%	54%	-1.5
Minneapolis/ St. Paul	$187	$172	-8%	62%	57%	-4.2
Non-hub Markets	$169	$148	-12%	11%	14%	3.8

Table 12: Absolute and Relative Changes in (a) PDEW Traffic and Revenue and (b) Average Fare and Market Share on all Hub and Non-Hub Markets of Northwest Airlines.

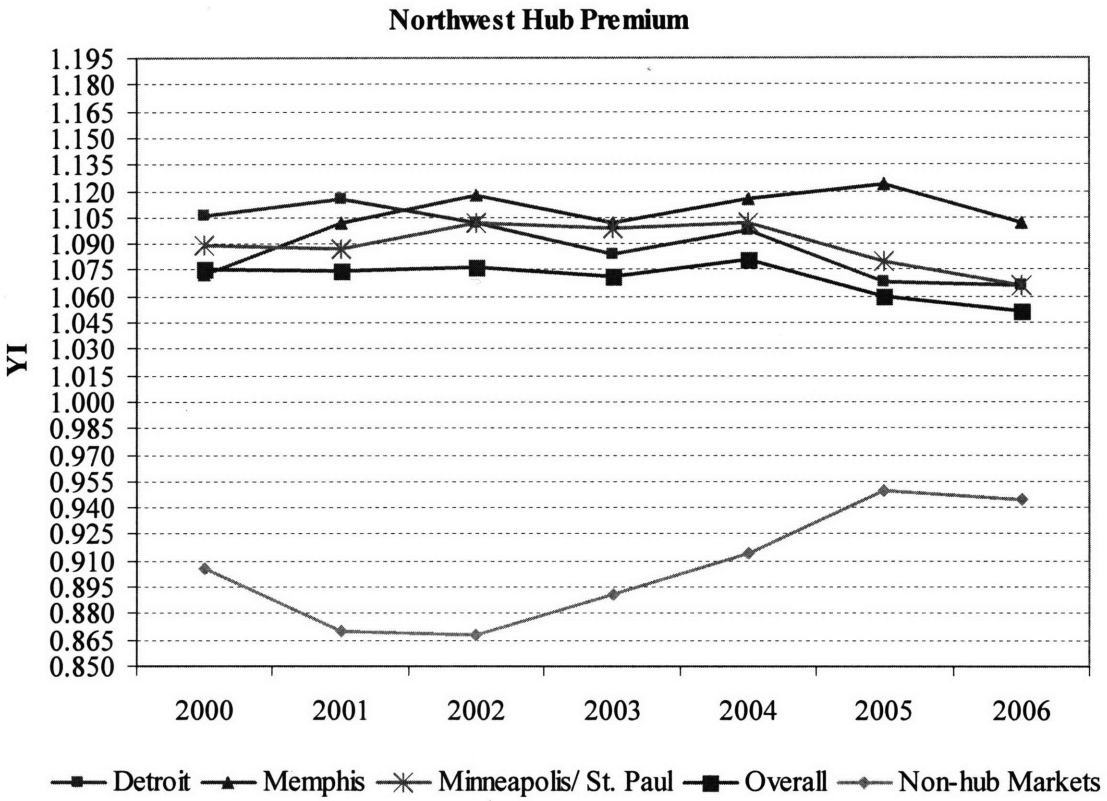

Figure 27: Time Series of Average Weighted Yield Index in Northwest Airline's Hub and Non-Hub Markets.

(a)

	Traffic			Revenues		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
Chicago O'Hare	14,376	14,550	1%	$2,794,470	$2,180,512	-22%
Denver	10,134	9,593	-5%	$2,212,235	$1,543,417	-30%
Washington DC	4,940	6,932	40%	$1,310,381	$1,312,257	0%
Non-hub Markets	19,030	14,194	-25%	$3,764,640	$2,647,601	-30%

(b)

	Average Fare			Market Share		
	2000	*2006*	*% Change*	*2000*	*2006*	*Change*
Chicago O'Hare	$194	$150	-23%	26%	30%	3.9
Denver	$218	$161	-26%	30%	29%	-1.8
Washington DC	$265	$189	-29%	51%	39%	-11.9
Non-hub Markets	$198	$187	-6%	23%	19%	-4.1

Table 13: Absolute and Relative Changes in (a) PDEW Traffic and Revenue and (b) Average Fare and Market Share on all Hub and Non-Hub Markets of United Airlines.

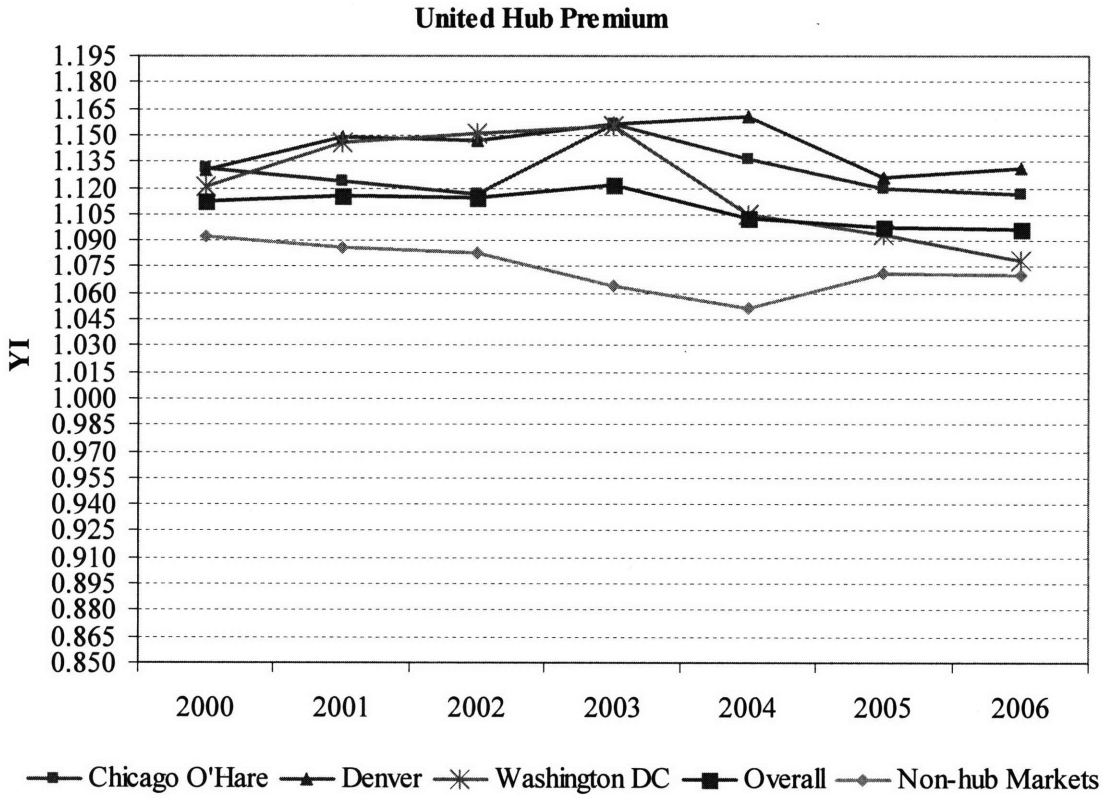

Figure 28: Time Series of Average Weighted Yield Index in United Airline's Hub and Non-Hub Markets.

(a)

	Traffic			Revenues		
	2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
Charlotte	2,783	3,189	15%	$633,150	$535,010	-16%
Philadelphia	7,213	7,188	0%	$1,333,059	$1,059,642	-21%
Pittsburgh	3,529	2,311	-35%	$665,839	$312,430	-53%
Non-hub Markets	19,462	8,178	-58%	$2,382,885	$1,199,042	-50%

(b)

	Average Fare			Market Share		
	2000	*2006*	*% Change*	*2000*	*2006*	*Change*
Charlotte	$228	$168	-26%	69%	53%	-16.1
Philadelphia	$185	$147	-20%	69%	40%	-29.1
Pittsburgh	$189	$135	-28%	51%	40%	-11.1
Non-hub Markets	$122	$147	20%	27%	16%	-10.3

Table 14: Absolute and Relative Changes in (a) PDEW Traffic and Revenue and (b) Average Fare and Market Share on all Hub and Non-Hub Markets of US Airways.

