Evolution of Domestic Traffic and Fares at the Top 200 US Airports between 1990 and 2008

by

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Abstract

The main objective of this thesis is to analyze the evolution of domestic Origin-Destination (O-D) traffic and fares at the Top 200 airports in the United States between 1990 and 2008. The impetus behind this research is to shed light on the differences in trends between the largest and smallest, primary and secondary, hub and non-hub airports, and to measure the impact of Low Cost carriers (LCC) on traffic, fares and competition. Furthermore, case studies of five multi-airport systems located within major US metropolitan areas were performed to identify the trends shaping multi-airport systems.

We find that domestic O-D passenger traffic at the Top 200 commercial airports in the United States increased by more than 52% between 1990 and 2005, but dropped by 2% from 2005 to 2008 because of the global economic downturn. Average fares at the Top 200 airports increased by 14% during the "golden 90s", decreased by 13% between 2000 and 2005, but rebounded by 16% between 2005 and 2008, as a result of soaring jet fuel prices and reduced capacity.

Low Cost carriers' share of the total domestic O-D traffic in the US is still growing, although leveling off, reaching 34% in 2008. LCC entry focused initially on largest airports, then grew rapidly in second and third airport tiers. As a result, in 2008, 95 of the Top 200 airports had an LCC aggregated market share greater than 20%, up from 27 airports in 1990. We show that LCC's effective entrance or substantial growth at a particular airport had a significant impact lowering average fares and stimulating passenger volumes. However in recent years, this market stimulation effect has been leveling off, as the gap in average fares between LCC and Network Legacy carriers (NLC) has narrowed.

Secondary airports played a critical role in accommodating the increase in demand for air traffic in the nation's largest metropolitan areas: They served 19.8% of the total domestic O-D passenger traffic in the 15 studied multi-airport systems in 2008, compared to 16.9% in 1990, highlighting their increasing importance. Finally, the airport concentration levels, as measured by the average weighted Herfindahl-Hirschman Index, increased by 8% during the studied period, demonstrating that the Top 200-airport sample is more concentrated in 2008 compared to 1990.

Thesis Supervisor: Peter P. Belobaba
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Chapter 1
Introduction

1.1 Recent Trends in the US Airline Industry

Since 2000, the US airline industry has gone through a severe crisis caused by the fierce competition among legacy airlines initialized with the industry deregulation in 1978, the 9/11 terrorist attacks, soaring jet fuel prices, the global recession and, most importantly, the unrelenting and rapid expansion of the low-cost carriers.

The largest US commercial air carriers can be segmented into two distinct categories: Network Legacy carriers (NLC) and new entrant Low Cost carriers (LCC). The first group operates vast hub-and-spoke networks using feeders to consolidate their domestic and international operations at their hubs. They offer mainly full-service, multiple cabin flights that generate higher average fares per passenger. The second group offers lower fares, no-frills services operating essentially point-to-point networks.

According to a 2008 Federal Aviation Administration study, commercial aviation contributes $692 billion a year to U.S. GDP which represents 5.2% of U.S. gross domestic product. Furthermore, commercial aviation generates more $1.142 trillion in annual economic activity and has a tremendous impact on U.S. employment totaling 10.2 million jobs[1].

The US airline industry has always been characterized by a cyclic profitability pattern. Since deregulation in the US and liberalization worldwide, the profitability's ten-to-eleven-year period cycle amplified, started resonating, and led to an exponential growth in volatility. Several reasons can explain the deterioration in the airlines profitability:

- The historically low profit margins of the airlines increase the volatility of their bottom lines under uncertainty. In fact, the airline industry's highest profit margins fluctuated between 4.3% and 4.7% for the period 1997-1999. In 2000, the average return on revenue was down to 1.9%. This low profit margin highlights the fact that US carriers are struggling to generate sustainable profits. It also explains the vulnerability of airlines earnings to non-aviation related factors.

- The fierce competition between legacy carriers started with domestic deregulation in 1978. Legacy carriers started competing not only over quality of service but also over routes, frequency shares and offering lower fares.

- The rapid expansion of the LCC, which have expanded low fares beyond the usual low-yield, leisure traveler circle, exacerbated the competition.

- Soaring jet fuel prices greatly contributed to the bad shape of the industry's finances in 2008. The price of a barrel of crude oil fluctuated between $145.29 and $33.87 in just 118 days of trading. If we add to that some jet fuel hedging losses posted by some US carriers, we understand that "the Industry's already largest cost center also became its most volatile with a 235 percent fluctuation in the span of a year"[2].

[1] Federal Aviation Administration, "The Economic Impact of Civil Aviation on the U.S. Economy", October 2008
[2] ATA, 2008 Economic Report, p. 9.

- The 9/11 terrorist attacks, the SARS epidemic, the Iraq and Afghanistan wars and more recently the H1N1 influenza changed the consumers' perception of air travel. Security hassles and threat of terrorism were deeply associated with the image of air travel in the general consciousness, hurting primarily short-haul traffic.

- The price of air travel has been steadily decreasing compared to other goods and services such as hotels for example. Domestic air travel spending used to represent 0.74% of the U.S. GDP. But in this decade, spending on domestic air travel has plunged to just 0.57% of GDP. *"If Americans' spending on travel in 2008 had been at the traditional ratio of 0.74% of GDP, U.S. carriers would have taken in an extra $27 billion in revenue last year"*[3]. This evidence suggests a reduced willingness-to-pay of consumers as the intrinsic value of air travel diminishes compared to other commodities.

- Finally, the capacity growth which has surpassed the demand growth led to an unbalanced system. This over-capacity of the system rapidly narrowed in the aftermath of the 9/11 attacks when legacy carriers started pulling out capacity by retiring some of their old aircrafts and grounding others. As a result, an industry-wide trend emerged in which the average load factor has steadily increased since 2002. According to the US Bureau of Transportation Statistics[4], airlines based in the US recorded an unprecedented peak in load factor in 2008 as US carriers' load factors reached 79.5% in comparison to only 71.6% in 2002 (see Figure 1). In hard financial times, US carriers can no longer afford to fly their aircraft half-full, and hence have steadily increased capacity utilization by flying fewer seats.

[3] Reed, D., *"Low-cost airlines grab 30% of travel market vs. full-price rivals"*, USA Today, 11/10/2009
[4] http://www.bts.gov/publications/key_transportation_indicators/october_2009/html/us_airline_load_factor.html

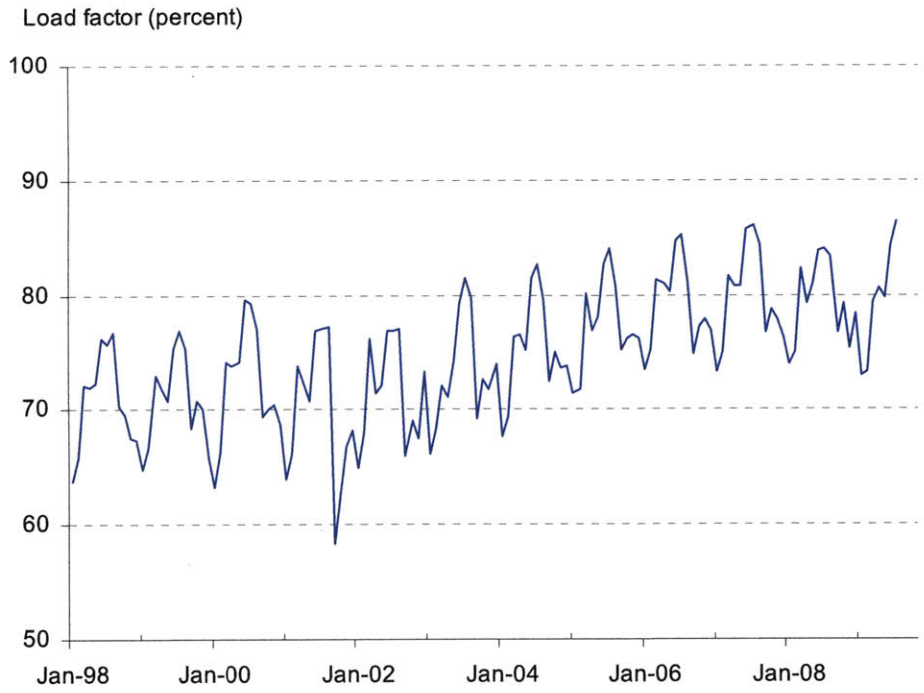

Figure 1: U.S. Airline Load Factor, Monthly data, not seasonally adjusted Data [Source: US Bureau of Transportation Statistics]

The period 2001-2008 can be decomposed into three distinct periods. First from 2001 to 2005, bankruptcy actions by US Airways, United Airlines, Delta Air Lines and Northwest Airlines, as well as the restructuring initiated by American Airlines and Continental, enabled NLC to realize dramatic progress in cost cutting and productivity improvement. Labor and distribution costs saw biggest reductions due to employees lay off, cuts in wages and salaries, re-negotiation of work rules and use of IT for passenger processing. These restructuring measures led to a convergence in unit cost between NLC and LCC. As a result of this competitive environment, Legacy carriers were obliged to match the new entrants LCC fares. This caused the average air fare in the US to drop significantly between 2000 and 2005, reducing even more the industry's historically very low margins. The second period was an upcycle between 2006 and 2007. During this period the total industry revenues rebounded to 2000 levels, revenue passenger miles and average fares went up. During these two years, US carriers took a breath and were able to generate cumulative profit of $25.9 billion, as shown in Figure 2. Unfortunately, this sum was insufficient to offset the $27.2 billion posted in net losses just for the 2005 fiscal year. In 2008, the airlines had to deal not only with an unprecedented fuel-price spike, but also with the global

financial meltdown. As a result, the airlines experienced revenue shortages on the most profitable markets and the yields collapsed due to business demand decreases.

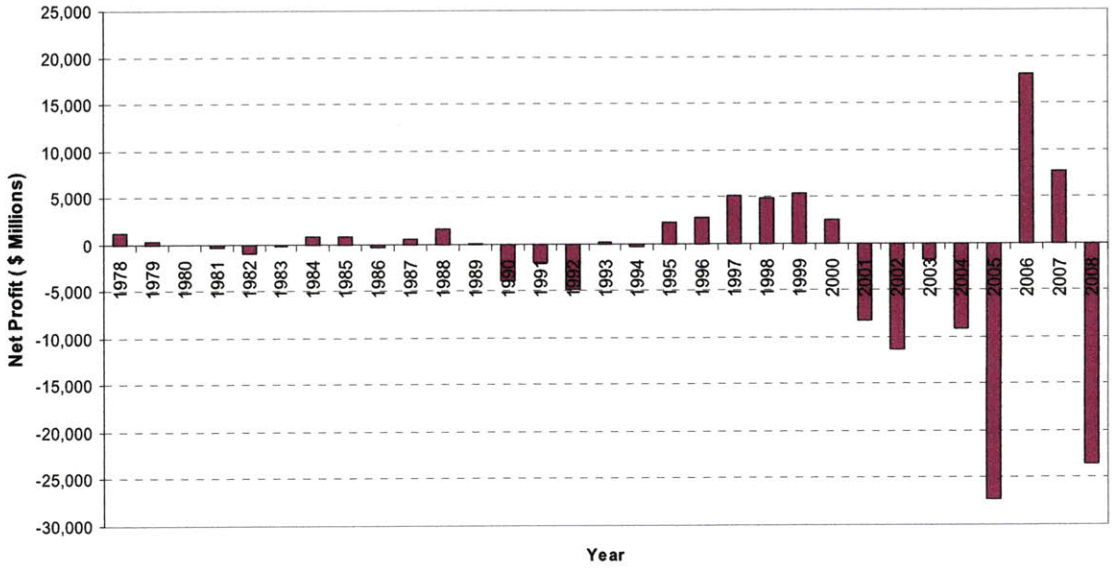

Figure 2: U.S. Airlines Net Profit since Deregulation
[Source: ATA, "Annual Earnings: U.S. Passenger and Cargo Airlines"]

In fact, the drop in yield is an unrelenting trend that started with the US airline industry deregulation in 1978. As often with economic deregulation, airlines used the freedom to choose routes, frequencies, and prices to compete fiercely with other carriers in order to gain both traffic and revenue market shares, and this without government control. Thus, it is interesting to observe that the race to lower fares started between the Legacy carriers themselves well before the broad penetration of the LCC. The rise of the Internet, which reshaped the air travel's distribution channels structure and enhanced price transparency, has certainly contributed to the yield decline shown in Figure 3.

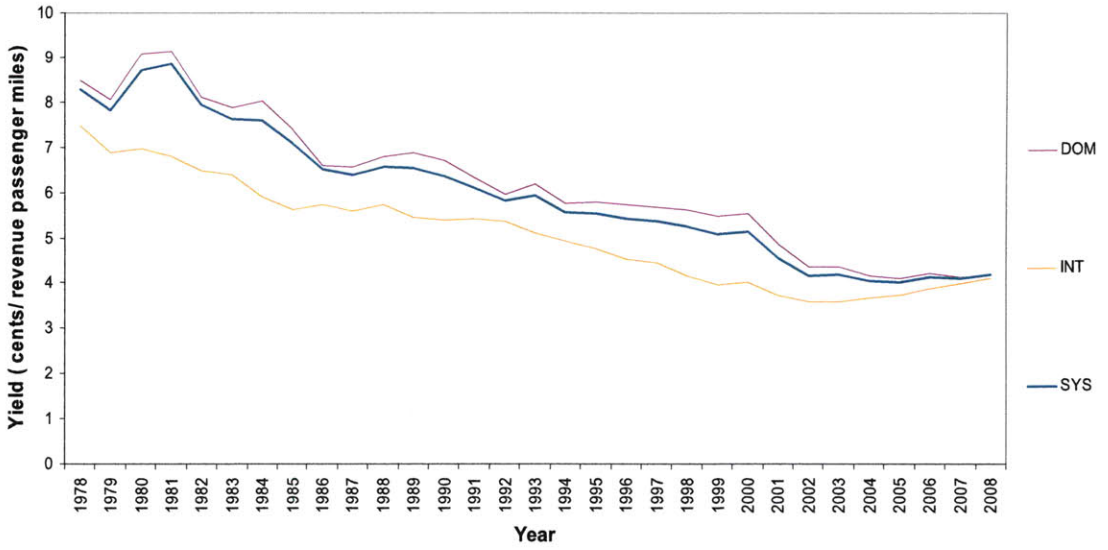

Figure 3: Trend in U.S. Airlines Domestic, International and System Yield since Deregulation, in 1978 cents
[Source: ATA, "Annual Passenger Yields: U.S. Airlines"]

At the other end of the spectrum, Low Cost carriers like Southwest, JetBlue and AirTran have been very successful implementing their point-to-point, no-frills business model. Those carriers have bet on direct access to the end customer's desktop via early Internet distribution channel (Southwest led the way with the first airline web site—southwest.com) as opposed to the usual global distribution system (GDS) adopted by all of the Legacy carriers. It is very interesting to compare this cost-based strategy implemented by LCC to the capacity-driven model where NLC have to compete on frequencies to take advantage of the non-linear relationship between frequency share and market share. The strategy used by the LCC is based on the customer confidence that he or she will find the lowest available fare without the hassle of shopping around for a better deal. As a consequence, LCC gained significant traffic and revenue shares over their network legacy peers offering not only lower average fares than their Legacy counterparts but also took advantage of their success to offer more service to more destinations continuing the virtuous circle. Since the industry's deregulation, LCC have expanded exceeding a market share of 25%[5] in US domestic markets. LCC still have lower total unit costs than NLC but they are starting to bear the cost of an aging workforce and an increasing cost structure as they expand their network coverage

[5] Geslin, C., *"Pricing and competition in US Airline markets: changes in Air Travel Demand since 2000"*, MIT Thesis, Department of Civil and Environmental Engineering, June 2006.

The Global Economic Downturn

The financial crisis obliged several airlines to cease operations in 2008. Among the liquidated carriers, there are Aloha Airlines, ATA Airlines, Champion Air, and Skybus. Frontier Airlines declared bankruptcy but continue to operate. During this global recession, US Legacy carriers have undertaken major cutbacks on their domestic capacity. The down-sizing in capacity can be interpreted as a move to adjust the supply to the free falling demand. This capacity reduction was associated with a shift of the resources to longer average haul markets and theoretically more profitable international routes.

As the financial crisis worsened, US Legacy airlines witnessed the rapid drop of their revenues and especially the business-driven revenues. The drop in premium demand was much steeper than the drop in the economy class booking. Business passengers, who used to pay several times as much as their leisure counterparts, were under budget constraints and tighter travel allocations. As a result, more and more business travelers shifted from first and business classes to the more spartan economy class. In other words, in the global economic downturn, companies have restrained to a minimum their travel expenses favoring alternatives such as teleconferencing or substitutes to air travel such as bus, car or rail travel. Even worse, many of the few remaining high yield premium business passengers have deserted the business cabin favoring the rear of the plane.

According to the Air Transport Association[6], the US airline industry posted $62 billion in cumulative net losses between 2001 and 2008. Since 2001, the US airline industry was able to generate profits only in two years (2006 and 2007) out of eight. Furthermore, U.S. airlines posted a net loss of $23.6 billion for the single 2008 fiscal year.

As in 2008, the consolidation trend persists in the global airline industry landscape. Airlines continue to merge and consolidate to avoid excessive competition, generate extra revenues through synergies and economies of scale, and to boost their destinations and route networks. US Airways, which filed for Chapter 11, merged with America West and exited bankruptcy in May 2005. The major recent merger that took place in the U.S. is the Delta Air Lines' acquisition of Northwest Airlines in October 2008, forming the largest commercial airline in the world.

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[6] http://www.airlines.org/economics/finance/Annual+US+Financial+Results.htm, last accessed 11/20/2009.

1.2 Implications for Airports

In the airline industry value chain, commercial aviation and airports business are closely tied together. One cannot sustainably thrive and prosper without the other. Every trend affecting the U.S. airlines has deep and direct consequences on the airports' business.

To begin with, the impact of the Airline Deregulation Act (ADA) of 1978 surpassed the airlines sphere to affect the commercial airports map in the United States. In fact, airlines took advantage of the newly acquired freedom to choose which domestic markets to serve, at what fares and at which frequency to shift their operations and assets away from some of the lower traffic routes to potentially more lucrative markets. To address this concern, Congress added section 419 to the Federal Aviation Act, which established the EAS program. According to the U. S. DOT's Office of Aviation Analysis[7]: "*The Essential Air Service (EAS) program was put into place to guarantee that small communities that were served by certificated air carriers before deregulation maintain a minimal level of scheduled air service. The Department currently subsidizes commuter airlines to serve approximately 140 rural communities across the country that otherwise would not receive any scheduled air service*". The Essential Air Service Program, which today is administered by the Department of Transportation and funded at approximately $152 Million for fiscal year 2009, aims "to ensure that smaller communities would retain a link to the national air transportation system, with Federal subsidy where necessary."

Another obvious example of the impact of airline operations on airports is illustrated with the drop of the number of aircraft movements at the major U.S. airports. The fact that U.S. carriers steadily increased load factors since 2002, reflected on the airports business in the sense that the same number of passenger are being served with fewer departures. The surge in jet fuel prices made it prohibitive for the airlines to fly half-full airplanes. This trend also means landing decreases for the airports. For instance, the improvement made by U.S. carriers in their capacity utilization led to a 32% contraction of the number of aircraft movement at Boston Logan airport. The Massachusetts's Massport authority recorded a total of 371,604[8] aircraft movements in 2008 with a load factor of 85%, down from 550,000 movements in 2000 when the load factor was around 71-72%.

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[7] Office of Aviation Analysis, U. S. DOT, *"What Is Essential Air Service (EAS)?"*, revised April 2009
[8] Massport Presentation at Boston Logan International Airport

Airport operating revenues can be segmented into two main revenue channels: The aeronautical operating revenue and the non-aeronautical operating revenue. Aeronautical operating revenue is the sum of the revenue from terminals, landing fees, cargo/hangar rentals, utilities and others. Terminal revenues are generated by the rent of the terminal's facilities such as gates, check-in and ticket counters, office space, hold rooms, and carousels for passenger baggage. In 2000, the terminal revenue at the 31[9] largest hub airports in the U.S. accounted for 24%[10] of the total operating revenue at these 31 airports, constituting the most important single revenue source. Next in proportion are the landing fees which are paid by the airline to the airport operator for the use of the runways, taxiways and apron areas. The tariff is usually a function of the maximum take-off weight (MTOW) of the arriving aircraft. Landing fees represent 20% of the total operating revenue at the 31 largest hub airports in the United States. Cargo/hangar rentals and other revenues (utilities, fuel flowage fees, apron charges, Fixed-Base operators (FBOs), etc) make up for 3% and 6% of the total revenue respectively.

Comprising 46% of the total revenue at the 31 largest hub airports in the U.S. in 2000, the non-aeronautical operating revenues have become vital to the airport operating revenue structure. Non-aeronautical revenue can be decomposed in five main revenue streams: parking, concessions, rental cars, rent and others. Parking facilities are by far the most important revenue center in this category totaling 17% of the total airports revenue in 2000. Concessions include revenue from food and beverages and from retail activities. It comprises 13% of the total airport revenue and is one of the fastest growing revenue streams. Car rentals are very important in the car-centric U.S. environment and accounts for 8% of the total revenue at the 31 studied airports. The remaining 9% in this revenue structure are generated by other non-aeronautical revenues. The nature of these cash flow sources can be very heterogeneous ranging from charges to catering firms and services provider on the airport property to contracts with hotels and valet services.

In recent years, large hub airports have refined their approach toward commercial activities and concessions' revenue causing non-aeronautical revenue to grow as a percentage of the aggregated aeronautical and non-aeronautical revenue. Accordingly, the new airport terminal projects as well as the rehabilitation of the existing facilities aims to optimize the retail, concession and commercial revenues.

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[9] Primary, commercial service airports with at least 1 percent share of all enplanements in the United States
[10] Rivas, V., *"Large Commercial Airports in the United States: Operating Revenue Framework"*, MIT Thesis, Dept of Urban Studies and Planning, September 2002.

In addition, the rapid growth of the low-cost carriers over the past decade impacted deeply the airport business. LCC which used to focus on the secondary airports in the large metropolitan area are shifting gears and expanding quickly in the primary airports. This trend constitutes a challenge for the primary airport operators since low-cost carriers are different from the legacy carriers in the way they use airport passenger buildings. De Neufville[11] posed the central question: *"how do airports, which have developed around the needs of the legacy carriers, deal with the different demands of the low-cost carriers?"*

The global economic downturn has also severely hit the airports business. In 2008, major U.S. airports have experienced a significant decline in traffic as measured by enplaned passengers. According to the Airports Council International – North America[12], the number of passengers at the Top 50 airports in North America[13] shrank by 3.1% compared to 2007. This drop in the number of passengers has been particularly severe at Oakland CA (OAK), Cincinnati OH (CVG) and Honolulu HA (HNL) with respectively 21.4%, 13.4% and 12.2% passenger reduction. Few lucky airports have experienced a healthy gain in traffic. For instance, San Francisco CA (SFO), Charlotte NC (CLT) and San Antonio TX (SAT) increased their traffic by 4.7%, 4.7% and 3.5% respectively. But, 38 airports out of the 50 busiest airports in North America have seen a decrease in passenger traffic. Similarly, 107 airports out of the Top 150 airport group have seen lower traffic.

The unprecedented financial crisis has also affected the cargo traffic. In 2008 the Top 50 cargo airports in North America have seen their aggregated cargo volume decline by 7.4% relatively to 2007 to reach 23,648,286 metric tonnes. This trend has been particularly severe for Fort Worth TX (AFW), Anchorage AK (ANC) and FT. Lauderdale FL (FLL) with respectively 34.9%, 17.2% and 13.7% annual drop in cargo volume.

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[11] de Neufville,R., *"Accommodating Low Cost Airlines at Main Airports"*, International Airport Review, 1, 62-65, 2006

[12] ACI-NA, stats and research, 2008 North American Airports Final Ranking, last accessed 11/21/09

[13] Top 50 airports in North America include 47 U.S. airports and 3 Canadian airports (Toronto YYZ, Montreal YUL and Calgary YYC). It accounts for 83.6% of all passenger traffic in North America.

1.3 Thesis Objectives and Approach

The main objective of this thesis is to analyze the evolution of the domestic traffic and fares at the Top 200 airports in the United States between 1990 and 2008. The goal is to shed light on the differences in trends between the largest and smaller airports within the sample studied airports. The impetus behind this research is also to measure the impact of low-cost carriers on traffic, fares and competition.

Furthermore, trends in the network coverage and airport concentration levels are investigated both at each airport and in aggregate. We also want to examine the evolution of the total number of competitors as well as the number of low-cost carriers at each studied airport. In addition, we examine growing and shrinking airports and highlight their attributes.

Finally, case studies of five multi-airport systems located within major U.S. metropolitan catchment areas were performed.

The objective of the present study is to address the following questions:

- How did the domestic passengers O&D traffic evolve over the past two decades?
- What are the trends in air travel fares and what do the distributions of fare changes over different time spans look like?
- What are the differences between largest and smaller airports?
- What percentage of the domestic O&D passenger traffic has been gained by the low-cost carriers over the years?
- How the average fare and passenger traffic at an airport are affected by the entrance of a low-cost carrier or by a substantial increase in LCC aggregated market share?
- How did the number of competitors and airport concentration level evolve at each airport?
- How did the number of destinations with reported O-D traffic evolve at each airport?
- What trends are shaping multi-airport systems?
- What are the differences between primarily and secondary airports?

1.4 Thesis Structure

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

Chapter One is a short introduction on the recent trends in the US airline industry. It highlights the implication of these tendencies on the airports policies, operation, design and finance over the past two decades.

Chapter Two contains two parts. The first part will contains definition and terminology that are used extensively through this thesis. The second will present a literature review of studies on domestic traffic and fares, competition and market concentration, network coverage, low-cost carriers' penetration of the domestic market and the commercial airports map in the US.

Chapter Three will introduce in detail the dataset that was extracted for the purpose of this study as well as the significance of the Top 200 airports data sample. In this Chapter we also define our methodology and explain the rationale behind the segmentations implemented in this thesis.

Chapter Four concentrates on the aggregate analysis of the data. Trends in domestic passenger O&D traffic, revenue and fares are investigated. Then, segmentation between largest and smaller airports as well as between hubs and non-hub airports will be analyzed. A section exploring the rapid expansion of low-cost carriers and describing the impact on traffic and fares will follow. Furthermore, a quantitative analysis of competition and market concentration at the airport level will be presented. Finally, a focus on growing and shrinking airports will be conducted in order to highlight their specificities and attributes.

Chapter Five deals with case studies of five multi-airport systems located within major U.S. metropolitan catchment areas. Each case is analyzed within the basic framework used to evaluate the Top 200 airports aggregated statistics. These case studies emphasize the unique characteristics of each case. The case studies include Boston area multi-airport system, New York area multi-airport system, Washington D.C. area multi-airport system, San Francisco area multi-airport, and Miami area multi-airport system.

Chapter Six 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, we will introduce some definitions and terminology that are used extensively throughout this thesis. In addition, a literature review is performed based on the objectives of this thesis. The first part of the literature review is devoted to some important studies that have been performed on pricing and fare competition in the US airline industry. We explore previous research on market concentration and trends in the level of competition, and we look at studies that compare hub-and-spoke and point-to-point networks. Most importantly, a reference is made to similar studies quantifying the impact of Low Cost carriers' expansion in the US domestic markets. Next, we review important papers related to the emergence of multi-airport systems. Finally, we look at the composition and evolution of the commercial airport map in the United States.

2.1 Definitions

For the objectives of this thesis, we measure passenger traffic volumes, revenues, average fares and airport concentration levels at the Top 200 airports in the United States. Thus, it is important to define the most important terms and indicators that are used extensively through this thesis.

Origin-Destination Market (O-D)

In the literature, an O-D market has been typically defined as the pair of *cities* from where a passenger originated his trip to where the passenger was ultimately destined. Hence in the following literature review, the term "O-D market" refers to the pair of cities, starting point and final destination of a passenger. Within an O-D market, we do not differentiate between passengers with the same origin and destination cities but with different itineraries. However in the rest of this thesis, we use an alternative definition of an O-D market to refer to the pair of *airports* from where a passenger originated his trip to his final destination. A more detailed definition of an O-D market is provided in Chapter 3.

Airport Market

An airport can be considered as a "market" and the airlines that serve this particular airport are the firms competing in it. The O-D passengers (i.e., the local passengers that are either originating their trips or ultimately destined to this airport) constitute the customer base of this "airport market." Hence, an airline serving this airport has a market share equal to the proportion of passenger it carries relative to the total number of O-D passengers handled in this "airport market."

Average Fare

The average fare at an airport is defined as the passenger revenue collected in a market over the total number of O-D passengers in this airport market:

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

In this thesis, the average fare was defined at the airport level as the total domestic passenger revenue generated at a particular airport divided by the total domestic passenger traffic at this airport;

$$Average\,Fare = \frac{\sum_i \sum_j Passenger\,\mathrm{Re}venue_i^j}{\sum_i \sum_i Total\,Traffic_i^j}$$

Where i is a market served out of the studied airport and j is a carrier serving this market. It is important to mention that the sum of in and out passengers and associated revenue at the airport result in double counting of passenger traffic and revenue.

Indicators of Market Concentration

In order to quantify the level of competition at a particular airport, we will use two commonly accepted measures of market concentration: The Concentration Ratio (CR) and the Herfindahl-Hirschman Index (HHI).

Concentration Ratio (CR)

The Concentration Ratio (CR)[14] measures the market share of the largest firms in a given market. It indicates whether the market is formed of a few large firms or many small firms. The CR concentrates on the competitors with larger market shares. For example, an airport whose airlines have 50, 25, 20 and 5 percent market share will have the following 2-firm, 3-firm and 4-firm concentration ratios:

[14] Adelman, M., *"The Measurement of Industrial Concentration"*, The Review of Economics and Statistics, 33, 4, November 1951.

$$CR_2 = 50\% + 25\% = 75\%$$

$$CR_3 = 50\% + 25\% + 20\% = 95\%$$

$$CR_4 = 50\% + 25\% + 20\% + 5\% = 100\%$$

Herfindahl-Hirschman Index (HHI)

The Herfindahl-Hirschman Index[15] (HHI) measures the level of market concentration by taking into account the relative size and distribution of the firms in the market. The index is computed by squaring the market share of each firm competing in the market and then summing the resulting numbers;

$$HHI = s_1^2 + s_2^2 + s_3^2 + ...s_n^2$$

Where s_i represents the market share of firm i, and n is the number of firms competing in the market. For example, an airport that is served by 4 carriers with respectively 50, 25, 20 and 5 percent market share will have the following HHI:

$$HHI = 50^2 + 25^2 + 20^2 + 5^2 = 3{,}550$$

The HHI index can range from a value close to zero, in a very competitive environment composed of a large number of equal–sized firms, to 10,000 in a pure monopoly case where one participant have the total control of the market (i.e., 100% market share and hence HHI= 100^2 =10,000). The HHI decreases if the number of firms in the market increases or if the disparity in size between those firms decreases.

The U.S. Department of Justice (DOJ) uses the Herfindahl-Hirschman Index as an indicator to determine whether a proposed merger is likely to raise antitrust concerns. DOJ considers markets with HHI values less than 1,000 to be "unconcentrated" markets; markets with HHI values between 1,000-1,800 to be "moderately concentrated" markets; and market with HHI values above 1,800 to be "highly concentrated" markets. As a general rule, mergers or transactions that increase the HHI by more than 100 points in concentrated markets (i.e., with

[15] Rhoades, S., "The Herfindahl-Hirschman Index", Federal Reserve Bulletin, 79, 3, March 1993.

HHI values above 1800) raise antitrust concerns under the Department of Justice and Federal Trade Commission 1992 Horizontal Merger Guidelines[16].

The Herfindahl Index[17] is a variation of the HHI and can be computed using the market shares expressed as fractions. As such, the result can range between 0 and 1. In the previous example the Herfindahl Index is 0.355.

Comparing the two measures of market concentration, the Concentration Ratio (CR) does not take into account the distribution of sales in the entire market, but rather focuses on a specific number of larger firms competing in the marketplace. The Herfindahl-Hirschman Index is a more comprehensive measure of the level of competition because it includes all the players comprised in the market, giving more weight to larger competitors.

Multi-Airport System

According to de Neufville (2003)[18], a Multi-Airport System (MAS) is "the set of significant airports that serve commercial transport in a metropolitan region, without regard to ownership or political control of the individual airports." This definition focuses on significant airports; i.e., airports contributing "meaningfully" to the air transportation system in a given metropolitan region. Typically, significant airports serve more than a million passengers a year. This definition focuses on airports with commercial transport service, and leaves out military airports. It does not take into account the ownership or the political control of the airport, but rather concentrates on the realities of the market. More importantly, this definition refers to a metropolitan region rather than a city. This region may include several distinct cities. For instance, the greater Boston metropolitan area includes the cities of Boston, Providence and Manchester, among others. The Boston multi-airport system is composed of airports serving the greater Boston area including the primary airport, Boston Logan, and the secondary airports of Providence, Rhode Island and Manchester, New Hampshire, although two of these airports serve the capitals of other states.

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[16] http://www.justice.gov/atr/public/guidelines/horiz_book/hmg1.html

[17] Herfindahl, O., *"Concentration In The Steel Industry"*, Columbia University Thesis (Ph.D.), Faculty of Political Science, 1950.

[18] De Neufville, R., Odoni, A., *"Airports Systems: Planning, Design and Management"*, McGraw-Hill, 2003.

2.2 Literature Review

The airline industry has received tremendous attention from academic researchers and economists. The unusual availability of corporate-level and operational data, the singularity of the business, the rare opportunity to observe the impacts of deregulation and the fierce competition era that followed are the main reasons behind the intensive research works that have been conducted on the airline industry. In fact, academic economists, such as Levine (1965)[19], Jordan (1970)[20], and Douglas and Miller (1974)[21] took an important role in advocating for the deregulation of the US airline industry. This thesis concentrates on the evolution of domestic traffic and fares at the Top 200 airports in the United States between 1990 and 2008. It quantifies the market concentration and level of competition at the busiest 200 airports. It also measures the impact of Low Cost carriers on traffic and fares at both hub and non-hub airports. Finally, it performs case study analyses of five multi-airport systems. In this section, a relevant and comprehensive literature review is conducted based on each of these topics.