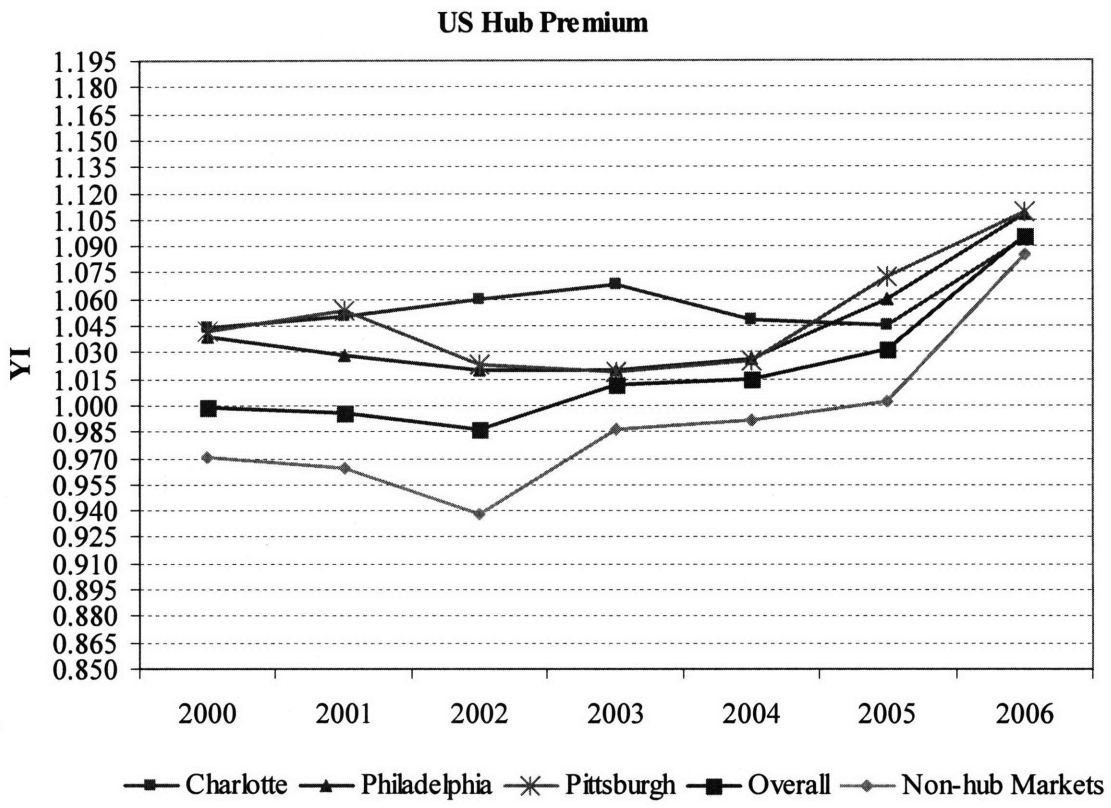

Figure 29: Time Series of Average Weighted Yield Index in US Airways' Hub and Non-Hub Markets.

Overall, it was observed that Legacy carriers have a much high higher Yield Index in their hub markets than in the rest of their markets. Some Legacy carriers received even more than 10% higher fares than the average of the competition in some of their hub markets. A few reasons why fares of Legacy carriers are higher than the competition at their hub markets are:

- For the "hubbing" airline the local markets of the hub are served by direct flights while most of the other airlines offer a connecting service.
- Frequency of service is usually higher for the "hubbing" airline hence obtaining a important market share advantage.
- Local business passengers are most likely to prefer the local "hubbing" airline due to a larger network from that airport and a higher frequency of service. This preference is quantifiable by the loyalty programs of airlines.
- The monopolizing power of the "hubbing" airline and the lack of other options for the passengers in terms of air travel can increase the pricing power of the hubbing airline.

5.3.3 Quantitative Analysis on Competition at Hub Markets

In this section the results of a quantitative analysis of competition at the hub markets of the Legacy carriers are presented. The same analysis that was performed in Section 4.4.2 for the total set of Sample Markets is repeated here for the hub markets only. Again the term effective number of competitors is used as it was defined in Section 4.4. Table 15 illustrates the average number of effective competitors for each set of hub markets for each Legacy carrier in addition to the average number of effective competitors in total, for the sake of comparison.

The first thing to observe is that there is no hub where the number of competitors that the corresponding hub airline faces is greater than that at the non-hub markets that this airline serves, with the exception of CO in New York in 2002 and 2006, NW in Memphis in 2004 and 2005 and UA in Washington DC in 2005. The three airlines that have been discussed so far to perform better than the rest of the Legacy carriers—namely AA, CO and UA—are the carriers that show a reduced number of competitors on average in all of their hubs. On the other hand, US faces by far the highest increase in the number of competitors it faces in all three hubs followed by NW and then by DL whose number of competitors remains almost unchanged. Relating to Table 14,

the huge loss of market share of US in its hubs comes as a result of the increased number of competitors that US had to face.

DL in Cincinnati faces the fewest number of competitors among the Legacy carriers in their hub markets, by having on average less than one effective competitor per market. On the contrary, CO in New York faces on average approximately three competitors per market—the highest among the Legacy carriers—but still, as illustrated in Table 10 and Figure 25, holds a very important yield premium and an increasing market share. Overall, UA faces the highest number of competitors in its hub markets while DL the lowest in 2006. A few observations worth mentioning are the large reduction of the number of competitors in AA's Dallas/ Fort Worth hub and CO's Houston and Cleveland hubs and the vast augmentation of competitors in US's Charlotte and Pittsburgh hub and in NW's Detroit hub.

		2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*% Change*
AA	*Chicago O'Hare*	2.55	2.67	2.54	2.55	2.66	2.46	2.31	-9.4%
	Dallas/ Fort Worth	2.00	2.03	2.03	1.97	1.87	1.52	1.44	-28.2%
	All Markets	3.07	3.05	2.87	2.78	2.76	2.58	2.57	-16.4%
CO	*Cleveland*	1.90	1.86	1.76	1.57	1.62	1.57	1.48	-22.5%
	Houston	1.90	1.92	1.90	1.82	1.67	1.57	1.41	-25.8%
	New York Newark	3.01	3.15	3.01	2.82	2.78	2.75	2.96	-2.0%
	All Markets	3.17	3.17	2.95	2.86	2.80	2.75	2.59	-18.2%
DL	*Atlanta*	1.48	1.73	1.57	1.57	1.39	1.48	1.52	2.4%
	Cincinnati	0.93	0.86	0.79	0.71	0.71	0.93	0.93	0.0%
	Salt Lake City	1.70	2.00	2.04	2.37	2.33	2.22	1.74	2.2%
	All Markets	2.77	2.85	2.73	2.70	2.65	2.67	2.79	0.5%
NW	*Detroit*	1.84	1.84	1.72	1.75	1.81	1.72	2.28	23.7%
	Memphis	2.43	2.71	2.57	2.57	3.14	3.00	2.71	11.8%
	Minneapolis/ St. Paul	1.89	1.97	2.14	2.25	2.17	1.81	2.06	8.8%
	All Markets	3.27	3.31	3.27	3.13	3.03	2.71	2.87	-12.1%
UA	*Chicago O'Hare*	2.55	2.67	2.54	2.55	2.66	2.46	2.31	-9.4%
	Denver	2.58	2.63	2.67	2.26	2.28	2.22	2.17	-15.7%
	Washington DC	2.37	2.35	2.27	2.35	2.71	3.21	2.33	-1.5%
	All Markets	3.12	3.09	3.04	2.90	2.86	2.76	2.68	-14.1%
US	*Charlotte*	1.56	1.61	1.61	2.11	2.11	1.94	2.44	57.1%
	Philadelphia	1.67	1.55	1.79	2.00	2.30	2.24	2.15	29.1%
	Pittsburgh	1.89	1.89	1.89	2.00	2.17	2.44	2.56	35.3%
	All Markets	2.57	2.66	2.62	2.60	2.66	2.45	2.71	5.3%

Table 15: Mean Number of Effective Competitors in the Hub Markets and the Sample Markets for each Legacy Carrier from 2000 to 2006.

For Figure 30, for each Legacy carrier the average number of competitors is computed across all the hubs of the carrier, but it is broken down by the type of competing carrier. It is worth comparing Figure 30 to Figure 15 in order to realize how the number of Legacy and LCC

competitors differs between hub and non-hub markets. First of all, the number of Legacy competitors that another Legacy carrier has to face at its hub markets is around 50% lower than across all its markets, which translates to much more than 50% lower than the non-hub markets.

The average number of Legacy competitors in the hub markets of an airline drops significantly from 2000 to 2006 for most Legacy carriers except NW and US. The highest drop is observed by CO that faces approximately 0.6 less Legacy competitors in its hub markets by 2006. It should be also noted that in 2006 both AA and DL compete against less than one Legacy on average at their hub markets a fact that, for DL, can be explained by the large dominance—in terms of market share—in all three hubs.

Three out of six Legacy carriers face more LCC competitors in their hub markets than in their non-hub markets—AA, CO and NW. Similarly to Figure 15, the number of LCC competitors in Legacies' hub markets has grown since 2000. NW is the only airline that faces on average above one LCC competitor per market and US has seen the largest increase in the absolute number of LCC competitors from 2000 to 2006.

In Appendix II is included a table that illustrates the mean number of effective competitors in each set of hub markets separately broken down by type of competing carrier for the years 2000 and 2006.

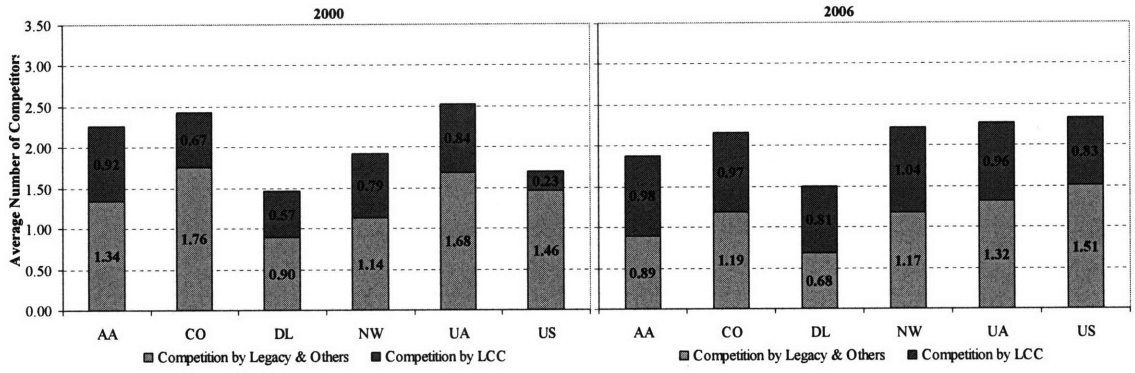

Figure 30: Mean Number of Effective Competitors for each Legacy Carrier at their Hub Markets Broken Down by Type of Competing Airline for 2000 and 2006.