The first part of the literature review is devoted to important studies of pricing and fare competition in the U.S. airline industry since deregulation focusing on recent period, i.e. between 1990 and 2008. Moreover, we explore previous research on market concentration and trends in level of competitiveness, which bring us to address the rapid development and fortification of hub-and-spoke networks by virtually all Legacy carriers as well as the Low Cost carriers' competitive advantages operating point-to-point network structure. Most importantly, a reference will be made to similar studies quantifying the expansion of Low Cost carriers in the US domestic market and measuring its impact on fares, passenger traffic, Legacy carriers' cost structure and airport operations. Furthermore, we review important papers related to the emergence of multi-airport systems as secondary airports developed in the nation's major metropolitan areas. Finally, we look at the composition and evolution of the commercial airport map in the United States. We give special attention to the regional airports serving small communities and to the policies implemented to connect these communities to the national transportation system.

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[19] Levine, M., *"Is Regulation Necessary? California Air Transportation and National Regulatory Policy"*, Yale Law Journal, 74, 1416-47, July 1965.
[20] Jordan, W., *"Airline Regulation in America: Effects and Imperfections"*, Baltimore: the Johns Hopkins University Press, 1970.
[21] Douglas, G., Miller, J., *"Economic Regulation of Domestic Air Transport: Theory and Policy"*, Washington D.C.: Brookings Institution, 1974.

2.2.1 Pricing and Fare Competition

As the U.S. airline industry moved from a highly regulated industry to a liberalized free-market, Network Legacy carriers used the newly acquired freedom to set fares at their own discretion which led in some cases to a pricing war in order to gain market shares from their competitors. As a result, a long-term decline in yield trend (approximately 2% per year) started shortly after deregulation. Morrison and Winston (1990)[22] showed that on average deregulated fares are lower than regulated fares by 18 percent which represented an annual saving to travelers of $ 6 billion in 1988 dollars. They found that although the number of effective competitors in the domestic market dropped from 8.7 in 1978 to 7.7 in 1988, the number of carriers effectively competing at the route level, where competition actually takes place, grew from 1.52 to 1.90 during this period, peaking at 1.96 in 1986.

The rapid expansion of the Low Cost carriers in the liberalized domestic airline industry exacerbated the fierce competition with the Legacy carriers. Southwest Airlines was the first carrier to implement the low-cost business model in the early 1970s. It is widely accepted that Southwest Airlines had a fundamental role in the success of the deregulation. Morrison (2001)[23] estimated that Southwest's low fares were directly responsible for $3.4 billion in savings for passengers in 1998. He also estimated the savings generated by other carriers matching Southwest's low fares as an effect of what he called "actual, adjacent and potential competition" (i.e., on routes served by Southwest, on routes adjacent to Southwest's routes, and on routes that saw a decrease in average fare initiated by NLC to pre-empt the competition, make the market less profitable, and because of the threat that is represented by Southwest Airlines entering the route). This study shed light on the beneficial impact of new entrant start-up carriers on passengers' welfare, improving the competitiveness of the marketplace. More recently, by investigating pricing and competition at the Top 1000 US O-D markets, Pyrgiotis (2008)[24] demonstrated a significant convergence in average fares collected by the NLC and LCC: the average fare gap between the two groups shrunk from $80 in 2000 to $50 in 2005 as a result of NLC matching lower fares and LCC rising fares as they expand to longer haul markets.

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[22] Morisson, S., Winston, C., *"The Dynamics of Airline Pricing and Competition"*, The American Economic Review, Vol. 80, No. 2, May 1990.
[23] Morisson, S., *"Actual, Adjacent, and Potential Competition: Estimating the Full Effect of Southwest Airlines"*, Journal of Transport Economics and Policy, Vol. 35, Part 2, May 2001.
[24] Pyrgiotis, N., *"Price Competition in the US Domestic Market: Revenue and Yield Premium"*, MIT Thesis, Department of Civil and Environmental Engineering, June 2008.

2.2.2 Market Concentration and Level of Competition

One of the fundamental arguments advocated for deregulation was the beneficial impact on the level of competition. The rationale was that a liberalized market will increase efficiency, generalize the industry's best practices, and hence increase competition by promoting the emergence of new innovative start-up airlines. According to the FAA, the number of air carriers has actually increased to 42 scheduled large US carriers in 1998, 12 more than in 1978.

Borenstein (1992)[25] analyzed the evolution of U.S. airline market competition. He measured the evolution of nationwide indicators of concentration showing that the eight largest firms captured 81.1% of the total domestic Revenue Passenger Miles (RPM) in 1977, while this share increased to 90.5% in 1990. Similarly, the study showed that the Herfindahl Index grew from 0.106 in 1977 to 0.121 in 1990, highlighting the early unexpected effect of the deregulation on market concentration. More importantly, Belobaba and Van Acker (1994)[26] analyzed changes in US domestic airline market concentration since deregulation focusing on the Top 100 O-D markets and on the largest markets out of "dominated" cities. They found that after an initial period of increasing level of competition that culminated in 1985, a subsequent decrease in the level of competitiveness was experienced in both the Top 100 O-D markets and the 150 markets out of the dominated cities. The authors attributed the decrease in concentration that was observed during the first years of deregulation as well as the subsequent rebound to two major structural changes affecting the industry: the rapid expansion of hub-and-spoke networks by all US Legacy airlines, and the several mergers between large airlines during the late 1980s.

In general, however, competition at the O-D market level, where competition actually takes place, increased significantly since deregulation and especially in the 1990s with the rapid expansion of LCC. The decline of domestic yields in real terms from about 60 cents per RPM in the late 1970s to below 10 cents per RPM in the late 1990s[27] is evidence of the fierce competition which is a key driving force of the industry.

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[25] Borenstein, S., *"The Evolution of U.S. Airline Competition"*, Journal of Economic Perspectives, 6, 2, Spring 1992.
[26] Belobaba, P., Van Acker, J., *"Airline Market Concentration: An Analysis of US Origin-Destination Markets"*, Journal of Air Transport Management, 1, 1, 1994.
[27] Roberts, Roach & Associates Inc., *Scorecard: Airline Industry Cost Management*, 1st Quarter, Hayward, USA, 2000.

Although deregulation was supposed to suppress the barriers to entry in the airline industry by allowing airlines to choose routes, frequency and fares, in reality some barriers to entry persisted, favoring the carriers that existed before the deregulation. As pointed out by the General Accounting Office[28] access to airports is still constrained first by the slot limits at the most congested airports in New York, Chicago and Washington, secondly by the long-term, exclusive-use gate leases and finally by "perimeter rules" restricting long-haul flights at New York's LaGuardia and Washington's National airports. These barriers prevented new carriers from entering important markets at these key airports, but Low Cost carriers have bypassed these barriers by serving secondary airports, and hence multi-airport systems.

Since deregulation, airlines' mergers and consolidation proposals have been under scrutiny as they raised concerns about a decrease in the level of competition. The U.S. General Accounting Office analyzed in 2001[29] the potential effects of the proposed merger between United and US Airways as well as the American-TWA acquisition proposal. The study concluded that each proposal could have mitigated impacts on consumers' welfare. In particular, it concluded that the two examined transactions would each reduce competition in 300 markets affecting potentially 10 million passengers and would allow the consolidated carrier to dominate over 100 new markets. On the other hand, the mergers could create new routings allowing connections over different cities as well as creating new effective competitors in markets where the two merging firms had less than 10 % market share.

These transactions were systematically investigated because they raised major public policy issues. Among these issues, the GAO asked *"how a more consolidated industry might further raise barriers to market entry by new airlines, how the two merged airlines might compete in key markets,..., whether the merged carriers would expose the public to greater risks of travel disruptions, and how service to small communities might be affected"*. The ultimate goal is to preserve consumers' welfare by promoting effective competition, and to facilitate the entrance of start-up airlines. In the end, the responsibility of validating these mergers is entrusted to the Department of Justice (DOJ) which considers in its evaluation several elements, including the increase in market concentration (as measured by the HHI), the potential adverse effects on

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[28] GAO, *Airline Deregulation: Barriers to Entry Continue to Limit Competition in Several Key Domestic Markets*, Report to Chairman, Committee on Commerce, Science, and Transportation, U.S. Senate, 1996.
[29] GAO, *Aviation Competition: Issues Raised by Consolidation Proposals*, Testimony Before the Committee on Commerce, Science and Transportation, U.S. Senate, 2001.

competition, the likelihood of new entry, the possible efficiencies or other benefits, and whether a less anticompetitive alternative to the merger exists.

2.2.3 Hub-and-spoke and Point-to-Point Networks

After the 1978 deregulation Act, virtually all Legacy carriers adopted hub-and-spoke network structures, realizing the fundamental economics benefits and operational advantages of hubs. The share of trips over 1500 miles that involve a flight connection increased from 42% in 1978 to 52% in 1990[17], while it rose from 33% in 1978 to 38% in 1990 on trips between 500 and 1500 miles. The revenue power of large hub networks result in market share advantages that translate into an increased revenue share. In particular, market dominance of local markets (i.e., in and out of the hub) generate pricing and revenue advantage. As Borenstein (1992)[17] commented:

"The value of hubs-and-spoke network for the cost savings they offered was recognized before deregulation, but few saw that hubs would also be valued for the market power that they permit. For people whose origin or destination is the hub city, there is often very little competition. The hub-and-spoke have evolved to the point that one airline will generally fly to another airline's hub only from its own hub. United, for instance, offers nonstop service to Atlanta-Delta's hub- only from Denver, Chicago-O'Hare, and Washington-Dulles, three of United's four largest hubs."

Abramowitz and Brown (1990)[30] demonstrated that average price for local traffic at hub airports are significantly higher than prices on comparable routes where both origin and destination are non-hub airports. Borenstein (1989)[31] addressed the ability of airlines to charge a yield premium, i.e. the ability of a dominant airline to generate a higher markup than the average within a market or across a set of markets due to domination and concentration at airport and routes market level. He found that prices charged by carriers at their hub markets, i.e. routes where the airline's hub is one of the endpoint airports, are significantly higher than prices on other comparable routes operated by the same airline. Besides, a hub enables its dominant

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[30] Abramowitz, A., Brown, S., *"The Effects of Hub Dominance and Barriers to Entry on Airline Competition and Fares"*, mimeo, U.S. General Accounting Office, October 1990.
[31] Borenstein, S., *"Hubs and High Fares: Dominance and Market Power in the U.S. Airline Industry"*, The RAND Journal of Economics, 20, 3, Autumn 1989.

airline(s) to gain customers' loyalty via greater frequent flyer programs earning, larger network coverage and higher frequencies. This is especially appealing to high yield business customers.

Hub-and-spoke networks are also associated with operational advantages such as load consolidation. In fact, each flight departing or arriving at a hub is serving many origin-destination (O-D) markets which enables the airline to serve greater number of markets flying the same number of aircrafts. Hub strengthening led to an increase in capacity utilization, i.e. increase in load factor, by bundling the traffic in and out of the hub. In particular, the hub-and-spoke network structure is essential for network legacy carriers to consolidate traffic for their international routes. In addition, new routes to smaller spoke cities become much easier to justify in an established hub network[32]. Small regional jets can be used as hub feeder which permits an increase in frequency of service to small communities, as opposed to over-fly the hub with nonstop service. Furthermore, concentrating large volume of operations at the hub can result in economies of scale in aircraft maintenance, catering facilities, crew bases, etc.

In addition, an airline dominant position at a particular airport, for example at its hub, strengthens its bargaining position vis-à-vis of the airport operator management when it comes to negotiating the terms of use and gates lease agreements. For instance, Delta holds the lion's share (with 53%) of passenger boarding at Atlanta Hartsfield/ATL which presumably allow Delta to negotiate more favorable commercial contracts at ATL relatively to a small carrier that handles only a small fraction of enplanements.

Low Cost carriers have typically adopted Point-to-Point networks, hence concentrating on the dense O-D markets where the level of traffic is sufficient to sustain service. Point-to-point networks are also characterized by simpler operations, helping LCC maintain higher aircraft productivities. The costs associated with operating this type of network are significantly lower than the cost incurred with the operation of complex hub-and-spoke networks. Franke (2004)[33] pointed out that LCC were not only spared, but even boosted during the industry down-cycle that started in 2001. He attributes this unexpected success, partially, to the "lean" and hence less expensive LCC's business model, as opposed to the complex to operate and costly to maintain

[32] Belobaba, P., Lecture notes from "The Airline Industry" class, MIT, 2008.
[33] Franke, M., *"Competition Between Network Carriers and Low-Cost Carriers—Retreat Battle or Breakthrough to a New Level of Efficiency?"*, Journal of Air Transport Management, 10, 2004

NLC's network Structure. Confirming this idea, Gillen and Lall (2004)[34] argued that the low-cost carriers' strategic advantages such as operational efficiency, "simplicity of process" and "simplicity of product design" derive from the strategic business model choice associated with point-to-point network structure.

2.2.4 Impact and Penetration of Low Cost Carriers in Domestic Markets

Numerous quantitative and qualitative studies have investigated the impact of Low Cost carriers on the domestic air travel industry under the free-market era. LCC have been very successful implementing their point-to-point, no-frills business model. The key competitive advantage of LCC is their ability to offer significantly lower fares and still able to generate profits due to very low unit costs and high productivities. During the 1990s and early 2000s, LCC experienced a rapid growth in previously unseen proportions; between 1998 and 2003, LCC expanded their presence from 1,594 to 2,304 of the top 5,000 domestic markets and as in 2004 have a presence in markets that serve about 85% of the total domestic passengers[35].

The rise of the LCC business model, which has expanded low fares beyond the usual low-yield, leisure traveler circle, exacerbated the competition in the domestic airline industry and created one of the biggest challenges that NLC ever faced. In response to these new challenges and following the economic downturn that followed the "golden 90s", NLC reported in 2001 an objective of $ 19.5 billions in cost-cutting measures in order to restore their profitability. As a group, NLC were very successful reducing labor costs through a restructuring of their workforce, and commission costs by remodeling the distribution channels toward online direct access to the customers. NLC also improved their cost efficiency by shifting capacity to longer stage length routes. Tsoukalas, Belobaba and Swelbar (2008)[36] analyzed the unit cost of both LCC and NLC groups between 1995 and 2006 and concluded that there is clear evidence of convergence in unit costs between the Network Legacy carriers and the Low-Cost carriers.

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[34] Gillen, D., Lall, A., *"Competitive Advantage of Low-Cost Carriers: Some Implications for Airports"*, Journal of Air Transport Management, 10, 2004.
[35] General Accounting Office, *Commercial Aviation: Legacy Airlines Must Further Reduce Costs to Restore Profitability*, Report to Congressional Committees, August 2004.
[36] Tsoukalas, G., Belobaba, P., and W., Swelbar, *"Cost Convergence in the US Airline Industry: An Analysis of Unit Costs 1995-2006"*, Journal of Air Transport Management, 14, 4, 2008.

The impact of low-cost carriers on fares and passenger traffic volumes has been well documented. Whinston and Collins (1992)[37] found that the entry of People Express, a low-cost start-up airline, resulted in a decrease of 34% in the average fare on 15 routes during the period 1984-1985. In a study for the United States Department of Transportation, Bennett and Craun (1993)[38] analyzed the impact of Southwest Airlines on a number of California markets. They found, for instance, that the carrier's entry into the Oakland-Burbank route in 1990 led to a 55% drop in mean price and a sixfold increase in passenger traffic. Furthermore, Windle and Dresner (1995)[39] used dataset spanning from 1991 to 1994 to show that Southwest Airlines entrance onto a route resulted in 48% decrease in average fare and 200 % increase in passenger traffic. Finally, Dresner, Jium-Sheng and Windle (1996)[40] analyzed the impact of Southwest's entry at Baltimore-Washington International/BWI in 1993 on other routes at BWI as well as on routes offered by other carriers from nearby airports. The authors found that yields dropped and traffic rose on competitive routes from nearby airports and other non-Southwest routes served from BWI.

More recently, Geslin (2005) [5] analyzed the changes in domestic passenger traffic and fares at the Top 1000 O-D markets in the United States between 2000 and 2004. She studied the effects of competition, hubs, low-fare airlines and distance as explanatory variables to the changes in fares and traffic in these dense markets. Her empirical analysis showed that the greatest decline in average fare for a specific subset of markets among all the segments considered reached 31% decrease and was observed in markets in which a low-cost carrier "effectively" entered (i.e. low-cost carrier's market share increased from less than to greater than 10%) between 2000 and 2004.

It is worth pointing out that the competitive effect of low-cost carrier on fares did not only impact short and medium-haul routes at secondary airports but had also impacted the pricing in concentrated market and hub airports. For example, AirTran is extensively competing with Delta in its Atlanta hub. Hofer, Windle and Dresner (2008)[41] investigated the relationship

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[37] Whinston, M., Collins, S., *"Entry and Competitive Structure in Deregulated Airline Markets: An Event Study Analysis of People Express"*, The RAND Journal of Economics, 23, 4, Winter 1992.
[38] Bennett, R., Craun, J., *"The Airline Deregulation Evolution Continues: The Southwest Effect"*, US Department of Transportation, mimeo, 1993.
[39] Windle, R., Dresener, M., *"The Short and Long Run Effect of Entry on US Domestic Air Routes"*, Transportation Journal, Vol. 35, 2, 1995.
[40] Dresner, M., Jium-Sheng, C., Windle, R., *"The Impact of low-cost carriers on airports and route competition"*, Journal of Transport Economics and Policy, 30, 1996.
[41] Hofer, C., Windle, R., Dresner, E., *"Price Premium and Low Cost Carrier Competition"*, Transportation Research Part E, 44, 2008.

between price premiums and low-cost carrier's competition. They showed that NLC's ability to charge a price premium is significantly compromised by the effective competition of a low-cost carrier. Using time series examination of data between 1992 and 2002, they showed that the absolute value of fare premiums remained fairly constant, but the proportion of US passengers paying the higher markup decreased significantly due to the increasing share of low-cost carrier's traffic.

2.2.5 Emergence of Multi-Airport Systems

The exceptional growth in demand for air traffic combined to capacity constraints on existing major airports led to the emergence of secondary airports in the nation's largest metropolitan areas. The development of these secondary airports, serving the same catchment areas as one or more primary airports, led to the emergence of Multi-Airport Systems (MAS). MAS play a critical role in accommodating the increase in demand. Furthermore, the development of such MAS increased the competition among airports themselves. In fact, the emergence of MAS pushed airports, which used to be natural monopolies, to compete for passenger market share. Cohas, Belobaba and Simpson (1995)[42] developed an airport market share model to estimate the distribution of traffic between airports situated in the same MAS, based on airline pricing and frequency decisions. This study examined the changes in airports market shares in nine O-D markets served by competing airports to demonstrate that the distribution of traffic is a function of relative fares offered at each airport facility and the effective frequency of service in the O-D market from each airport.

De Neufville (1995)[43] proposed a dynamic strategy for developing multi-airport systems necessary for the large metropolitan region. He emphasized on the importance of investing progressively as the demand arises over time as opposed to a significant upfront investment in a capital-intensive facility that will be under utilized for a long period of time before the traffic shows up. He also insisted on the importance of a flexible design, robust under uncertainty and easily adjustable to changes in traffic trends.

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[42] Cohas, F., Belobaba, P. ,and Simpson, R., *"Competitive Fare and Frequency Effects in Airport Market Share Modeling"*, Journal of Air Transport Management, 1, 2, 1995.
[43] de Neufville, R., *"Management of Multi-Airport Systems A Development strategy"*, Journal of Air Transport Management, 2, 2, 1995.

More recently, Bonnefoy, Hansman and de Neufville (2009)[44] analyzed the dynamics of evolution of multi-airport systems. They stated that in North America, 81% of the emergence of a secondary airport passed through the use of an existing airport, including 4 secondary airports converted from military airports. Based on OAG 2005 data, they also found evidence of low-cost carriers' preference for secondary airports since the percentage of flights operated by low-cost carriers at the North-American secondary airports accounted for 21%, against only 12% for primary airports. According to this study, the growth of the low-cost carriers at new secondary airports in metropolitan regions resulted in the development of parallel networks as well as semi-parallel networks. Parallel networks refer to the network composed of routes linking two secondary airports. For example, a flight from Chicago/Midway to Boston/Providence is considered a parallel route to a flight from Chicago/O'Hare to Boston/Logan—which are the two primary airports in these metropolitan regions. A semi-parallel network involves flights departing from a primary airport and arriving at a secondary airport and vice versa.

Southwest Airlines' business model played a key role in the emergence of secondary airports in the United States. In fact, Southwest built its network using uncongested and less expensive secondary airports targeting price-sensitive customers. Southwest reliance on secondary airports turns out to be a competitive advantage in terms of higher aircraft productivity due to shorter turnaround times and lower airport fees that can be translated into lower unit costs and average fares. In return, the secondary airports entered by Southwest recorded a significant increase in traffic, commonly known as the "Southwest Effect". Southwest stimulated the traffic at these airports by offering appealing low fares and using the price elastic behavior of consumers to air travel to attract passengers that would have otherwise never considered travelling.

Pitfield (2008)[45] examined the Southwest effect on traffic volumes and market shares in markets where the carrier had started service. He applied a time-series analysis on passenger traffic and compared the Southwest as well as the incumbent airlines' market shares variations on selected routes such as Philadelphia-Chicago, Boston-Chicago, and Denver-Las Vegas. On the Washington-Chicago route for example, the author found that the market size increased by 18%

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[44] Bonnefoy, P., Hansman, J., de Neufville, R., *"Evolution and Development of Multi-Airport Systems: A worldwide Perspective"*, ASCE Journal of Transportation Engineering, Special Issue, 2009.
[45] Pitfield, D.E, *"The Southwest Effect: A time-Series Analysis on Passenger Carried by Selected Routes and a Market Share Comparison"*, Journal of Air Transport Management, 14, 2008.

following Southwest's first year of operation, and the new entrant airline gained 11% of the total market stealing away market share from both United and American.

2.2.6 Commercial Airports in the United States

According to the commonly used FAA airports categorization, commercial service airports are publicly owned airports that have at least 2,500 passengers boarding each calendar year. As we can observe in Figure 4, there are 522 commercial service airports in 2008. Of these, 383 have more than 10,000 annual passenger enplanements and are categorized as primary airports. Primary airports are also divided into four sub-categories; large hub (that have 1% or more of the total passenger boarding), medium hub (that have between 0.25% and 1% of the total passenger enplanement), small hub (that have at lest 0.05% but less than 0.25% of the nation passenger boarding), and finally non-hub airports (that have more than 10,000 boarding but less than 0.05% of the total passenger enplanements). In 2008, there were 30 large hubs, 37 medium hubs, 72 small hubs and 244 non-hub primary airports. This categorization is based on the percentage of passenger boardings at each airport, but does not differentiate between domestic and international travelers or between connecting and local passengers, and hence is irrelevant as far as this thesis is concerned since this thesis concentrates on the evolution of the domestic, O-D (local) passenger traffic. This point will be emphasized in Chapter 3.

Large commercial airports handle the largest proportion of passenger traffic in the United States. In 2006, the 30 large hub airports which represented about one percent of the 3,411 airports in the U.S. National Plan of Integrated Airport Systems (NPIAS) handled over 69% of all passenger enplanements[46].

[46] FAA, *National Plan of Integrated Airport Systems NPIAS (2009-2013)*, Report to Congress, 2008.

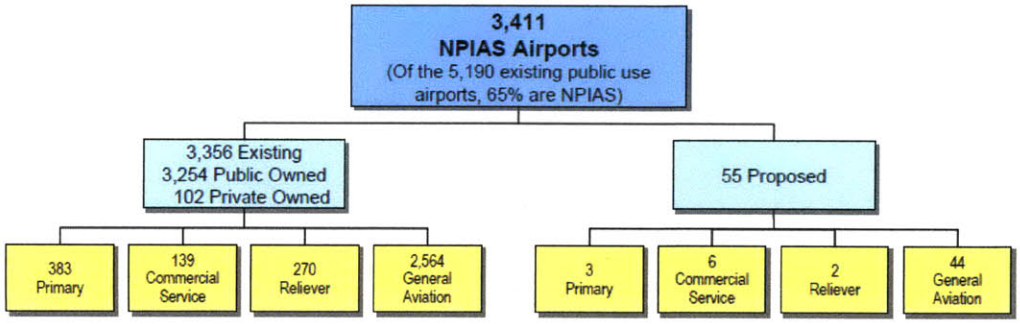


Figure 4: National Plan of Integrated Airport Systems, January 2008
[Source: FAA, NPIAS 2009-2013, Report to Congress]

More recently, the contraction of the U.S. airline industry in 2008 reduced airport revenues and revenues for the Federal Airport and Airway Trust Fund. The airline capacity reductions resulted in a diminishing access to the commercial air service system for certain passengers. According to the U.S. General Accounting Office (2009)[47], small airports, which already offer fewer flight options, are the most concerned by the capacity cuts. Small airports experienced a 16% drop in the number of nonstop destinations as well as a 10% capacity reduction between 2007 and 2008. The report also highlights that 38 airports lost all service from 2007-Q4 to 2008-Q4, which is twice the number of airports that lost service during the same period one year before. Out of these 38 airports, 14 were eligible to receive subsidies from the Essential Air Service (EAS) program.

The EAS program which was designed and implemented 30 years ago is also experiencing an unprecedented increasing financial pressure as its funding level are expected to increase by over $ 75 million within three years (2007-2010) in order to support the rapidly rising subsidies to the approximately 140 communities that otherwise would not receive schedule service. The number of carrier receiving subsidies to serve these communities declined from 38 carriers in 1978 to 10 carries in 2008[48]. Additionally, Low Cost carriers expanded rapidly at most of the large, medium and small hub airports; because they offer an appealing low-fare alternative to the relatively expensive EAS tickets, they accelerated the reshaping of the U.S. commercial

[47] General Accounting Office, *Commercial Aviation: Airline Industry Contraction Due to Volatile Fuel Prices and Falling Demand Affects Airports, Passengers, and Federal Government Revenues*, Report to Congressional Requesters, April 2009.
[48] General Accounting Office, *National Transportation System: Options and Analytical Tools to Strengthen DOT's Approach to Supporting Communities' Access to the System*, Report to Congressional Requesters, July 2009.

airport map by diverting traffic away from these small airports. Travelers living in these small communities are faced with the choice of either less affordable EAS fares, or to bypass the small airport and drive to the nearest hub airport.

2.3 Summary

In this Chapter, we defined relevant terminology and conducted a literature review based on the subject and objectives of this thesis. This review highlighted a convergence in average fares collected by the NLC and LCC as consequence of pricing and fare competition. The review drew attention to the increase in the level of competition at the O-D market level. The literature discussion underscored the strengthening of hub-and-spoke networks by all Legacy carriers, while Low Cost carriers developed leaner and hence less expensive point-to-point networks. It demonstrated the impacts of LCC's expansion on passenger traffic volumes, fares, and competition. More importantly, it was shown that many synergies existed between the low-cost business model and the development of secondary airports, a fact that led to the emergence of multi-airport systems in the nation's major metropolitan areas. Finally, investigating the composition of commercial airports in the United States, we shed light on diminishing air service at many of the small airports.

Although many studies have addressed the issues of pricing between competing airlines as well as the evolution of market concentration and level of competition, nearly all of them have analyzed the problem by concentrating on a set of O-D markets. This thesis has a different approach since it attempts to analyze the evolution of domestic O-D traffic and fares at the airport level, using a database comprised of the Top 200 airports in the United States. In the next chapter we will introduce this data set as well as the methodology used in this thesis.

Chapter 3
Dataset and Methodology

The goal of this chapter is to familiarize the reader with the dataset analyzed and methodology followed in this thesis. To this end, we first define the Top 200 airports included in this analysis, as well as the examined time period. In addition, we explain the methodology that was used to collect the data presented in this study. Then, we present the main data source which is derived from the Origin and Destination Survey of the US Department of Transportation. Furthermore, we indentify the size of the dataset, its significance and its limitations. Finally, we list all the segmentations that have been performed on the dataset. These segmentations, which aim to analyze a particular subset of airports according to different dimensions and criteria, allow us to test certain hypotheses.

3.1 The Database

The database used in the elaboration of this thesis contains US domestic Origin and Destination data only. Thus, it is important to define the term Origin-Destination market, which will be referred hereafter as an O-D market. An O-D market usually refers to the pair of cities from where a passenger started his trip to his final destination. This means that two passengers with the same origin and destination, but with different flight itineraries, belong to the same O-D market. Hence, this definition of an O-D market does not differentiate between a passenger on a non-stop trip between his origin "A" and his final destination "B" and a passenger flying from his origin "A" to his destination "B", but connecting through an intermediate city "C".

In the data analyzed in this thesis, the O-D market is defined at the level of airport pairs instead of the alternative city pairs definition. For example, a passenger traveling from New York, NY to San Francisco, CA will be assigned to LaGuardia/LGA-San Francisco International/SFO airports O-D market if the passenger originated his trip in LGA and was finally heading to SFO, or he could be assigned to John F. Kennedy/JFK-Oakland/OAK airports O-D market if JFK was his starting point and OAK the ending point of his trip. This definition is more relevant to the topic of this thesis which is the evolution of traffic and fares at the Top 200 airports in the United States as it allows breaking down the passenger traffic by airport. Hence, we can observe how the distribution of traffic inside each metropolitan region is evolving and distinguish between airports which are winning and airports which are loosing passengers. This way we can also see the impact of new entrant, for example a Low Cost Carrier, on the level of traffic and average fares at a particular airport.

On the other hand, this definition of an O-D market as an airport pair has limitations. Given that the fare competition between airlines is in most cases set at the city pair level, airlines are competing against each other not only if they are serving the same airport, but also if they serve alternatives airports situated in the same metropolitan region or catchment area. We address and investigate these issues in Chapter 5 through an in-depth multiple-case study analysis of five multi-airport systems.

The data used in this thesis represents the sum of "true" Origin and Destination domestic itineraries, in and out (i.e., departing plus arriving) passenger traffic at each airport. For now on, we designate by the term Passenger a domestic O-D passenger starting or finishing his trip at the

studied airport. This definition excludes arriving or departing international passengers as well as all connecting passengers at that airport. For example, a passenger flying from Los Angeles International/LAX to Miami International/MIA connecting through Atlanta Hartsfield-Jackson International/ATL will only be counted as a departing passenger in LAX and as an arriving passenger in MIA, not at ATL.

The analysis performed in this thesis includes data for the time period spanning between 1990 and 2008. The rationale behind the choice to start the analysis in 1990 is to encompass the period of the regional jet's advent; hence, we can monitor the development and rapid expansion of the regional jet usage as hub feeder in the US domestic market. The period's ending year, i.e. 2008, corresponds to the most recent available data at the time this study was initiated. In order to simplify the extraction and processing of the data, the necessary reports were extracted from the US Department of Transportation's O&D Survey for the following five key years; 1990, 1995, 2000, 2005 and 2008. This process led to having snapshots of the level of traffic, revenue and fares at five milestones fairly distributed across the nearly two decade time span of this analysis.

The database analyzed in this thesis includes the Top 200 airports in the U.S. ranked by number of passengers in the fourth quarter of 2005. For consistency reasons, the same list of 200 airports was matched between 1990 and 2008. It is hence important to mention that some of the airports included in the Top 200 list were without schedule services in previous years. For instance, five airports (Northwest Arkansas Regional/XNA, AR; Gray Aaf/GRK, TX; Orlando Sanford International/SFB, FL; St. Petersburg-Clearwater International/PIE, FL; Alexandria International/AEX, LA) out of the 200 did not serve domestic O-D passengers in 1990. Similarly, four airports (Northwest Arkansas Regional/XNA, AR; Gray Aaf/GRK, TX; Orlando Sanford International/SFB, FL; Alexandria International/AEX, LA) did not report any domestic O-D passenger traffic in 1995. In 2000, only one airport (Gray Aaf/GRK, TX) was missing in the Top 200 list. Throughout this thesis, the Top 200 airports included in the database will be referred as the total sample. Table 1 presents the 200 airports included in the total sample.