5.4 Summary

In Chapter 5 the Top 1000 US Domestic Markets were segmented according to three main characteristics:

- The number of competitors serving each market,
- the aggregate market share of the LCCs serving each market,
- the average haul of each market (see Appendix III),
- and whether a market is a local market at a hub of a Legacy carrier.

The main findings of this analysis can be summarized in the following points:

- The number of competitors that an airline has to face greatly affects its Yield Index, in addition to its revenue and market share. DL and US collected lower fares than their competitors in markets with more than two competitors, very close to average at markets with two competitors and only achieve a significant yield premium at markets with just one competitor. On the other hand CO and UA stand out as the airlines that have the highest Yield Index, especially at markets with 4 or more competitors.
- The average fare at markets served primarily by Legacy airlines is much higher than that at markets with significant LCC presence, but the gap has been steadily closing over the years—from $81 in 2000 down to $45 in 2005 but up at $59 in 2006.
- DL and US lost almost half of their market share to their Legacy competitors at markets with minor LCC presence, while only AA and CO gained share in markets with significant LCC presence.
- DL is the only airline that has a $\overline{YI}$ below 1.0 for every year since 2000 at markets with minor LCC presence. Overall Legacy carriers achieve a larger yield premium at markets with high LCC market share— fares collected by LCCs bring the average fare of a market down.
- Large differences in the $\overline{YI}$ also exist between short-, medium- and long-haul markets

for all Major US airlines as it can be observed in Appendix III.

- Although the average fare in hub markets has been higher than in non-hub markets for most years, by 2006 the gap has vanished.

- Overall, the $\overline{YI}$ of Legacy carriers in their hub markets is much larger than that in their set of non-hub markets. Interestingly half of the Legacy carriers have lost market share in their hub markets while only American and Continental and United increased their market share.

- AA and CO, which used to have the highest $\overline{YI}$ in their hub markets, have recently seen their $\overline{YI}$ to drop. Again the lowest $\overline{YI}$ in a set of hub markets over time was observed at US's Pittsburgh and Philadelphia hubs and at DL's Cincinnati hub.

- The mean number of effective competitors in hub markets is much lower than in non-hub markets and has also decreased for most Legacy carriers from 2000 to 2006. Again, the largest portion of competitors that a Legacy carrier faces in its hub markets comes from other Legacy carriers—a number which dropped over the years. On the other hand LCCs have penetrated Legacies' hub markets so that the number of LCC competitors that a Legacy carrier faces at its hub markets has increased significantly.

Overall, in this chapter we saw that the average fare that Legacy carriers collect relative to their competitors ($\overline{YI}$) strongly depends on the number of effective competitors in the market and whether or not it is a hub market. As we discussed in the literature review section (2.2), earlier studies have proved the pricing advantage of Legacy carriers at their hub markets in comparison to their non-hub markets. Here we tried to observe if Legacy carriers collect higher fares than their competitors at their hub markets and if so by how much, and in addition how this advantage (or disadvantage) has changed during the latest industry crisis. All Legacy carriers were able to maintain a yield premium in their hub markets although most of them were under financial crisis and even though LCCs have penetrated their hub markets (hence increasing the competition in these markets). On the other hand only UA was able to maintain an average yield premium at non-hub markets constantly from 2000 to 2006.

Chapter 6
Regression Analyses

In the previous chapters, we analyzed and compared both the yields (average fares) and the yield premiums (fare premiums) of airlines and realized how different factors such as hubs, Low Cost Carriers presence and number of competitors, affected these. In this chapter we perform an econometric analysis both on the total sample and on each of the Legacy carriers separately in order to observe how yields for each airline depend on the combination of different factors.

Hence, in this chapter we perform several regression analyses on yields of each Legacy carrier in its top US domestic markets. As a first step we will look into—and explain—the different possible explanatory variables, then identify possible relations between them and finally run a regression on the whole data set. Then we will run regressions for each of the Legacy carriers, and we will elaborate on the results and try to explain the differences between the airlines.

6.1 Model and Variables

All regressions performed in this chapter are linear models that are based on the following equation:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n \qquad \text{Equation 5}$$

where y is the dependent or endogenous variable, and $x_1 \ldots x_n$ represent the independent, explanatory or exogenous variables. Parameters $\beta_0 \ldots \beta_n$ are estimated by the method of ordinary least squares (OLS) and represent the strength of the relation of y to the respective explanatory variable.

We performed significance tests on the coefficients of our models' explanatory variables $\beta_0 \ldots \beta_n$, in other words we tested if each of the coefficients is significantly different from 0. In order to do this we formulated a null hypothesis that a coefficient β_n is equal to 0 and tested it with using the t-statistic:

$$H_0 : \beta_n = 0$$
$$H_1 : \beta_n \neq 0$$

The test statistic is then:

$$t_{\beta_n} = \frac{\beta_n}{s_{\beta_n}}$$

where $S_{\beta n}$ is the standard error of the coefficient β_n.

If $t_{\beta_n} > t_{cr}$, where t_{cr} is a critical value obtained from t-stat tables for a specific number of degrees of freedom and a level of significance α (usually $\alpha=0.05$), then we shall reject the null hypothesis with a confidence $1-\alpha$. For $\alpha=0.05$ then $t_{cr} \approx 1.96$ so for a t-stat greater than 1.96 we shall assume that the coefficient is significantly different from zero with 95% confidence.

The sample analyzed throughout this thesis consists of the Top 1000 US Domestic markets from 2000 to 2006, as explained in Chapter 3. A single observation in the sample is an O-D

market at a specific year. Hence, the total sample contains both cross-sectional data (all the markets in a single year) and time series (a specific market from year 2000 to 2006). However, the regression analyses in this thesis are performed only for 2006 (cross-sectional data) since we are interested in investigating how the yields of different airlines depend on different factors. Thus we chose the most recent year to perform the analyses, when most Legacy carriers have recovered from the crisis and LCCs have deeply penetrated the Top US markets as well as the hubs of the Legacy airlines. A more extensive regression analyses can be found in Geslin[5], where the regression models try to estimate the effect of different factors on the change of average fares from 2000 to 2004. The following variables were used for the regressions performed in this chapter:

YIELD represents the yield of an airline each O-D market in 2006. It is the dependent variable in all our models and its units are cents per passenger-mile.

COMP represents the number of effective competitors—as defined in Section 4.4—in each O-D market in 2006. It is a discrete explanatory variable.

LCC is a dummy variable that takes on value 1 if at least one of the competitors in each O-D market is a Low Cost Carrier, and 0 otherwise. It is an independent variable used in some of the models.

HUB is a dummy variable that takes on value 1 if either of the cities in each O-D market is a hub of a Legacy carrier. Hub markets have been defined in Section 2.1. It is an independent variable used in some of the models.

DIST represents the distance in non-stop miles between the city pair of each O-D market. It is an independent variable used in all models.

PAX represents the average number of passengers flying in each O-D market per day each way. It is an independent variable used in some of the models.

6.1.1 Multi-collinearity

Before performing any regressions we need to test for multi-collinearity between the independent variables. That is we need to check the correlation between the independent variables. High correlated independent variables within a model will reduce the efficiency of a model while at the same time it may lead to inaccurate estimates for the coefficients of the variables. Moreover, high degree of collinearity will increase the standard errors of the coefficients, which in turn will decrease the t-ratios. Then variables which in reality might be significant may appear as insignificant in a model with high multi-collinearity. We thus construct the correlation matrix, Table 16.

	COMP	*LCC*	*HUB*	*DIST*	*PAX*
COMP	1.000	0.308	-0.408	0.410	-0.240
LCC		1.000	-0.020	-0.044	-0.014
HUB			1.000	-0.345	0.374
DIST				1.000	-0.162
PAX					1.000

Table 16. Correlation Matrix for the Independent Variables

The closer a value in the correlation matrix is to 1 or -1 the more correlated are the two variables. Here we observe that COMP is highly correlated with most other variables. The higher the number of competitors in a market is, the higher the chance that one of the competitors will be an LCC. Also in hub markets it is more likely to observe fewer competing airlines.

Furthermore, *HUB* is correlated with *DIST* and *PAX*. The first relation might be explained by the fact that hubs are usually in the middle of the country hence on average hub markets will be shorter than non-hub markets. The second relation can be explained by the fact that airlines base their hubs in cities with high local traffic (or that local traffic is boosted by the strong presence of an airline in the area).

From the results of Table 16, it was decided to leave out of all regression models the variable *COMP* due to its high correlation with all other variables. Furthermore, as it will be shown later in some of the regression model s we will use only either *HUB* or *PAX* again due to the high correlation between the two variables.

6.2 Overall Yield Regression

The first regression model that was run tries to estimate the effect of factors upon yield irrespective of airlines. Hence, the data used includes all airlines and all markets in the database in 2006. The regression model to be estimated is as follows, and it excludes the variable *COMP* which was founded to be highly correlated with all the other explanatory variables:

$$YIELD = \alpha + \beta_{LCC} \cdot LCC + \beta_{HUB} \cdot HUB + \beta_{DIST} \cdot DIST + \beta_{PAX} \cdot PAX \qquad \text{Equation 6}$$

Table 17 shows the results for the linear regression on yield for 2006. The adjusted R^2 for this regression is 51.2% which means that a little more than half of variation of the yield is explained by the four explanatory variables but the other half is left unexplained by variables that are not included in the model and for which no data is provided.

	Coefficients	*Std Error*	*t Stat*
Intercept	36.6706	0.9281	39.5115
LCC	-8.9531	0.7150	-12.5220
HUB	1.4783	0.5993	2.4668
DIST	-0.0108	0.0004	-27.3731
PAX	-0.0008	0.0006	-1.4695
Adjusted R^2	0.5117		

Table 17: Overall Yield Regression Results

Looking at the estimates of the coefficients, we observe that in the 5% level only *PAX* is not significant and could thus be excluded from the model, since its t-stat is lower than the critical value of 1.96.

The most significant variable of the regression is distance (*DIST*). The negative coefficient means that the farther a passenger is carried (i.e. the longer the market) the less he will pay for a single mile of his trip. Of course this is expected since the fare of airlines doesn't increased linearly with distance and from theory developed on the airline industry[1] the longer the market distance the smaller the yield. Hence for any additional 100 miles the yield will decrease by 1 cent.

The next variable in terms of significance is the presence of a Low Cost Carrier (*LCC*). The presence of a single LCC is estimated by the regression to decrease the yield in the market by almost 9 cents. This is also an expected result since we have shown in both Chapter 4 and Chapter 5 that the appearance of LCCs in the industry has significantly reduced the average fares.

Finally, whether or not one of the cities in a market is a hub plays an important role in average yield of the market. If a market is a domestic hub market for a Legacy airline then the yield in the market is expected to increase by 1.5 cents. As we saw in Chapter 5 the average fare in the hub markets of the industry is higher than in the hub markets. Also, Legacy carriers still maintain a hub premium which increases the yield in these markets.

Literature, however, suggests that the relation between yield and distance is exponential and not linear as the above model suggested. Hence the original model was modified as follows, and the regressions were run on the same data:

$$YIELD = \alpha + \beta_{LCC} \cdot LCC + \beta_{HUB} \cdot HUB + \beta_{\ln(DIST)} \cdot \ln(DIST) + \beta_{PAX} \cdot PAX \qquad \text{Equation 7}$$

Table 18 shows the results for the new regression model. In order to compare the two models we use the F-test which tests the overall significance of a model. For the original the value of the F-test was 225.2 while for the modified model the value was 548.1. This means that even though both models are significant the modified model performs better than the original one.

	Coefficients	*Std Error*	*t Stat*
Intercept	115.7692	2.1990	52.6470
LCC	-7.5398	0.5416	-13.9217
HUB	2.4551	0.4540	5.4072
ln(DIST)	-13.6323	0.3104	-43.9199
PAX	-0.0015	0.0004	-3.5049
Adjusted R^2	0.7188		

Table 18: Overall Yield Regression Results for Modified Model

The modified model is able to explain almost 72% of the variation in yield as implied by the value of the adjusted R square. All four explanatory variables are significant in this model with a 95% confidence.

The coefficient of *ln(DIST)* can be explained as follows: a 1% increase in the distance will incur a 0.13 cent reduction in the yield, all else equal. *HUB* now gets a higher coefficient, which means that on average the yield at hub markets is expected to be 2.5 cents higher than in non-hub markets. *LCC* however in the modified model has smaller coefficient but still a negative sign, so the presence of an LCC in a market is expected to drop the average yield by 7.5 cents.

6.3 Yield Regressions per Airline

Based on the results from the previous section, here we perform yield regressions on each Legacy carrier separately in order to identify differences between the airlines on their dependency upon different factors and realize how these differences match our findings from Chapter 4 and Chapter 5. Hence, the model shown in Equation 7 will be used to run regressions on the data for each of the Legacy carriers at the markets out of the Top 1000 US domestic markets that they serve.

The set of tables shown in the next page presents the results for the six regressions run for each Legacy carrier.

Looking at the significance of the explanatory variables for each of the regressions, the first thing to point out is that NW's regression is the only whose all four explanatory variables are significantly different than zero with 95% confidence. On the other hand in the regressions of AA, CO, UA and US we can accept that both the HUB and PAX variable in this model do not provide any explanation for the variation of their yield, since for all four airlines the t-stat of these variables is below the critical value (1.96). Finally DL's regression model has only one variable—PAX—for which the null hypothesis that it's coefficient is zero can be accepted.

Again the most significant explanatory variable—for all six regression models—is *ln(DIST)*. US shows the largest sensitivity to distance, so for every 1% longer haul market its

yield is expected to reduce by 0.15 cents. Of course all six Legacy carriers have, as expected, an inversely proportional relationship between *YIELD* and *ln(DIST)*.

American Airlines	*Coefficients*	*Std Error*	*t Stat*
Intercept	132.0627	4.1715	31.6583
LCC	-4.0463	0.9694	-4.1741
HUB	-1.1157	0.9046	-1.2333
ln(DIST)	-15.8999	0.5611	-28.3382
PAX	-0.0030	0.0019	-1.5849
Adjusted R^2	0.7049		

Northwest	*Coefficients*	*Std Error*	*t Stat*
Intercept	114.6092	7.0851	16.1761
LCC	-2.9002	1.4051	-2.0641
HUB	6.3557	1.2858	4.9429
ln(DIST)	-13.8585	0.9496	-14.5934
PAX	-0.0113	0.0034	-3.3186
Adjusted R^2	0.7327		

Continental	*Coefficients*	*Std Error*	*t Stat*
Intercept	151.8459	7.9809	19.0262
LCC	-4.9635	1.5793	-3.1429
HUB	-1.4527	1.9043	-0.7628
ln(DIST)	-18.1836	1.0147	-17.9208
PAX	-0.0044	0.0033	-1.3245
Adjusted R^2	0.7089		

United Airlines	*Coefficients*	*Std Error*	*t Stat*
Intercept	127.1059	4.3580	29.1661
LCC	-5.3448	0.9872	-5.4142
HUB	-0.5627	0.8782	-0.6408
ln(DIST)	-14.9763	0.5859	-25.5630
PAX	-0.0024	0.0025	-0.9558
Adjusted R^2	0.6873		

Delta Air Lines	*Coefficients*	*Std Error*	*t Stat*
Intercept	129.5799	4.2351	30.5969
LCC	-7.2996	0.9541	-7.6505
HUB	3.2888	0.8748	3.7597
ln(DIST)	-15.3571	0.5652	-27.1711
PAX	-0.0013	0.0019	-0.6976
Adjusted R^2	0.7820		

US Airways	*Coefficients*	*Std Error*	*t Stat*
Intercept	157.2848	5.9138	26.5962
LCC	-3.8847	1.3671	-2.8415
HUB	0.4283	1.2813	0.3343
ln(DIST)	-19.6147	0.8439	-23.2427
PAX	-0.0006	0.0049	-0.1242
Adjusted R^2	0.7569		

Figure 31: Yield Regression Results for each of the Legacy Carriers

The fact that the coefficient of *HUB* can be assumed to be zero for four out of six Legacy carriers is a very important result. It means that for these four airlines—namely AA, CO, UA and US—a market that either originates (terminates) from (to) one of their hubs it will not incur a yield advantage over a market that doesn't include a hub, assuming that all other variables are equal between the two markets. Hence these Legacy carriers on average do not maintain a yield premium in their hub markets over their non-hub markets as it has been extensively suggested from the literature. On the other hand though, as it was shown in Section 5.3, Legacy carriers do maintain a strong yield premium compared to their competitors. One possible reason for this result from the regression is that on average hub markets are shorter than the non-hub markets (a

fact that also explains the substantial correlation between *HUB* and *DIST*) and thus the effect of *HUB* on *YIELD* might be partially captured by *ln(DIST)*. Another speculation for this result is that the high degree of correlation between *HUB* and *PAX* may reduce the t-statistics for both variables. However looking at the regression results for DL and NW it can be observed that a hub market is expected to produce higher yields for the airline than a non-hub market.

Finally, the yields of all Legacies are susceptible to the presence of an LCC in a market and are expected to have lower yields in markets where LCCs are present, as implied by the negative sign of the *LCC* coefficient. The most sensitive airline to LCC competition is DL which is expected to have 7 cents lower yield from markets with competition by LCCs. On the other hand NW's yield will only drop by 2.9 cents in a market with LCC competition.