LAS	McCarran Intl	BUR	Hollywood Burbank	ICT	Mid-Continent	PSC	Pasco
LAX	Los Angeles Intl	ABQ	Albuquerque Intl	PWM	Portland	DAB	Daytona Beach
ORD	O'Hare Intl	JAX	Jacksonville Intl	SRQ	Sarasota/Bradento	CHA	Chattanooga
MCO	Orlando Intl	MKE	Milwaukee	ITO	Hilo (Hawaii)	EVV	Evansville
ATL	Wm B Hartsfield	PVD	Providence	LBB	Lubbock Intl	BMI	Bloomington-Norma
PHX	Sky Harbor Intl	CVG	Cincinnati/N Ktky	MDT	Harrisburg Intl	RAP	Rapid City Reg
LGA	La Guardia	DAL	Love Field	FAT	Fresno Air Term	TRI	Bristol/Kngspt/Jn
DFW	Dallas/Ft Wor Int	OGG	Kahului (Maui)	HSV	Madison County	AZO	Kalamazoo
DEN	Denver Intl	BUF	Buffalo	MYR	Myrtle Beach Intl	AVP	Scranton/Wilkes-B
BOS	Logan Intl	MEM	Memphis Intl	FNT	Flint	MGM	Dannelly Field
EWR	Newark Intl	RNO	Reno	XNA	Northwest Ark Reg	MLB	Melbourne
SEA	Seattle/Tacoma In	MHT	Manchester	PHF	Patrick Henry Int	MRY	Monterey Penin
PHL	Philadelphia Intl	TUS	Tucson Intl	TLH	Tallahassee	BGR	Bangor
JFK	John F Kennedy In	OMA	Eppley Airfield	STT	Harry S Truman	JNU	Juneau Intl
FLL	Fort Laud Intl	SDF	Standiford Field	LEX	Lexington	LNK	Lincoln
SFO	San Francisco In	ORF	Norfolk Intl	MAF	Midland Intl	BIS	Bismarck
TPA	Tampa Intl	OKC	Will Rogers World	CID	Cedar Rapids	CHO	Charlottesville
SAN	Lindberg Field	MSY	Moisant Intl	AMA	Amarillo	LFT	Lafayette
BWI	Baltimore/Wash In	GEG	Spokane Intl	HPN	Westchester Count	TOL	Toledo
MSP	St Paul Intl	ELP	El Paso Intl	SGF	Springfield	MBS	Saginaw/By Cty/Md
DTW	Wayne County	BHM	Birmingham	HRL	Harlingen	RDM	Bend/Redmond
IAD	Dulles Intl	BOI	Boise	MLI	Quad-City	STX	Alex Hamilton
DCA	Ronald Reagan Ntl	TUL	Tulsa	SBA	Santa Barbara	GRK	Killeen (AAF)
IAH	George Bush Intc	RIC	Richmond (Intl)	CRP	Corpus Chris Intl	PFN	Bay Co
OAK	Metropol Oakland	ALB	Albany	GRB	Green Bay	SBP	San Luis Obis Co
MDW	Chicago Midway	LGB	Long Beach	BIL	Billings	GNV	Gainesville
HNL	Honolulu (Intl)	ROC	Rochester	FSD	Sioux Falls	TVC	Traverse City
PDX	Portland	ANC	Anchorage Intl	VPS	Valparaiso (Ft Wa	ERI	Erie
STL	Lambert-St Louis	LIT	Little Rock Reg	SBN	South Bend	BFL	Meadows Field
SJC	San Jose Muni	DAY	Jm Cox Dayton In	FAI	Fairbanks Intl	SWF	Newburgh
SLC	Salt Lake Intl	KOA	Kona (Hawaii)	ABE	Allentown/Bthl/Es	GJT	Grand Junction
SMF	Sacramento Metro	LIH	Lihue (Kauai)	MFE	Mission/McAlln/Ed	CWA	Central Wisconsin
SNA	John Wayne Intl	GSO	Greensboro/High P	EUG	Eugene	GTF	Great Falls Intl
MCI	Kansas City Intl	SYR	Syracuse	GPT	Gulfport	SFB	Sanford
MIA	Miami Intl	ISP	Islip (MacArthur)	SHV	Shreveport Reg	FAY	Fayetteville Muni
RDU	Raleigh/Durham	CHS	Charleston	ACY	Atlantic Cty Intl	BET	Bethel
CLE	Hopkins Intl	COS	Colorado Springs	CRW	Charleston	EGE	Vail/Eagle
BNA	Nashville	SAV	Savannah Intl	LAN	Lansing	PIE	St Petersburg Int
CLT	Charlotte	GRR	Grand Rapids	ILM	Wilmington	FCA	Kalispell
PIT	Pittsburgh Intl	TYS	Knoxville	MOB	Bates Field (Mun)	JAC	Jackson
IND	Indianapolis	DSM	Des Moines	ROA	Roanoke	IDA	Idaho Falls
SAT	San Antonio Intl	JAN	Jackson	AVL	Asheville/Hndrsnv	ASE	Aspen
RSW	SW Florida Reg	GSP	Greenville/Sptbrg	BZN	Bozeman	SCE	State College
BDL	Bradley Intl	PNS	Pensacola Reg	FAR	Fargo	VGT	North Air Term
AUS	Bergstom Intl	CAE	Columbia Metro	MFR	Medford	RST	Rochester
ONT	Ontario Intl	MSN	Madison	EYW	Key West Intl	ACK	Nantucket
PBI	West Palm Beach	CAK	Akron/Canton Reg	ATW	Appleton	CMI	Champaign
CMH	Port Columbus Int	PSP	Palm Springs	FWA	Fort Wayne	AEX	Alexandria Intl
SJU	Luis Munoz Marin	BTV	Burlington	PIA	Peoria	AGS	Bush Field
HOU	Hobby Airport	BTR	Baton Rouge	MSO	Missoula	DLH	Duluth Intl

Table 1: List of the Top 200 US Airports Sorted by Decreasing Domestic O-D Passenger Traffic in Q4-2005

In order to create this database, a standardized spreadsheet form was designed. This standardized form was filled for every airport included in the total sample. As a result, we developed a 200 airport forms database. This individual airport form includes the following set of information:

- For each year:
  - Aggregated annual number of domestic O-D passengers and passenger revenues
  - Total number of destinations (airports) with reported domestic O-D traffic in which the studied airport is one of the ending points
- For each carrier:
  - Annual domestic O-D passenger traffic and revenues
  - Number of destinations (airports) with reported domestic O-D traffic by carrier

Legacy Carriers		Low Cost Carriers		Others	
American Airlines	AA	AirTran/Frontier	FL	Alaska Airlines	AS
Continental Airlines	CO	Allegiant Air	G4	Aloha Airlines	AQ
Delta Air Lines	DL	America West Airlines	HP	Chautauqua	RP
Northwest Airlines	NW	American Trans Air	TZ	Eastern Air Lines	EA
Trans World Airlines	TW	Frontier Airlines	F9	Hawaiian	HA
Unites Airlines	UA	Independence Air	DH	Legend	LC
US Airways	US	JetBlue Airways	B6	Midway Airlines	JI
		National Airlines	N7	Midwest Express Airlines	YX
		Pro Air Services	P9	Pan American Airways	PA
		Southwest Airlines	WN	Reno Air	QQ
		Spirit Air Lines	NK	Trump/US Air Shuttle	TB
		Sun Country Airlines	SY		
		USA 3000	U5		
		ValueJet Airlines Inc.	J7		
		Vanguard	NJ		
		Virgin America	VX		
		Western Pacific Airlines	W7		

Table 2: Major Legacy, Low Cost and others airlines included in the database

A list of the major carriers which are included in the database is summarized in Table 2. This is by no means an exhaustive list but rather enumerates large US airlines between 1990 and 2008. In other words, some small regional carriers have been excluded from this list. Based on the definition of Legacy and Low Cost carriers provided in Chapter 1, major airlines have been categorized in three groups: Legacy airlines, Low Cost Carriers and "Others". The term "Others" refers to airlines not satisfying the conditions of neither the Legacy nor the LCC groups. Some of these airlines, such as Pan American Airways (PA) or Eastern Air Lines (EA), ceased operations

in 1991, and hence are included in our database only for the year 1990. Furthermore, carriers such as US Airways (US) and America West Airlines (HP) merged at the end of 2005, and hence are jointly reported in the database in 2008. More importantly, we included 17 carriers in the LCC group to investigate the impact of LCC's presence on traffic and fares at the airport level.

3.2 Data Source

The main data source used to create the Top 200 airports database comes from the Origin and Destination Survey (O&D Survey) conducted by the US Department of Transportation (DOT) in collaboration with the Bureau of Transportation Statistics (BTS). All "Large" US scheduled passenger air carriers certificated by the Federal Aviation Administration (FAA) are required to complete the O&D Survey for the US DOT. The O&D Survey is a ten percent sample of all "lifted" tickets used on U.S. carriers in scheduled passenger service covering both domestic and international operations[49]. In other words for every passenger holding a ticket number ending with "0", the carrier will sample the first coupon of the ticket for reporting to the DOT in the 10 percent "O&D Survey". The data which is reported includes the number of passengers on the ticket, the itinerary of the passengers' trip and the gross fare paid by the passenger including Federal Excise Tax (FET) and Passenger Facility Charges (PFC's). After the submission of the O&D Survey filing by the reporting carriers, the US DOT processes this data to add the distance of each segment as well as the total. Hence, each passenger is assigned to an O-D market. For this thesis, we accessed the data through a database called O&D Plus commercialized by Data Base Products, Inc.

The O&D Survey's data utilized in this thesis have two main limitations. The First limitation is due to the fact that the small commuter carriers, at each airport, are represented in aggregate under the code "XX". Hence, it is very difficult to discover the identity/identities of the "XX" carrier/s, and even if we did, then we must decide how to allocate the aggregated traffic among these small commuter carriers. The second limitation comes from the fact that the survey's data does not differentiate between various fare structures, which prohibit, for example, the highly interesting distinction between leisure and business passengers. As a result, the analysis on the evolution of fares at any particular airport as well as the fares comparison between airports situated in the same metropolitan region is limited to average fare statistics.

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

3.3 Data Sample Size

As mentioned in section 3.1, the Top 200 airports on which the analysis presented in this thesis was performed are defined as the Top 200 commercial airports in the United States ranked by number of passengers in Q4-2005.

In order to determine the size and scope of the total sample, we need to compare the total annual passenger traffic recorded in our total sample to the overall annual passenger O&D domestic traffic in the United States. Figure 5 presents this comparison for the year 1990, 1995 and 2008.

The US domestic O-D air traffic is heavily concentrated at the largest commercial airport facilities. Looking at the cumulative passenger traffic share as a percentage of the total domestic O-D traffic, as depicted in Figure 5, it becomes evident that the nation's Top 30 airports handled 58.5% of the total domestic O-D passenger traffic in 2008, while 74.9% of the traffic was handled by the 50 busiest airports. More importantly, the Top 200 airports studied in this research accounted for 94.7 and 97.1 percent of the total domestic O-D traffic, respectively, in 1990 and 2008.

It is worth pointing that the concentration of traffic at the busiest airports is an increasing trend; the Top 50 airports' cumulative passenger traffic share increased from 71.9% to 74.9% of the total domestic O-D traffic between 1990 and 2008, while the Top 100 airports' share progressed from 87.9% to 91% during the same period. In 1990, the Top 200 airports total sample handled 94.7% of the total O-D passenger traffic, but the same share of traffic was handled by the Top 140 airports in 2008 demonstrating the increase in the concentration of traffic at the busiest airports. This trend clearly stands out in Figure 5 as the cumulative passenger traffic share per airport rank curve for 2008 is significantly and consistently above the cumulative passenger traffic share per airport rank curve corresponding to 1995, which is also higher than the similar curve for 1990.

On the revenue side, the busiest airports included in this study generated a disproportionate share of the total domestic O-D passenger revenues. As we can observe on Figure 6, the Top 30 airports included in the total sample generated 58.2% of the total domestic O-D passenger revenues in 2008, while this share rises to 73.3% for the Top 50 airports.

Furthermore, the concentration of revenues at the busiest airports pattern is increasing, following the similar trend in traffic. The Top 30 airports generated 58.2% of the total domestic revenues in 2008, up from 56.9% in 1990. The rising concentration of passenger revenues is highlighted by the fact that 92.4% of the revenues were collected in the Top 130 airports in 2008, while the same share was collected in the Top 190 airports in 1990. Finally, it is interesting to note that although the Top 200 airports included in this research handled 97.1% of the total O-D passenger traffic in 2008, these airports generated only 96.1% of the total O-D passenger revenues collected in the US domestic market. In fact for all the studied years, the revenue percentage collected in the Top 200 total sample is lower than the associated traffic share handled at these Top 200 airports, a fact that may be explained by the higher average fares in the smaller commercial airports which are not included in this thesis (i.e., the remaining 322 airports which are part of the commercial service airports' map in the United States as described in section 2.2.6).

In Summary, given the fact that the Top 200 total sample represents 97.1% of the total domestic O-D traffic and 96.1% of the total passenger revenues collected in the United States, we can conclude that the Top 200 airports analyzed in this thesis are representatives of the overall US domestic market. In particular, we can generalize the trends in average fares and changes in average fares to draw conclusions applicable to the total US domestic market.

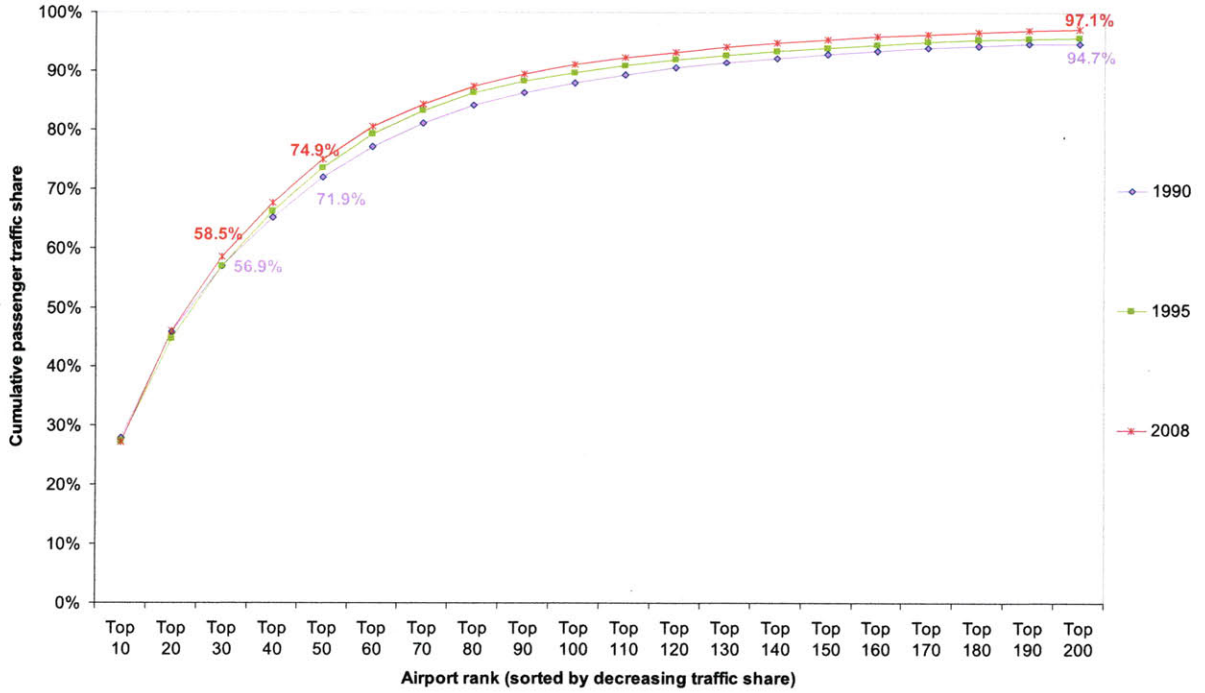


Figure 5: Lorenz Curve of Airport Traffic Share as a Percentage of the Total Domestic O-D Traffic

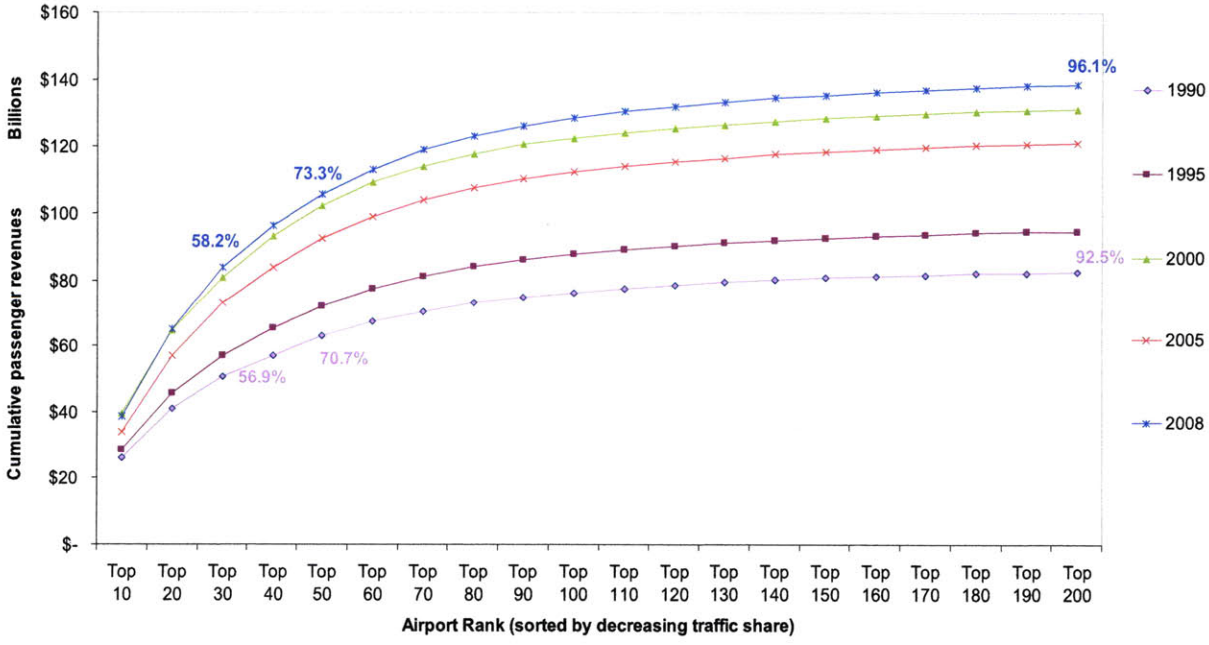


Figure 6: Cumulative Passenger Revenues per Airport Rank, and Share as a Percentage of the Total Domestic Passenger Revenues

3.4 Segmentation of the Data Set

Several segmentations of the data set were performed on the total sample studied in this thesis. These segmentations aim to analyze a particular subset of airports according to different dimensions and criteria, in order to test certain hypothesis.

The most important segmentation categories applied in this study are:

- The total sample: As a starting point, analyzing the aggregated statistics for the Top 200 US airports will unveil the overall trends in domestic O-D passenger traffic, revenues and average fares. It will also serve as a benchmark for the subsequent segmentations.

- Largest and smaller airports by differentiating the 200 airports into 4 tiers according to their rank (i.e., airports ranked 1-50, 51-100, 101-150 and 151-200): Based on the discussion presented in the literature review, we can hypothesize that fares increased the most at the smaller airports, and that LCC targeted in priority the busiest airports where there are sufficient traffic to sustain their point-to-point network structure.

- Hub and non-hub airports: Given the previous studies on yield and fare premium, we can hypothesize that the gap between the average fares collected at hub and non-hub airports is closing up, due to fierce competition with the LCC.

- Airports "winners" and "losers" of traffic: We expect to observe a redistribution of traffic between airports located in the same catchment area. We also imagine big increases in domestic O-D passenger traffic at the popular leisure destinations.