Based on the results of these regressions it was decided to perform another set of regressions since for five airlines either *HUB* or *PAX* or both variables can be assumed to have no effect on *YIELD* with 95% confidence (AA, CO, DL, UA and US). Thus, we removed the PAX variable from the regression model in order to estimate what effect that will have on the HUB. Hence the modified regression model was:

$$YIELD = \alpha + \beta_{LCC} \cdot LCC + +\beta_{HUB} \cdot HUB + \beta_{\ln(DIST)} \cdot \ln(DIST) \qquad \text{Equation 8}$$

The regressions were run again on all six airlines for the sake of comparison and the following set of tables presents the results:

American Airlines				Northwest			
	Coefficients	*Std Error*	*t Stat*		*Coefficients*	*Std Error*	*t Stat*
Intercept	131.5692	4.1685	31.5627	Intercept	113.8660	7.3236	15.5478
LCC	-3.7514	0.9533	-3.9351	LCC	-3.5741	1.4378	-2.4858
HUB	-1.5686	0.8601	-1.8237	HUB	4.0792	1.1247	3.6268
ln(DIST)	-15.9070	0.5622	-28.2931	ln(DIST)	-13.7341	0.9813	-13.9953
Adjusted R^2	0.7037			Adjusted R^2	0.7141		

Continental				United Airlines			
	Coefficients	*Std Error*	*t Stat*		*Coefficients*	*Std Error*	*t Stat*
Intercept	154.0667	7.7672	19.8355	Intercept	126.9296	4.3535	29.1556
LCC	-5.0874	1.5763	-3.2275	LCC	-5.3989	0.9854	-5.4787
HUB	-2.5434	1.6713	-1.5218	HUB	-0.8321	0.8316	-1.0005
ln(DIST)	-18.4859	0.9860	-18.7487	ln(DIST)	-14.9709	0.5858	-25.5583
Adjusted R^2	0.7079			Adjusted R^2	0.6874		

Delta Air Lines				US Airways			
	Coefficients	*Std Error*	*t Stat*		*Coefficients*	*Std Error*	*t Stat*
Intercept	129.2496	4.2048	30.7384	Intercept	157.0396	5.5604	28.2423
LCC	-7.3626	0.9490	-7.7581	LCC	-3.9007	1.3576	-2.8732
HUB	3.1028	0.8324	3.7277	HUB	0.3525	1.1239	0.3137
ln(DIST)	-15.3187	0.5620	-27.2566	ln(DIST)	-19.5824	0.8009	-24.4509
Adjusted R^2	0.7823			Adjusted R^2	0.7581		

Figure 32: Yield Regression Results for AA, CO, DL, UA and US for the modified regression model of Equation 6.

Looking at Figure 32 one can observe that only for DL and NW all three variables of their regression models are statistically significant at the 5% significance level. For DL *ln(DIST)* is again the most significant variable, followed by *LCC* and finally by HUB. It may also be observed that the adjusted R^2 of the new model is only slightly improved for the regression models of DL, UA and US from the previous model (Equation 7, Figure 31) but not for CO, AA and as expected for NW.

The most important observation is that the removal of the PAX variable didn't improve the significance of the HUB variable for DL and US since the t-statistic for these variables fell, while for the AA, CO and UA airlines although it increased it still remained insignificant at the 5% level. The regression for AA now has the HUB variable significant at the 10% level. Furthermore, there are three airlines for which the sign of the HUB coefficient is negative, which is a very counterintuitive result—especially when combined with the results from section 5.3 on Hub Markets—since we expect the yield generated by Legacy carriers in their hub markets to be higher than in their non-hub markets. Hence it was decided to accept the null hypothesis that the

HUB variable has no effect on YIELD for AA, CO, UA and US and thus remove it from the respective regression models.

The final set of regressions that was performed on all six Legacy carriers, again for the sake of comparison, uses the following model:

$$YIELD = \alpha + \beta_{LCC} \cdot LCC + \beta_{\ln(DIST)} \cdot \ln(DIST) \qquad \text{Equation 9}$$

The results are summarized in the following set of tables, ***Figure 33***:

American Airlines			
	Coefficients	*Std Error*	*t Stat*
Intercept	128.7185	3.8766	33.2039
LCC	-3.9002	0.9529	-4.0932
ln(DIST)	-15.5584	0.5304	-29.3326
Adjusted R^2	0.7018		

Northwest			
	Coefficients	*Std Error*	*t Stat*
Intercept	128.9706	6.2716	20.5643
LCC	-3.5387	1.4968	-2.3641
ln(DIST)	-15.5838	0.8728	-17.8544
Adjusted R^2	0.6901		

Continental			
	Coefficients	*Std Error*	*t Stat*
Intercept	146.8201	6.1591	23.8379
LCC	-4.8537	1.5746	-3.0825
ln(DIST)	-17.7411	0.8591	-20.6499
Adjusted R^2	0.7058		

United Airlines			
	Coefficients	*Std Error*	*t Stat*
Intercept	125.2467	4.0155	31.1910
LCC	-5.4195	0.9852	-5.5009
ln(DIST)	-14.7826	0.5547	-26.6501
Adjusted R^2	0.6874		

Delta Air Lines			
	Coefficients	*Std Error*	*t Stat*
Intercept	136.5154	3.8069	35.8602
LCC	-7.9890	0.9543	-8.3711
ln(DIST)	-16.1379	0.5285	-30.5333
Adjusted R^2	0.7728		

US Airways			
	Coefficients	*Std Error*	*t Stat*
Intercept	157.2857	5.4922	28.6380
LCC	-3.9333	1.3505	-2.9123
ln(DIST)	-19.5978	0.7976	-24.5723
Adjusted R^2	0.7592		

Figure 33: Yield Regression Results for AA, CO, UA and US for the modified regression model of Equation 7.

Observing the results it is evident that all variables in the regressions of all six carriers are now significant at the 0.05 level. However we shall perform an F-test in order to test if this model should be selected over the model of Equation 8 for each of the four airlines that HUB was an insignificant variable in the model of Equation 8. The model of Equation 8 is the unrestricted model while the model of Equation 9 is restricted since we impose the restriction that the coefficient of the HUB variable is equal to zero.

The corresponding formula is:

$$F_{q,N-K} = \frac{(R_{UR}^2 - R_R^2)/q}{(1 - R_{UR}^2)/(N-K)}$$

where q is the number of restrictions, N is the number of observations, K is the number of parameters—so that N-K are the degrees of freedom—and the subscripts UR and R stand for the unrestricted and the restricted model respectively. If the F statistic is greater than the critical value of the F distribution at the 0.05 significance level we shall reject the null hypothesis that the restrictions are true and hence accept the unrestricted model.

From F-distribution tables, the critical F for more than 200 degrees of freedom, 1 restriction and 0.05 level of significance, is 253. The values of the F-statistic are 3.3, 2.3, 1.0 and 0.1 for the regressions of AA, CO, UA and US respectively. Hence, we should prefer the restricted model (Equation 9) over the unrestricted model for these four airlines.

Hence based on the data analyzed in this thesis and probably due to the large collinearity between HUB and DIST a hub market is found to have no effect for four out of six Legacy carriers. Also, from the results shown on Figure 33, we can observe that UA's yield is most susceptible to LCC presence than AA, CO and US. Finally, it is important to note that for NW the best model is the one given by Equation 7, for DL by Equation 8, and for the other four Legacy carriers the model given by Equation 9.

6.4 Summary

In this final Chapter of this Thesis we performed a regression analysis on the yields of airlines in the Top 1000 US Domestic markets in order to test how different parameters (number of effective competitors, hub markets, LCC presence, average haul and demand) affect the yields both across all airlines and for each Legacy airline separately. The different regressions showed that:

- Overall the five parameters, whose influence on yields were tested, explain more than 70%

of the variation of yields in the top US domestic markets both on aggregate (across all airlines) and for each Legacy carrier separately.

- Yield is exponentially related to distance. Hence the longer the market the smaller (exponentially) will be the yield of airlines. Also the haul of a market is the parameter that influences the most the yield of airlines in that market.

- The presence of an LCC in a market plays, also, a very important role in decreasing yield. However, each Legacy carrier is affected differently by LCC competition. So for example the yields of DL and UA show the largest vulnerability on LCC competition, while NW the smallest.

- The effect of the hub as one of the two airports in a market affects only the yields of NW and DL, who as expected show higher yields in their hub markets than in their non-hub markets. Hub markets do not significantly affect the yields of the other Legacy carriers.

- The level of demand at a market does little in explaining a change in yield in a market since on average every additional 1000 passengers there is approximately a 1 cent decrease in yield.

Overall, the analysis performed in this Chapter comes as a supplement to the yield premium analyses and market segmentations that were presented in Chapter 4 and Chapter 5. It helped us better understand how yields are affected by the parameters based on which we segmented the market sample and performed the analysis on yield premiums for each of the Legacy carriers in the US.

Chapter 7
Summary of Findings and Future Research

7.1 Summary of Findings

In this Thesis we have shown how the yields and fares of Legacy Carriers and LCCs have changed during the downturn period of the airline Industry from 2000 to 2006 and most importantly how the yield premiums of the airlines have changed due to the fierce competition and financial instability of many airlines. In Chapter 1 we introduced the scope of this Thesis with a set of questions that we ultimately wanted to answer. After performing and presenting the research and analysis in Chapters 4, 5 and 6 we can now respond to all these questions in order to summarize our findings:

- *Is there any evidence of convergence between the average fare of LCCs and Legacy carriers from 2000 to 2006?*

The average fare gap between Legacy carriers and LCCs that existed in 2000 was shrinking until 2005 (from $80 to $50) both because Legacies tried to match the fares of LCCs in order to remain competitive, and because the average fares of LCCs have been increasing as their networks expanded to include longer haul markets. Soaring fuel prices have led to increasing average fares since 2005 for both types of carriers and a slight increase in the fare gap between Legacies and LCCs. Furthermore, traffic and revenue losses of Legacy carriers combined with the rapid expansion of LCCs have mitigated the market share difference and revenue difference between Legacy and LCC carriers.