- Primary and secondary airports in aggregate, across all multi-airport systems: we hypothesize that secondary airports are handling an increasing share of the domestic O-D passenger traffic across all multi-airport systems, as a result of the exceptional growth in demand, and capacity constraints at primary airports.

Is there a trend emerging where individual carriers are consolidating their capacity to focus on a primary airport in a catchment area? How does average fares at secondary airport compare relatively to average fares at primary airports? The following five case study analyses of multi-airports systems provide answers to these questions, and hence are important to understand the evolution of multi-airport systems.

- Boston metropolitan area multi-airport system
- New York metropolitan area multi-airport system
- Washington D.C. metropolitan area multi-airport system
- San Francisco metropolitan area multi-airport system
- Miami metropolitan area multi-airport system

The aggregated total sample as well as the segmentation in largest and smaller, hubs and non-hubs, primary and secondary, and growing and shrinking airports will be analyzed in the Chapter 4 of this thesis. The five remaining segmentation categories, which correspond to case study analyses of multi-airports systems, will be treated in Chapter 5.

Chapter 4
Aggregated Analysis of Domestic Traffic and Fares at the Top 200 US Airports

First, this chapter analyzes the aggregated statistics for the Top 200 US airports, unveiling the overall trends in domestic O-D passenger traffic, revenues and average fare. Second, we refine our analysis by segmenting the total sample of Top 200 airports (total sample) into 4 airport tiers, highlighting the differences in trends between the largest and smaller airports. Third, we look at hub and non-hub airports to monitor the evolution of hubs' consolidation and the average fare gap between hub and non-hub airports. In addition, we quantify Low Cost carriers' expansion in order to investigate their impacts on traffic and fares. We perform a quantitative analysis of competition at the airport level to determine if the total sample is less or more concentrated in 2008 compared to 1990. To this end, we use two commonly accepted measures of market concentration: the Herfindahl-Hirschman Index (HHI) and the Concentration Ratio (CR). Moreover, we differentiate between airports "winners" and "losers" of traffic as we imagine big increases in passenger volumes at popular leisure destinations. Finally, we study primary and secondary airports in aggregate across 15 multi-airport systems in the United States, shedding light on the characteristics and tendencies of primary and secondary airports.

4.1 Aggregate Trends

Looking at the evolution of the domestic O-D passenger traffic as depicted in Figure 7, it becomes evident that the total volume of traffic increased by more than 52% between 1990 and 2005. The demand for air travel in the U.S. has been steadily increasing as it became a commodity accessible to a larger number of potential costumers. The increase in passenger traffic persisted even during the industry down cycle that started in 1990 and ended in 1994 as the number of passengers increased by 18% — 52 million passengers— between 1990 and 1995. In the same time period, the total revenues generated increased only by 15%, a fact that can be attributed to a 3% drop in the average fare at the Top 200 airports. The fall in average fare can be explained by the economic downturn that followed the first Gulf War in 1990-1991, obliging the airlines to lower their fares to stimulate the demand.

During "the golden 90s," when the industry reported record profits, the number of passengers increased by 21% between 1990 and 2000. More importantly, the revenues generated in the total sample jumped by 39% culminating at $65.6 billion. It is interesting to notice that the increase in revenues significantly outpaced the increase in traffic during this period due to a rise by 14% in average fare, which reached its highest level— $156 in 2000: that is, $19 more than in 1995.

The period 2001-2005 corresponded to a period of crisis in the US airline industry; the industry reported cumulative losses of more than $57 billion during this period. The fact that the passenger traffic increased by 6% between 2000 and 2005 must not hide that the traffic was down between 2000 and 2002, before it started increasing again in 2003. Lower average fares contributed to higher passenger volumes but lower revenues in 2005; average fares dropped by 13% compared to 2000 levels which resulted in total revenues to contract by 8%.

Finally, 2005-2008 can be decomposed into two periods. First, the period 2006-2007 marked a short recovery for the US airline industry, but rapidly the soaring jet fuel prices followed by the unprecedented global financial crisis drained away the profits posted in 2006 and 2007. As a result, passenger volumes fell by 2% in 2008 compared to 2005, while revenues increased by 14%. Driven by the record high crude oil and jet fuel prices in 2008, the US carriers had no choice but to increase fares. This situation resulted in average fares in the total sample increasing by 16% in 2008 relatively to 2005.

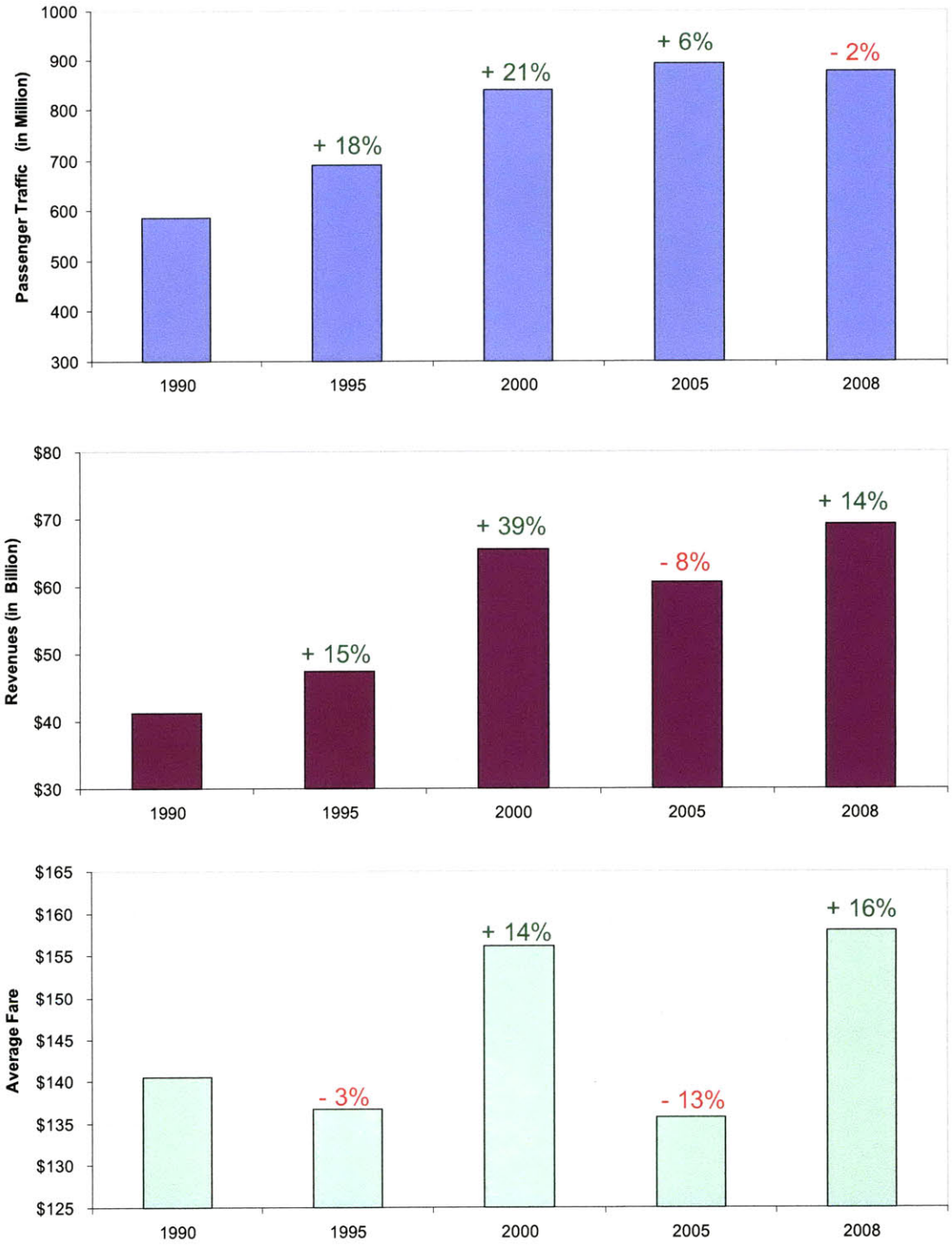


Figure 7: Total Passenger Traffic (In & Out), Passenger Revenues and Average Fare in the Total Sample from 1990 to 2008 (Percentage represents change relative to previous data point). Sum of in & out passengers and revenue at each airport results in double counting

From a broader perspective, we can observe that the general patterns in the total O-D domestic passenger traffic, as highlighted in Figure 7, are quite similar to the trends in Revenue Passenger Miles (RPM) flown in the United States since 1990 as depicted in ***Figure 8***. The demand for air travel has been steadily increasing since 1990, except for the period 1990-1991 corresponding to the first Gulf War, and for the period 2000-2002 corresponding to the 9/11 terrorist attacks and industry crisis. The small differences in percentage increases between RPM and O-D passenger traffic are due to the increase of the average haul in the US.

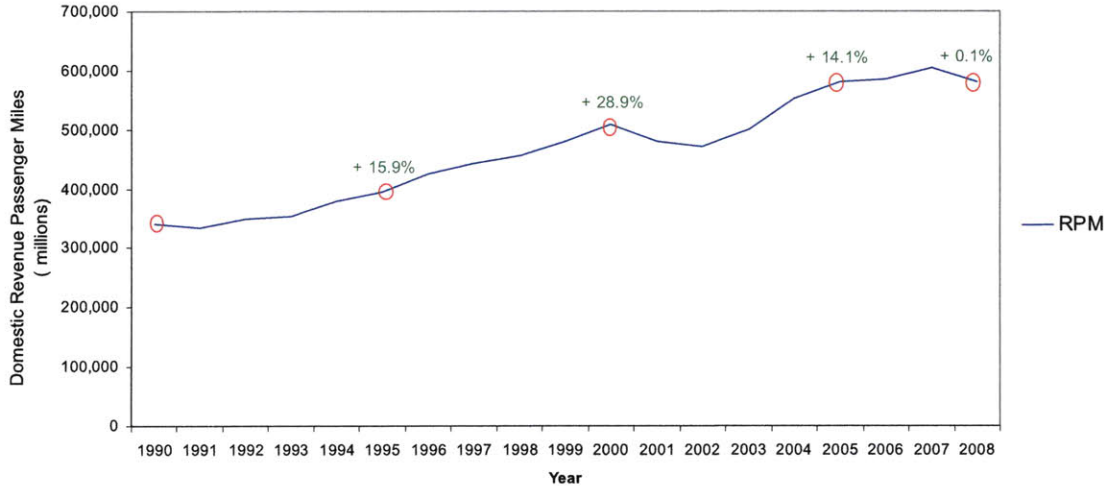
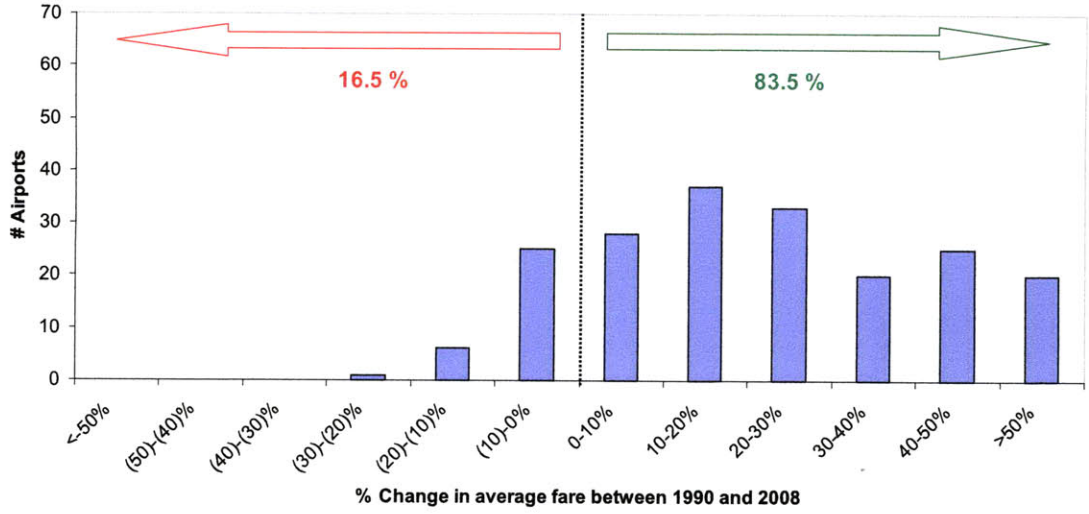
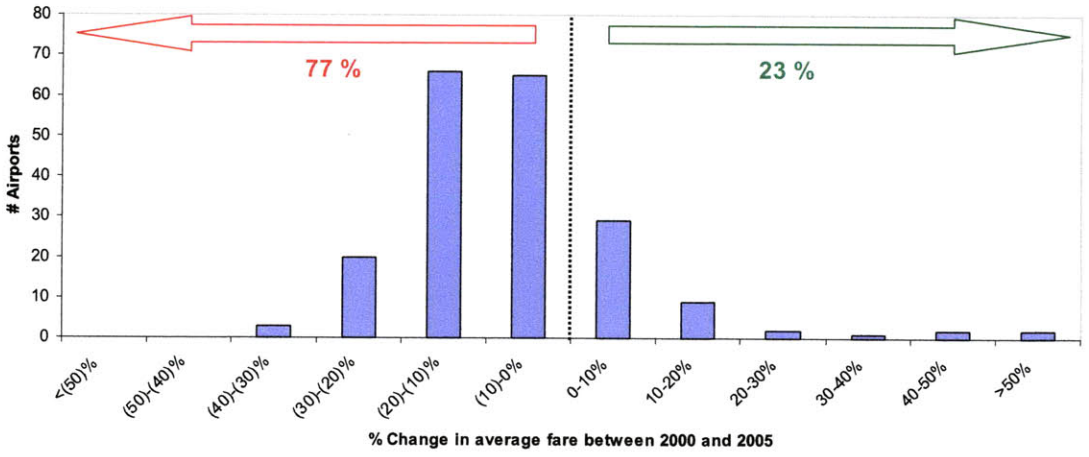


Figure 8: US Domestic Revenue Passenger Miles (RPM)
[Source: ATA]

4.1.1 Changes in Average Fares

For the Top 200 US airports, we have analyzed the trends in average fare at the aggregate level, but in reality there are great variations across markets. As an example of this disparity, the average fare at Boise/BOI dropped by 21.4%— from $172 to $135— between 1990 and 2008, while the average fare at Dallas Love Field/DAL increased by 120% during the same period. In order to quantify the variations in average fares across markets, we have plotted in Figure 9 the distribution of average fare changes for the three key periods: 1990-2008, 2000-2005 and 2000-2008. To begin with, in 2008 32 airports— 16.5%— saw lower average fares compared to 1990, whereas the majority of airports— 83.5% or 168 out of 200— saw higher average fares. Among these 168 airports, ticket prices increased on average by 32%. Overall, the average fares went up by 12% between 1990 and 2008.





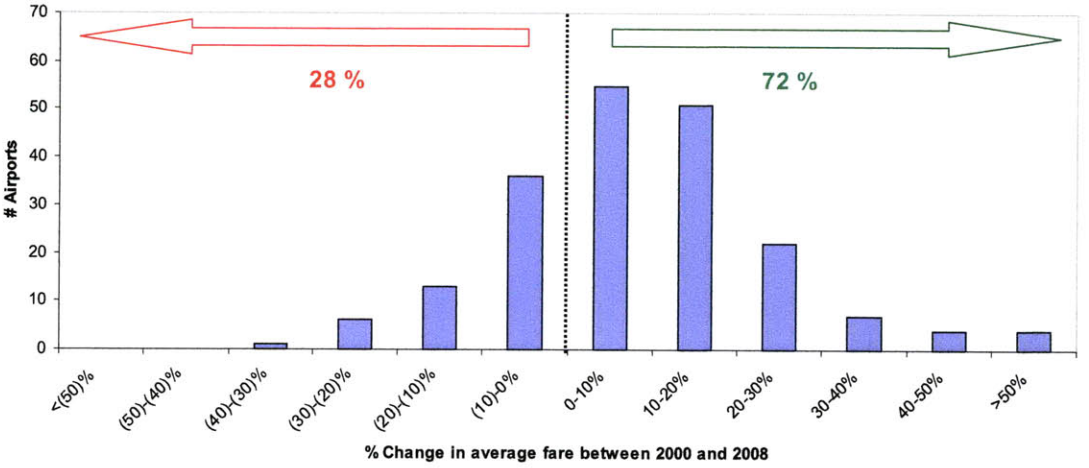


Figure 9: Distributions of Changes in Average Fare between 1990 and 2008, 2000 and 2005, and 2000 and 2008

Focusing on recent years, we can observe that 77% of the airports in the Top 200 sample saw average fare reduction from 2000 to 2005. On average, fares dropped by 13% driven by two main factors; first, the airlines' will to regain and stimulate demand after the significant fall in passenger volumes between 2001 and 2002, and second the fierce competition by low-cost carriers which, by offering more attractive fares to more markets, obliged the Legacy carriers to match their lower fares.

In contrast, the picture is completely different if we examine the distribution of changes in average fare between 2000 and 2008 as we may remark that 72% of the airports in the total sample faced an increase in average air fares, while the remaining 28% experienced a decrease. These observations lead to the conclusion that average fare in most of the US airports have risen between 2005 and 2008. Indeed between 2005 and 2008, the mean prices increased in 96% of the markets— 196 airports out of 200— a fact that can be attributed primarily to the soaring crude oil prices which peaked at $145 a barrel on July 3rd, 2008. Even Legacy airlines, which have gone through a severe cost-cutting and restructuring period, had no choice but to charge costumers for fuel increases.

4.1.2 Number of Domestic Destinations with reported O-D Traffic

For a particular airport, the number of domestic destinations with reported O-D traffic, i.e. the number of airports with non-zero local passenger traffic originating or ultimately arriving at the studied airport during the course of the year, can be viewed as an indicator of the airlines' network density and coverage. By comparing this metric over time, we can identify the trends in levels of commercial air service at the Top 200 airports in the United States and answer the fundamental question: Is the US domestic commercial air network shrinking or expanding over time?

We have to be very careful interpreting this metric: The number of destinations with reported O-D traffic per airport is by no means to be interpreted as a straightforward measure of the level of commercial air service available at each airport, as offered by each airline at the flight leg or flight route level, and summarized in the Official Airline Guide (OAG), but rather as an indicator or proxy of the network coverage.

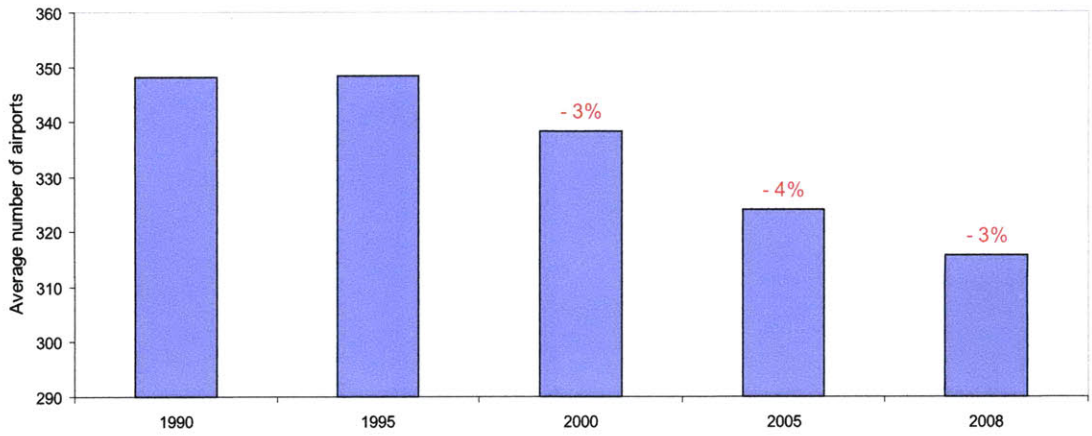


Figure 10: Average Number of Destinations with reported O-D Traffic per Airport From 1990 to 2008 (Percentages signify the relative drop from the previous data point)

Looking at Figure 10, showing the evolution of the average number of destinations with reported O-D traffic per airport in the Top 200 sample, it becomes evident that the average number of destinations steadily decreased since 1995, dropping by more than 9%— from 348 to 316 airports— from 1995 to 2008. However, there are great variations in number of destinations with reported O-D traffic changes between largest and smaller airports as unveiled in Section 4.2.

4.2 Segmentation Between Largest and Smaller Airports

We refine our analysis in this section by differentiating between largest and smaller airports. This segmentation consists in dividing the Top 200 airports into four groups based on airport rank; i.e., the largest airport group includes airports ranked from 1 to 50 in a given year, the second tier regroups airports ranked from 51 to 100, the third tier includes airports ranked 101 to 150, and the fourth tier combines the 50 smallest airports— ranked from 151 to 200.

It is worth pointing out that the four airport groups are not constant across the time period spanning between 1990 and 2008, but evolve as airports in the total sample changed their respective ranks, and hence switched groups. To illustrate our point, Bradley International/BDL was ranked 41st among the Top 200-airport list in 1990, whereas it was ranked 53rd in 2008, hence moving from the first to the second airport tier. This definition permits us to investigate the trends

in passenger volumes, revenues and average fare in the four airport tiers based on the updated ranking for each year.

When taking a closer look at Figure 11, it is obvious that the passenger traffic increased the most, between 1990 and 2008, in absolute and percentage terms— 52%— at the Top 50 airports. In parallel, the revenues generated at the busiest airports rose by 68%. However, during the industry crisis that started in 2001 and ended in 2005, the passenger revenues decreased the most at the Top 50 airports. These observations highlight the concentration of traffic and revenues at the busiest airports which are affected directly and disproportionately by the variations in the air travel demand.

The second airport tier, which represented between 16 and 17% of the total passenger traffic in the total sample, faced an increase in passenger volumes by 47% and in associated revenues by 73% from 1990 to 2008. In the same time period, the third airport tier increased its traffic by 28% and its revenues by 52%. However, this group accounted for only 4.5% of the total passenger traffic in the Top 200 sample in 2008 compared to 5.3% in 1990. The fourth airport tier experienced an increase in passenger traffic by 41%, while the associated revenues grew outstandingly by 93%, a fact that can be attributed to the significant increase in average fares at the smaller airports.

The picture of average fare evolution by airport group is both predictable and understandable. First, we can remark that since 1995, average fare at each of the four groups followed the same pattern as the aggregate average fare in the total sample; that is, an increase in average fares during the "golden 90s," a significant drop during the industry crisis between 2001 and 2005, and finally a significant increase between 2005 and 2008. The latter was due to the skyrocketing jet fuel burden on the US airlines' cost structure. A very interesting observation is that, as we can imagine, average fares at the smaller airports are consistently higher than average fares at the busiest airports. This can be explained by the fact that the competition is fiercer at the busiest airports where low-cost carriers are more present since their point-to-point networks do not allow for consolidation of traffic and hence require high levels of demand. Another plausible reason is the fact that passengers at the smaller airports have to connect more, on average, in order to reach their final destinations hence incurring higher ticket price.

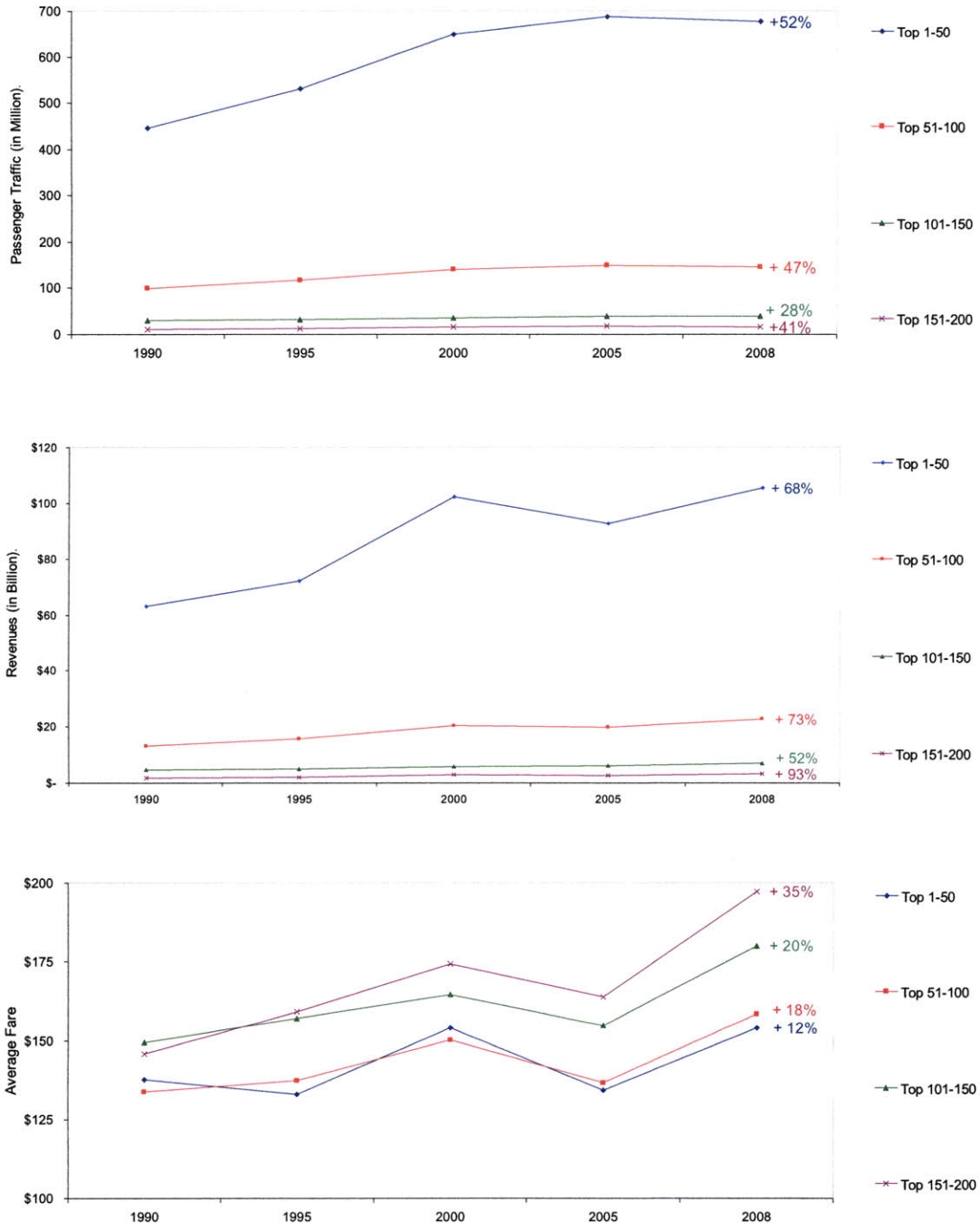


Figure 11: Passenger Traffic, Revenues and Average Fare by Airport Rank from 1990 to 2008
(Percentage represent the relative progression compared to 1990 levels)

It is also interesting to notice that the average fare increased the most— 35%— at the smallest 50 airports from 1990 to 2008, followed by airports ranked from 101 to 150 in the Top 200 list which have recorded a progression by 20%. At the end of the spectrum, average fare rose only by 12% between 1990 and 2008 at the 50 busiest airports; that is the lowest increase in average fare among the four airport groups. Higher levels of competition at the most popular airports prevent fiercely competing airlines from increasing their fares.

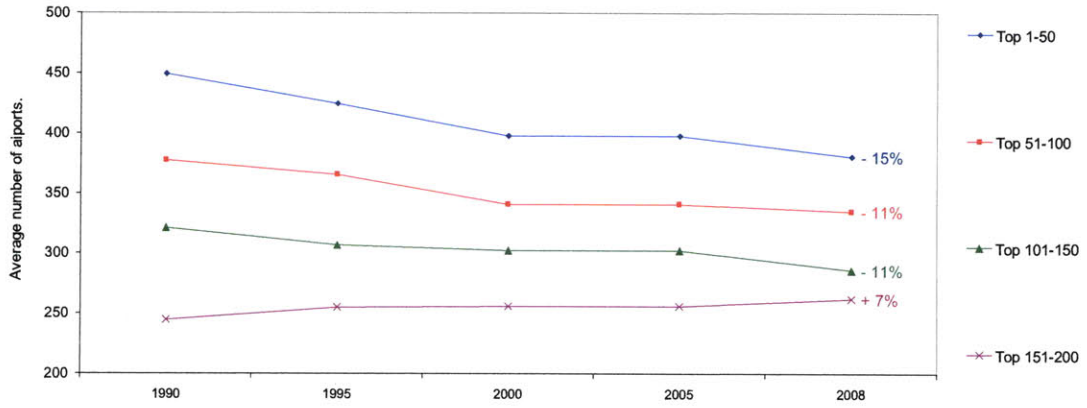


Figure 12: Average Number of Destinations with reported O-D Traffic by Airports Group between 1990 and 2008 (Percentages signify relative change compared to 1990)

The differences in trends between airport groups are also evident in Figure 12 in which we investigate the variations in the average number of destinations with reported O-D traffic across the four airport tiers. Indeed over the period 1990-2008, the decrease in the number of destinations was more pronounced for the biggest airports, while the smallest airports increased by 7% their number of destinations. As expected, we can also note that the Top 50 airports consistently have a higher average number of destinations than the airports in the second tier, which have a higher mean number of destinations than the third tier, which also have on average more destinations than the fourth airport tier.

4.3 Low Cost Carriers Market Penetration and Impacts

After the industry's deregulation in 1978, new start-up airlines took advantage of the market liberalization and the suppression of barriers to entry to start competing in the US domestic market. Low Cost carriers have particularly flourished during the 1990s and early 2000s

experiencing a growth in previously unseen proportions. Indeed with their lower average fares, LCC are offering attractive alternatives to increasingly price-conscious customers. In addition, LCC took advantage of their success to offer more service to more destinations continuing the virtuous circle. Consequently, LCC gained significant traffic and revenue shares over their Legacy peers. As mentioned in earlier chapters, low-cost carriers, such as Southwest Airlines (WN), JetBlue Airways (B6) or AirTran Airways (FL), have been transforming the industry landscape.

In this section, we analyze the LCC penetration of the Top 200 sample both at the aggregate level and by individual carrier. We also investigate the impact of LCC presence on passenger traffic and average fares charged in total sample. It is important to recall that Low Cost carrier group has been defined as a group of 17 carriers listed in section 3.1 of this thesis.

4.3.1 Low Cost Carriers Presence at Top 200 Airports

In order to quantify the low-cost carriers' presence in the total sample, the number of low-cost competitors was calculated at each airport and then the average number of low-cost competitors per airport was derived and plotted in Figure 13.

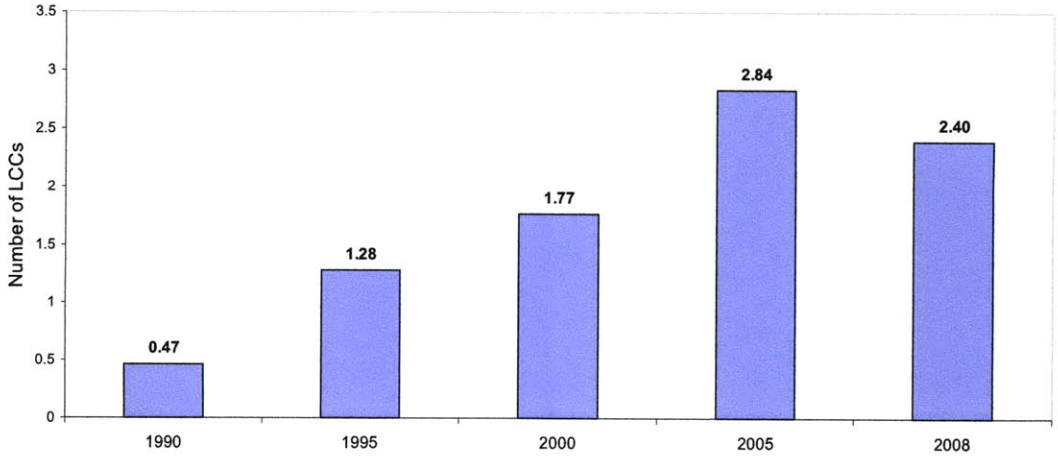


Figure 13: Average Number of Low Cost Carriers per Airport

The first thing to point out when looking at Figure 13 is that the average number of Low Cost carriers per airport steadily increased from 1990 to 2005— from 0.47 per airport in 1990 to 2.84 LCC per airport in 2005. It is very interesting to note that the highest increase was recorded between 2000 and 2005, precisely when the industry went through a severe crisis; many airlines were forced into bankruptcy while many others disappeared. This observation corroborates the conclusions made by Franke (2004) [27] according to which low-cost carriers were not only spared, but even boosted during the industry's worst down-cycle that started in 2001, a fact that can be attributed to the "lean" and hence less expensive LCC business model, as opposed to the complex NLC network structure.

However, the average number of Low Cost carriers per airport in the total sample has recently dropped between 2005 and 2008 as a consequence of the financial crisis and economic downturn, the increasing level of competition, and perhaps a saturation of the market. Low Cost airlines were forced by the fierce competition and the rising jet fuel prices to pull out of certain airports.

To refine this analysis, we may take a closer look at Figure 14 detailing the evolution of the average number of Low Cost carriers per airport across the four airport tiers as defined in the previous section.