- *Which airlines have a yield premium in the Top US domestic markets? Are the Legacy carriers able to maintain a yield premium?*

Continental has the strongest yield premium in the Top US Domestic Markets and together with American, Northwest and United have consistently shown a yield premium in the markets they serve. On the other hand DL and US, on average, did not maintain a yield premium between 2000 and 2006, which means that on average they collected lower fares than their competitors. The latter two have faced very strong financial instability during the recent downturn and were forced out of many of the Top US Domestic Markets. Finally, all LCCs receive at least 5% lower fares on average than the competition in the Top US Domestic Markets.

- *How is the average fare in a market affected by the presence of Low Cost Carriers and how does this presence affect the yield premium of Legacy Carriers?*

Although the average fare at markets served primarily by Legacy airlines is much higher than that at markets with significant LCC presence, the gap has been steadily closing until 2005—from $81 in 2000 down to $45 in 2005 but up to $59 in 2006. All Legacies were collecting higher than average fares at markets in which they compete with LCCs but that premium tends to fall over the years for most carriers. In markets where Legacies primarily compete with each other only Delta consistently generates yields lower than the average—another sign of Delta's financial weakness.

- *Are there any differences revenues and traffic between markets with significant LCC presence and those with minimal presence for each of the major Legacy carriers?*

Only American and Continental were able to increase their market share at markets with significant LCC presence and all Legacy carriers, except Continental, have lost their 2000 revenue share by being forced to apply lower fares in order to regain some of the traffic lost during the peak of the crisis. From the fierce competition between Legacy carriers, at markets where Legacy carriers compete primarily with each other, again only DL and US have lost market share—by losing almost half of their market share in 7 years.

- *How do Legacy carriers perform in terms of fares, revenues and traffic in their hub markets?*

The financial crisis of Legacy carriers has not left unaffected their performance in hub markets. Although the average fare in hub markets has been higher than in non-hub markets for most years, by 2006 the gap has vanished. Three Legacy carriers (Delta, Northwest and US) have lost a great portion of their market share due to the large LCC intrusion in their hub markets but American, Continental and United were able to increase their market share. The total revenues generated by the Legacies in their hub markets have dropped in almost all hubs, which comes as a result of either reduced traffic or reduced average fares or—as in many hubs—both.

- *Do Legacy carriers have a yield premium at their hub markets?*

All Legacy carriers were able to maintain a yield premium in their hub markets. However, this premium has been declining during the airline industry crisis for most hubs but for some of them has recovered since 2005. We also noticed that the Yield Index of Legacy carriers in their hub markets is much larger than that in their set of non-hub markets; although Legacies collect higher fares than the average in their hub markets they receive lower fares in all other markets with the exception of UA, which receives higher than average fares in all sets of markets. Again we noticed that US and Delta have the lowest yield premiums over time in all the hubs they operate. American experienced the largest fall in hub premium in both Chicago and Dallas/Fort Worth, while Continental and United in Newark and Denver respectively operate with the highest premium observed.

- *How much has the number of competitors in the Top US markets changed and what portion of it does it come from Low Cost Carriers?*

The average number of effective competitors[34] per market has dropped by 8.2% in the Top US Domestic markets, so from more than 3 competitors per market in 2000, there were on

[34] Effective competitor defined as a carrier that holds at least 5% of the market share in a single market.

average less than 3 competitors per market in 2006. This is a result of the financial distress of many airlines that forced them to withdraw from many markets—like Delta that moved out of 150 markets in 7 years—or entirely shut down. Hence in 2006 there were more monopoly and duopoly markets than in 2000. Out of the Legacy carrier group only Delta and US show the average number of effective competitors to increase from 2000 to 2006. However the exposure of Legacy carriers to LCCs has increased so that on average more than 1/3 of the competition comes from LCCs in 2006.

- *How much competition do Legacy carriers face in their hub markets? Is it lower or higher than in the non-hub markets? How much have the LCCs intruded the major US domestic hubs?*

The mean number of effective competitors in hub markets is much lower than in the non-hub markets and has also decreased for most Legacy carriers from 2000 to 2006. Again, the largest portion of competitors that a Legacy carrier faces in its hub markets comes from other Legacy carriers—a number though that dropped over the years. Furthermore LCCs have penetrated Legacies' hub markets so that the number of LCC competitors that a Legacy carrier faces at its hub markets has increased to almost 1 competitor per hub market.

- *How is the yield premium of airlines affected by the number of competitors in a market?*

The number of competitors that an airline has to face greatly affects its Yield Index. For example Delta and US collected lower fares than their competitors in markets with three or more competitors, very close to average at markets with two competitors and only achieved a significant yield premium at markets with just one competitor (duopoly markets). On the other hand CO and UA stand out as the airlines that have the highest Yield Index, especially at markets where they compete against 3 or more airlines.

- *How does the combination of all these factors (stage length, traffic, hubs, LCC presence and amount of competition) affect the average fare or yield in a market and more specifically how does it affect each of the Legacy carriers separately?*

We performed an econometric analysis in order to evaluate the relationship between yield and certain parameters. Overall the five parameters, whose influence on yields was tested, explain more than 70% of the variation of yields in the top US domestic markets. Yield is exponentially related to market distance which is the parameter that influences the most the yield of airlines.

The presence of an LCC in a market also plays a very important role in decreasing the yield. However, each Legacy carrier is affected differently by LCC competition. The presence of a hub as one of the two airports in a market affects the average yield in that market and as expected yield is higher in hub markets than in non-hub markets.

7.2 Conclusions and Future Research

Based on 2006 and 2007 reports most Legacy carriers were able to recover from the crisis and return to profitable operations. Legacy carriers were able to financially recover from the increased LCC competition but with a significant reduction in the exposure to other competing Legacy carriers a fact that may imply that one of the major reasons for their financial downturn was the fierce competition between them. Furthermore, based on the analysis that was performed in this Thesis, Legacies seem to rely on their hub operations were the competition is lower and the hub-carriers are able to hold a strong yield premium. Furthermore, it was evident throughout the analysis that the most financially distressed airlines, like Delta and US, were the ones that held the lowest yield premiums. A possible explanation for this fact is the protection offered from Chapter 11 that lowers the airlines costs and enables them to apply lower fares.

Overall, we have observed a large convergence between the average fares collected by Legacy carriers and LCCs as well as in their respective market shares and traffic. However the network structures of these two types of carriers still remain distinct since as mentioned earlier Legacy carriers did, and probably will continue to, rely on their hub operations which offer them a significant competitive advantage. It will thus be very interesting to continue this research on the same track to identify if the airline industry will reach equilibrium where these two types of carriers will both operate profitably but still with the different business structures. That will require a combinatory study on the revenue and cost and productivity side of airlines.

The airline industry is highly cyclical and unstable. Hence this research should be conducted periodically in order to realize how different incidents affect both the carriers and the travelers. In the years to come many important changes might occur that will affect in a great way the performance of US carriers and the environment of the airline industry. Mergers between Legacy carriers, like the merger talks of Delta-Northwest and US-United, and between Legacies

and LCCs—like the merger of US with America West—might lead to a different competitive environment with fewer but larger airlines and smaller competition. Also new agreements between countries, like the Open Skies agreement, might bring new strong competitors in the US domestic markets. It will thus be very interesting to investigate further how these changes will affect the fares and the wellbeing of the competing airlines and how the yield premiums will change.

During the past few years Low Cost Carriers have started operating through hubs; like AirTran in Atlanta and JetBlue in New York. During this thesis we noticed that the average fares of LCCs grew since 2000. There are then a few questions raised: Are LCCs network structures converging towards Legacy carriers? Is it just the fares of Legacies that converge towards LCCs or are the fares of LCCs and Legacies converging towards a mediate state, an equilibrium? How will the pricing of LCCs change as their fleets become older and the point-to-point service is fully exploited? Further analysis, as the one performed in Section 5.3 for the hub markets of Legacy carriers, should also be performed for LCCs that operate through hubs in order to identify the differences and similarities between Legacy and LCC hub operations.

As already discussed in Chapter 3, an important limitation in our analysis was that the database did not separate between leisure and business passengers. Having this kind of data available will allow a more detailed analysis on yield and hub premiums and identify different trends in the for air travel for different types of passengers. It is often suggested that one of the reasons that Legacy carriers maintain a hub premium is that they attract many business passengers at their hub markets, which are willing to pay more for air travel. Hence it will be very interesting to observe what are the trends of business travel in hub markets and how much of it has been captured by LCCs.

The regression analysis that was performed in this Thesis should not be used as the basis for forecasting fares or yields in the US airline industry. A more extensive econometric analysis may be performed that might help forecast changes in fares and traffic demand by introducing into the models many more attributes of air travel (such as quality of service and delays) and characteristics of travelers (like income and segregation between business and leisure travelers).

Appendix I: Airline Market Participation

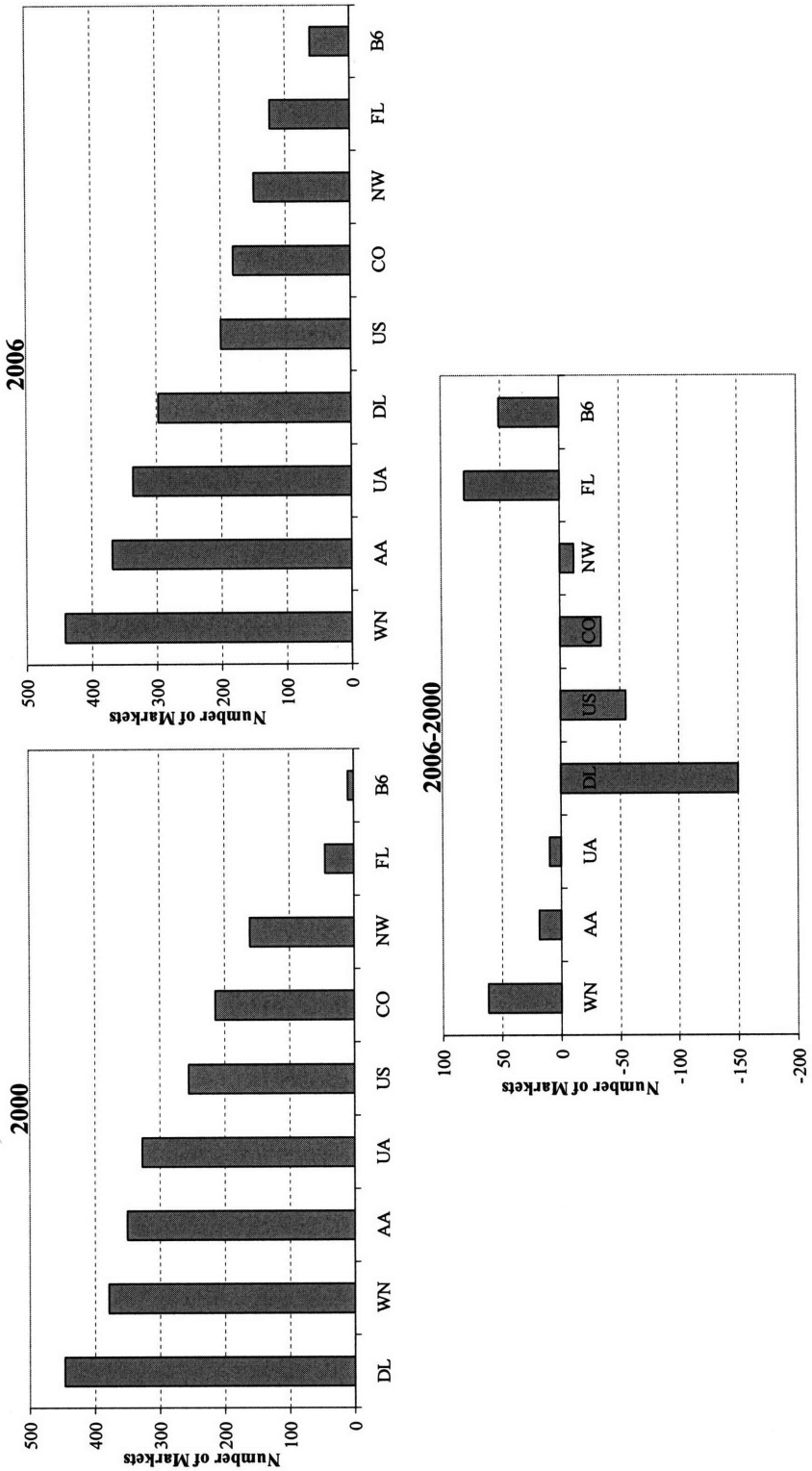

Figure 34: Number of Markets Served by Major Airlines in 2000 and 2006 and the Absolute Change between the Two Years

Appendix II: Competition Analysis in the Hubs

		Competition by LCC			Competition By Legacy Carriers		
		2000	*2006*	*% Change*	*2000*	*2006*	*% Change*
AA	*Dallas/ Fort Worth*	0.68	0.87	28.6%	1.32	0.56	-57.3%
	Chicago O'Hare	1.19	1.09	-8.7%	1.36	1.22	-9.9%
	Avg Hubs	0.92	0.98	6.8%	1.34	0.89	-33.2%
CO	*New York*	0.41	0.74	78.6%	2.60	2.22	-14.7%
	Cleveland	0.57	1.48	158.3%	1.33	0.00	-100.0%
	Houston	1.04	1.06	1.9%	0.86	0.35	-59.1%
	Avg Hubs	0.67	0.97	44.5%	1.76	1.19	-32.3%
DL	*Cincinnati*	0.00	0.00	0.0%	0.93	0.93	0.0%
	Atlanta	0.63	0.91	45.7%	0.86	0.61	-29.2%
	Salt Lake City	0.74	1.04	40.0%	0.96	0.70	-26.9%
	Avg Hubs	0.57	0.81	43.7%	0.90	0.68	-23.9%
NW	*Memphis*	0.57	0.86	50.0%	1.86	1.86	0.0%
	Detroit	0.88	1.19	35.7%	0.97	1.09	12.9%
	Minneapolis/ St. Paul	0.75	0.94	25.9%	1.14	1.11	-2.4%
	Avg Hubs	0.79	1.04	32.4%	1.14	1.17	3.3%
UA	*Washington DC*	0.19	0.42	117.6%	2.18	1.92	-12.0%
	Chicago O'Hare	1.19	1.09	-8.7%	1.36	1.22	-9.9%
	Denver	0.76	1.28	68.6%	1.82	0.89	-50.9%
	Avg Hubs	0.84	0.96	14.2%	1.68	1.32	-21.7%
US	*Charlotte*	0.00	0.61	-	1.56	1.83	17.9%
	Pittsburgh	0.22	1.00	350.0%	1.67	1.56	-6.7%
	Philadelphia	0.36	0.85	133.3%	1.30	1.30	0.0%
	Avg Hubs	0.23	0.83	256.3%	1.46	1.51	3.0%

Figure 35: Mean Number of Effective Competitors in the Hub Markets of each Legacy Carrier Broken Down by Hub and by Type of Competing Airline for 2000 and 2006.

Appendix III: Segmentation of Sample Markets by the Length of Haul

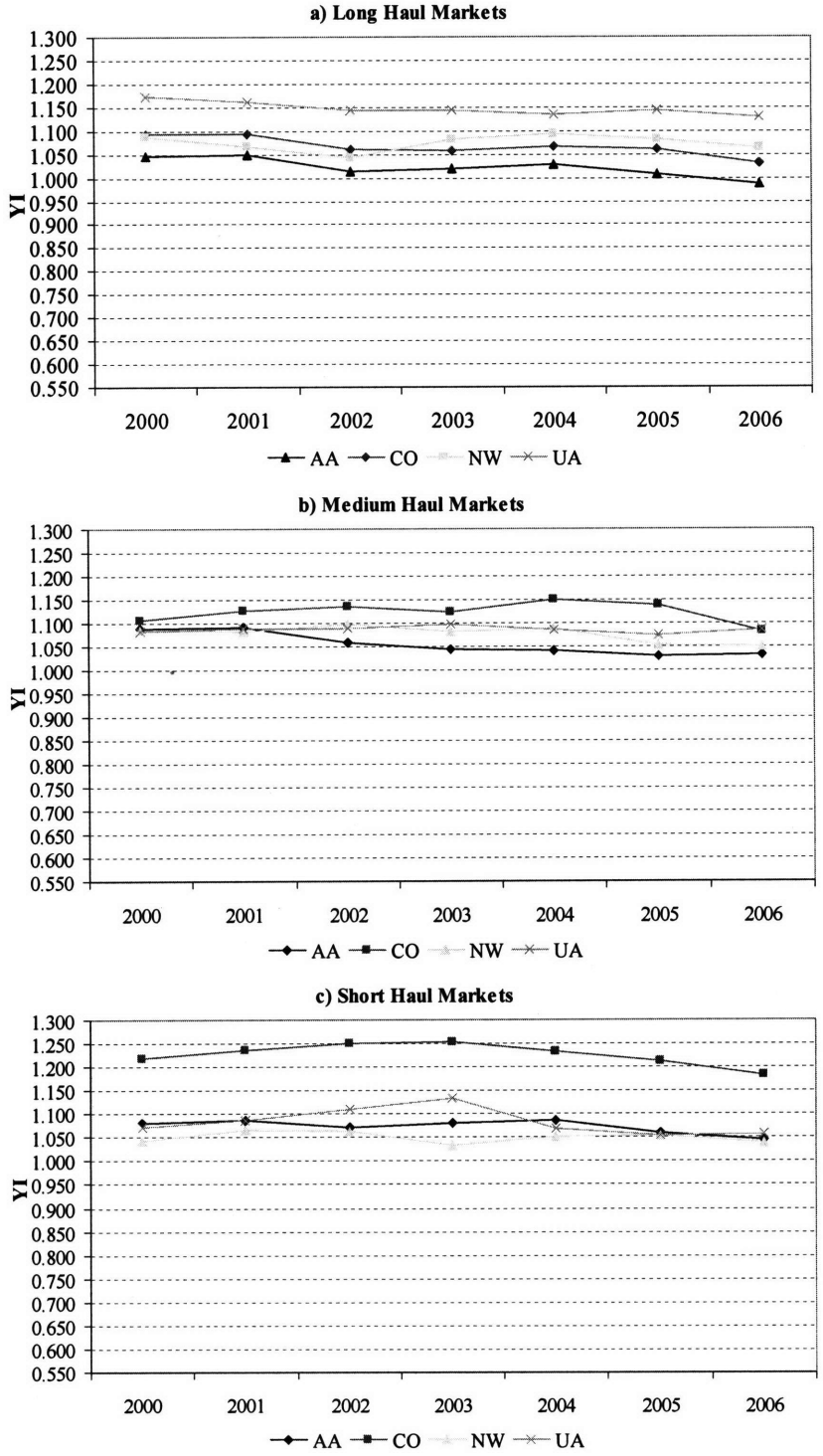

Figure 36: Time Series of the Average Weighted Yield Index for AA, CO, NW and UA at a) Long Haul, b) Medium Haul and c) Short Haul Sample Markets.

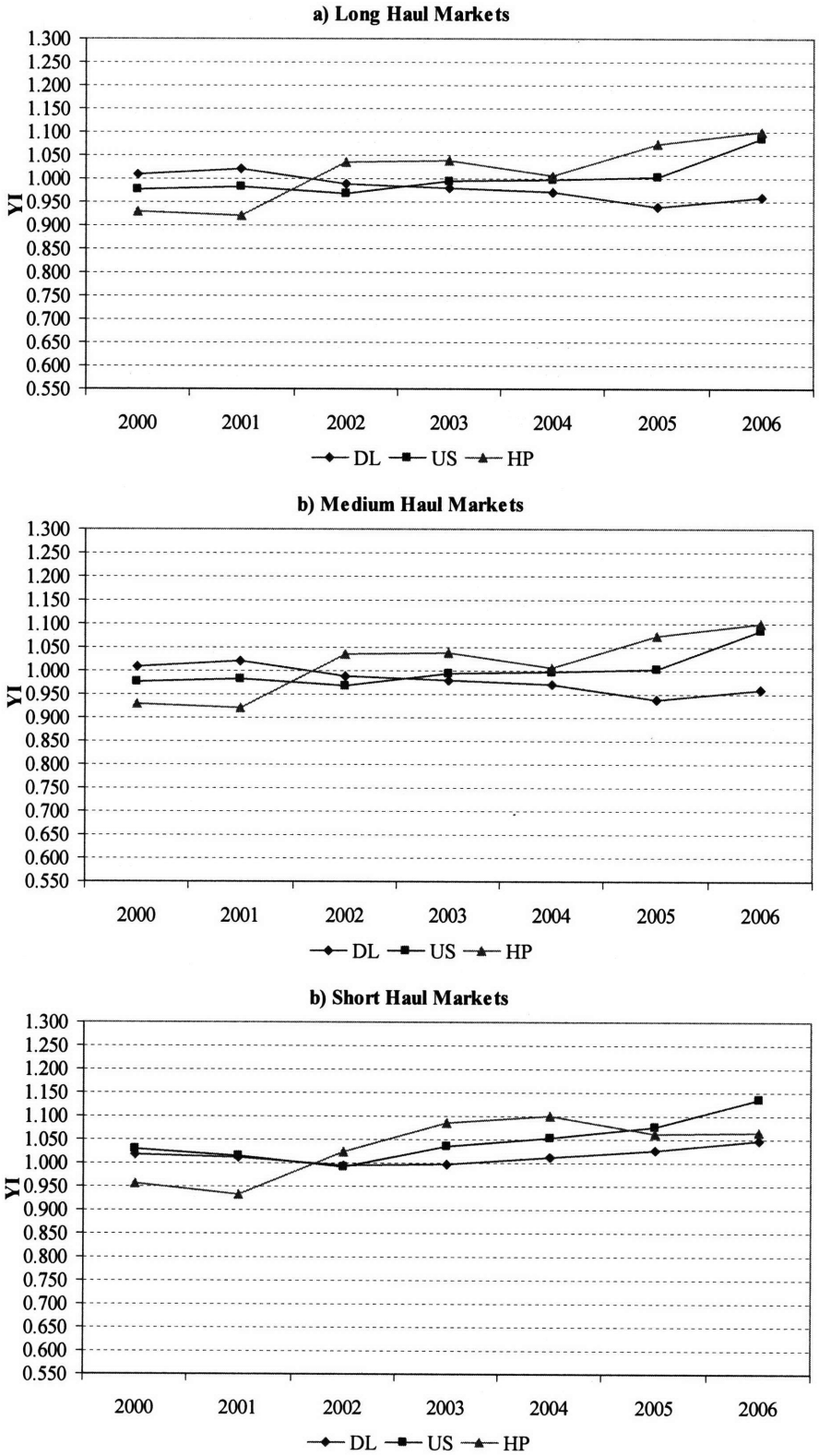

Figure 37: Time Series of the Average Weighted Yield Index for DL, US and HP at a) Long Haul, b) Medium Haul and c) Short Haul Sample Markets.

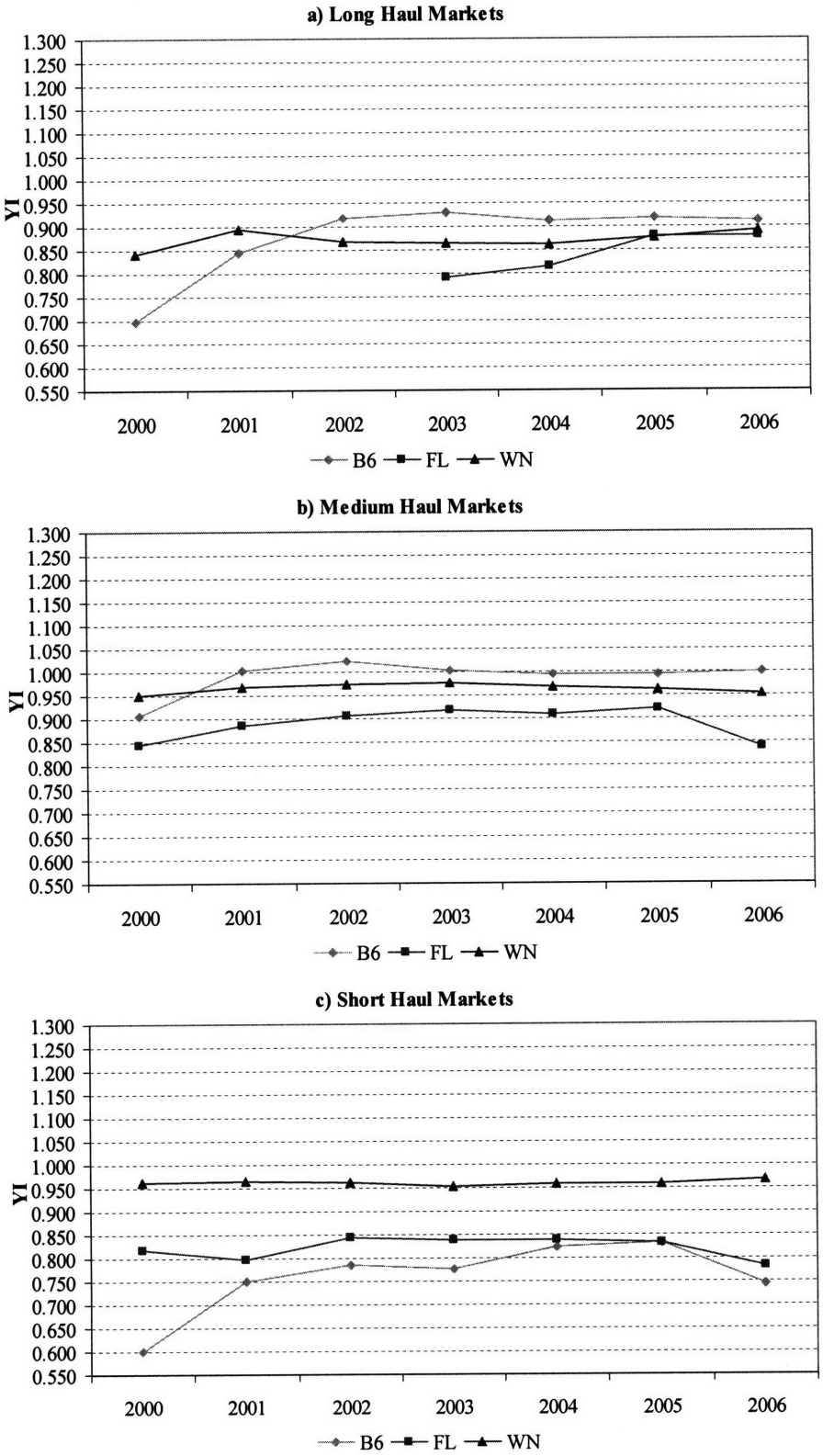

Figure 38: Time Series of the Average Weighted Yield Index for B6, FL and WN at a) Long Haul, b) Medium Haul and c) Short Haul Sample Markets.

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