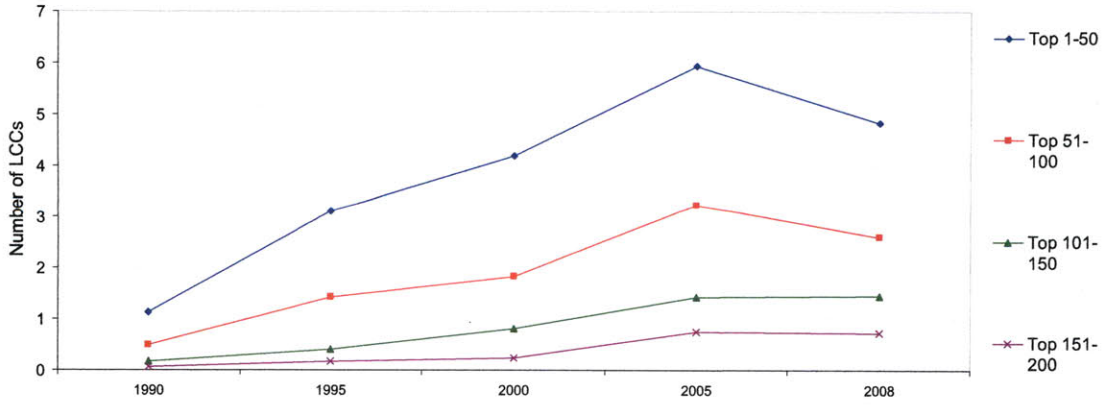


Figure 14: Average Number of Low Cost Carriers per Airport, by Airport Tier

As we can observe, Low Cost carriers' presence is greatest at the biggest airports— 4.82 competitors per airport in 2008. This observation leads to the conclusion that LCC are not only competing against their Legacy counterparts, but they are also increasingly competing against

each other at the busiest airports in the United States. Historically, Low Cost carriers tried to avoid head-to-head competition with each other, preferring confrontation with Legacy carriers. But as LCC are expanding in the domestic markets, there are fewer and fewer airports left, with both limited Low Cost carriers' presence and sufficient local traffic, for the leading Low Cost carriers to accommodate their organic growth. This phenomenon forced Low Cost carriers to enter airports where significant competition came from other Low Cost carriers. For example, although JetBlue Airways and AirTran held respectively 18.2% and 6.7% of total domestic O-D passenger traffic at Boston Logan/BOS in 2008, Southwest Airlines entered the BOS market during August 2009, revealing the scarcer opportunities for expansion. As a primary airport, BOS is not a typical airport for WN to enter; historically WN relied on uncongested secondary airports.

4.3.2 LCC Share of Total Domestic Passenger Traffic

The most straightforward way to measure LCC penetration in the total sample is to analyze the evolution of the LCC's share of total domestic passenger traffic at the Top 200 airports over the studied period. Thus, we computed the aggregated LCC group passenger market share at each airport. Then, by weighting each of these market shares with the associated airport passenger share as a percentage of the total traffic we derived the LCC's share of the total domestic passenger traffic at the Top 200 airports between 1990 and 2008. The results are summarized in Figure 15.

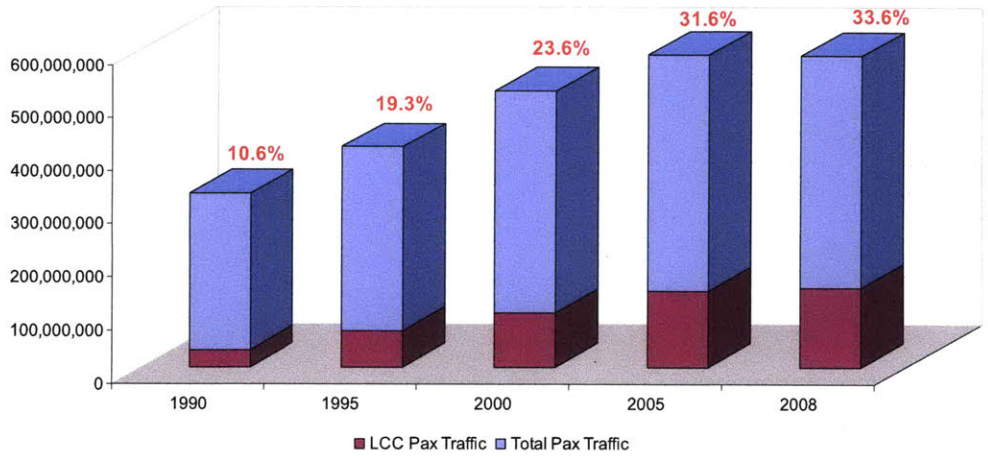


Figure 15: LCC Share of Total Domestic Passenger Traffic in the Total Sample

Looking at Figure 15, it becomes evident that LCC market share of total domestic traffic at the Top 200 airports increased from 10.6% in 1990 to 19.3% in 1995, to 23.6% in 2000, then to 31.6% in 2005, to finally reach 33.6% in 2008. It is worth pointing out that LCC market share in the total sample increased only by 2%, between 2005 and 2008, due to the slowing LCC's growth and to the exclusion of America West Airlines (HP) from the LCC group in 2008. HP, which served 12% of the passengers carried by the LCC in 2005, merged with the Legacy carriers– US Airlines (US) — at the end of 2005. The newly formed airline was reporting under the "US" code in 2008, reducing the LCC group market share. But as we can observe on Figure 15, Low Cost carriers have steadily increased their market share from 1990 to 2008. LCC market share is still growing but leveling off, reaching 33.6% of total US domestic passengers in 2008. It is very interesting to note that the progressions were more pronounced during periods when the industry's performance was weak; LCC's share rose by 8.7 percentage points between 1990 and 1995 and by 8 percentage points from 2000 to 2005, which correspond respectively to the first Gulf War down-cycle and to the 2001-2005 industry crisis. During these down-cycles, certain airlines, which were already in a poor financial situation, were shaken by the deteriorating environment, forcing many of them to file for bankruptcy and others to cease operations. Leveraging their advantageous cost structure, LCC have taken these opportunities to fill the gap, expand their networks and continue the virtuous cycle.

4.3.3 Low Cost Carriers Aggregated Market Share by Airport Tier

In the fierce competition between Network Legacy carriers and new entrant airlines, since 1990, the new entrant airlines have adopted a strategy of entering in priority the busiest airports where there is sufficient local O-D passenger traffic to accommodate and sustain their new services. Looking at Figure 16, it becomes obvious that low-cost carriers focused first on the largest airports, then grew rapidly in the second and third tiers. During the early 1990s, average low-cost carriers' aggregated market share at the Top 50 airports increased from 14% in 1990 to 24% in 1995, while this share grew only by 3 percentage points in the three remaining airport groups during the same period. But as LCC expanded in the domestic markets, there were fewer and fewer opportunities for a start-up airline to enter an airport in the first tier either because of gates or demand constraints or because of Legacy carriers lowering their average fares to pre-empt the competition. Hence, low-cost carriers shifted gears and started expanding aggressively at airports in the second tier. As a consequence, the average aggregated LCC's market share at the

airports in the second tier rose from 18% in 2000 to 30% in 2005. Finally, the same pattern repeated itself as low-cost carriers ran out of attractive expansion opportunities among airports in the second tier, moving on to airports included in the third tier; low-cost carriers' average market share in this airport category went from 16% in 2005 to 24% in 2008.

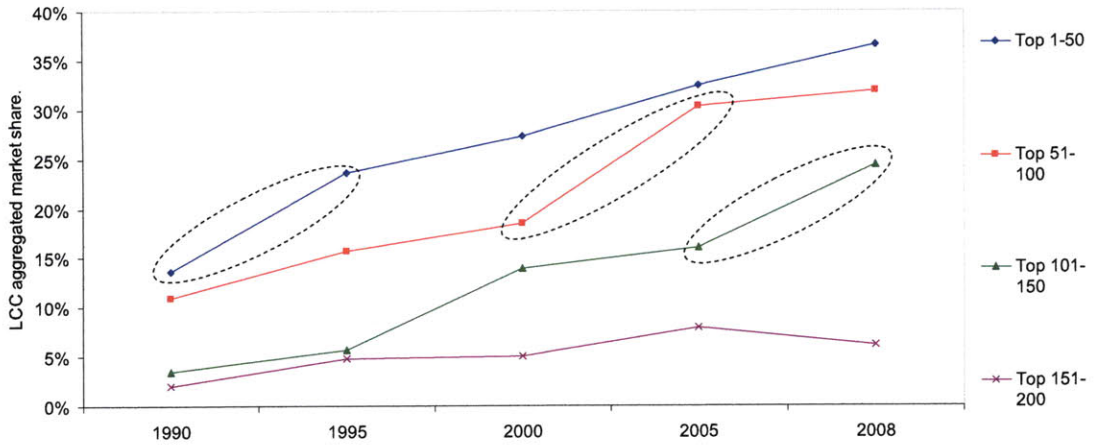


Figure 16: Average Low Cost Carriers Aggregated Market Share per Airport, by Airport Group between 1990 and 2008

4.3.4 Low Cost Carriers Effective Market Penetration

It order to quantify the rapid expansion of Low Cost carriers in US domestic markets, we can monitor the evolution, over the studied period, of the number of airports with a specified level of aggregate LCC market share. In this section, we define two market share levels as thresholds to what we consider as an effective and a significant market penetration: the first level was fixed to 5% of the total O-D passenger traffic in and out of a particular airport, while the second level, more conservative, was fixed to 20%. Figure 17, representing the trends in the number of airports in the total sample with LCC market share greater than 5% and 20%, permits us to visualize some interesting conclusions concerning how deeply low-cost carriers penetrated the Top 200 airports in the US from 1990 to 2008.

In 2008, 144 out of the Top 200 airports had aggregated LCC market share greater than 5%, up from 52 airports in 1990. It is worth pointing out that most of the 52 airports that did have LCC market share greater than 5% in 1990 are large airports from the first and second airport

tiers, whereas most of the 56 airports that did not have aggregate LCC market share greater than 5% by 2008 are small airports included in the fourth tier.

Furthermore in 2008, 47.5% of the airports included in the Top 200-airport sample— 95 of the Top 200 US airports— had aggregated Low Cost carriers' market share greater than 20%, up from only 13.5%— 27 airports— in 1990.

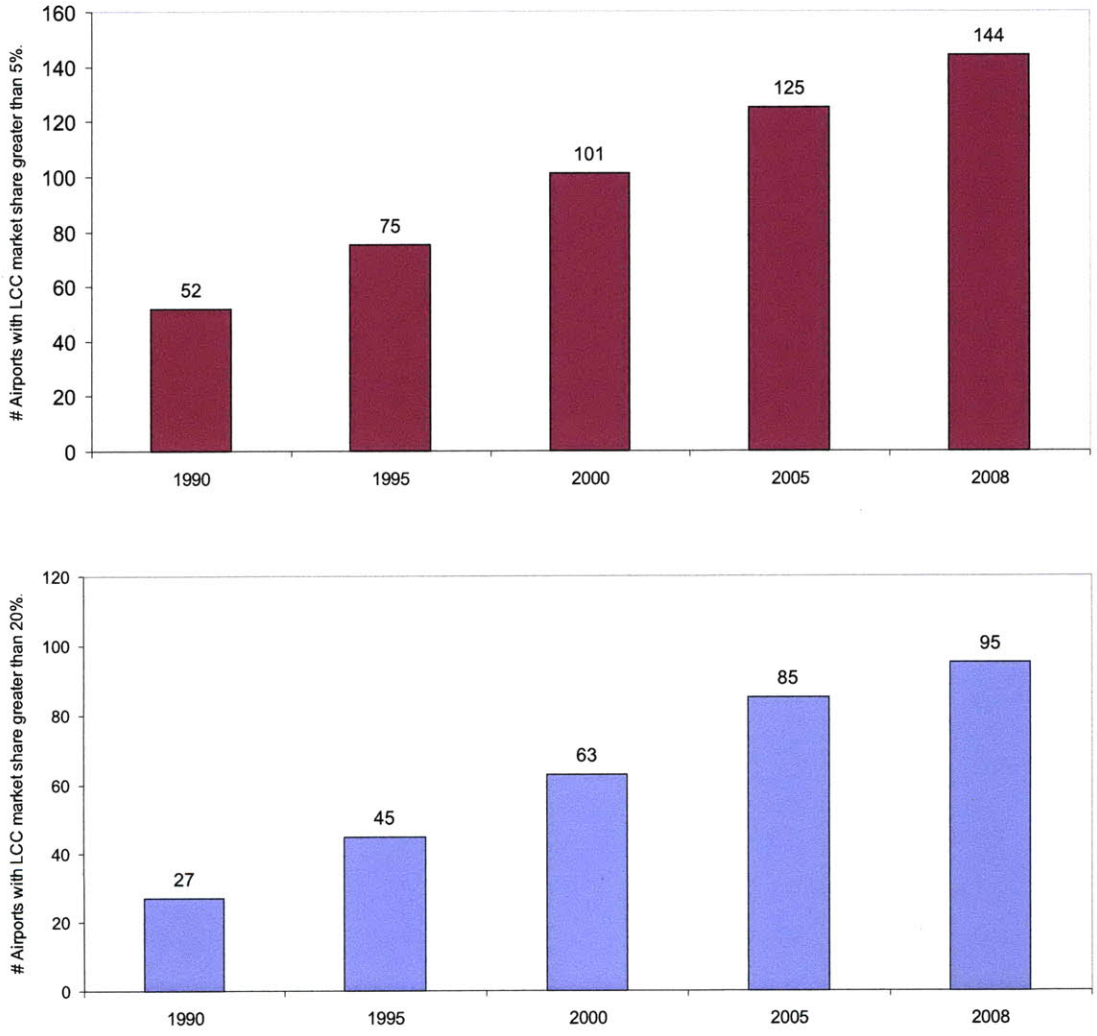


Figure 17: Number of Airports in the Total Sample with an aggregated Low Cost Carriers Market Share greater than 5% and 20%

As we have demonstrated so far, new entrant airlines have been very successful diverting passenger traffic and increasing their market share to the detriment of the Network Legacy carriers. However inside the LCC group, some carriers, especially WN, B6, and FL, have been

outperforming their peers in term of markets presence, competition and growth. In the next section, we analyze the expansion of individual Low Cost carrier, focusing on eight major low-cost airlines out of the 17 that are listed in Section 3.1: AirTran (FL), Allegiant Air (G4), America West Airlines (HP), American Trans Air (TZ), Frontier Airlines (F9), JetBlue Airways (B6), Southwest Airlines (WN) and Spirit Air Lines (NK).

4.3.5 Low Cost Carrier Presence and Market Share by Carrier

Looking at the evolution of the number of airports with presence by carrier as represented in Figure 18, we can infer that all major low-cost carriers except TZ have steadily expanded their networks over time. This observation corroborates previous results and confirms the rapid expansion of Low Cost carriers in the US domestic markets. It should be reiterated that America West Airlines (HP) merged with US Airlines (US) at the end of 2005. The newly formed airline was reporting under the "US" code in 2008. As a consequence, LCC group presence and aggregated market share in the total sample were negatively affected in the 2008 data.

Another interesting note is that JetBlue (B6), which started operating at 12 airports in 2000, is still expanding its presence in the Top 200-airport list as it served 46 airports in 2008. However, Southwest (WN) withdrew from 3 airports in 2008 as compared to 2005, but effectively entered 2 important airports during this period: Washington Dulles/IAD where it achieved 8.1% of passenger market share, and San Francisco International/SFO with 10.5% of passenger market share in 2008. More importantly, with 64 airports served in 2008, WN had the largest presence in the sample among the low-cost carriers group. During January 2010, Southwest was offering flights from 69 airports in the United States[50]. AirTran (FL) also expanded its presence from 22 airports in 1995 to 60 airports in 2008.

[50] http://www.southwest.com/, last accessed 01/14/2010.

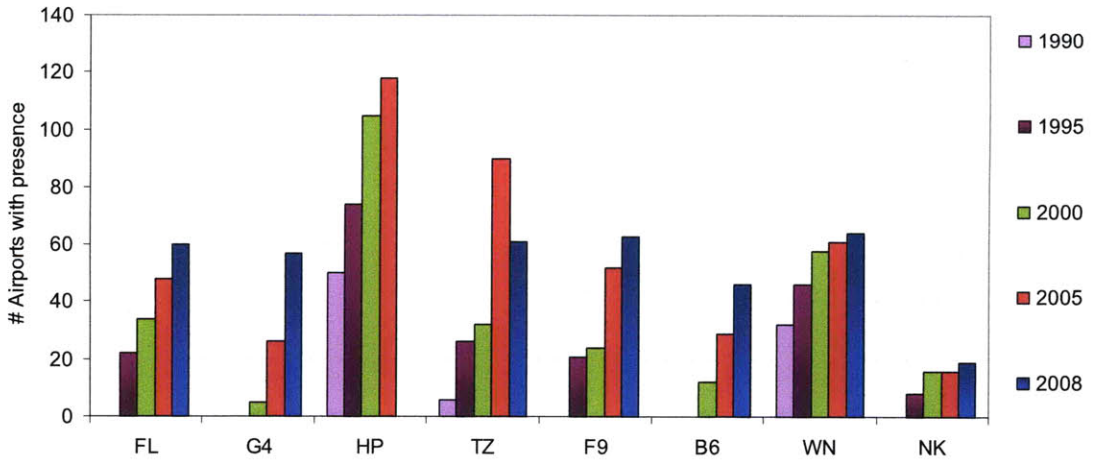


Figure 18: Number of Airports with Presence by Carrier

In order to quantify LCC's penetration, looking at the number of airports with presence by carrier is only part of the equation. To have an accurate and complete picture, we need to analyze the average market share per airport in markets with presence for the major Low Cost carriers.

Figure 19 illustrates the average market share per airport in markets with presence for the major Low Cost carriers, except TZ which had a very low average market share— 0.15% in 2008. JetBlue (B6) has increased its average market share from 2.6% per airport with presence at its beginning in 2000 to 11% in 2008. Although B6's average market share at airports with presence slightly decreased between 2005 and 2008, the carrier expanded to 17 new airports during that period, a fact that highlights the continuing low-cost carriers' healthy growth in the United States. AirTran (FL) has also been very successful; the low-cost carrier not only increased market share in its airports— from 1.2% in 1995 to 11.9% in 2008, but also expanded from 22 to 60 airports during the same period.

Another important observation is that Southwest has significantly increased its market share at the airports that it served; WN's average market share grew from 29.6% in 1990 to 38.8% in 2008. In other words, it had an average market share of 38.8% across the 64 markets where it was present in 2008.

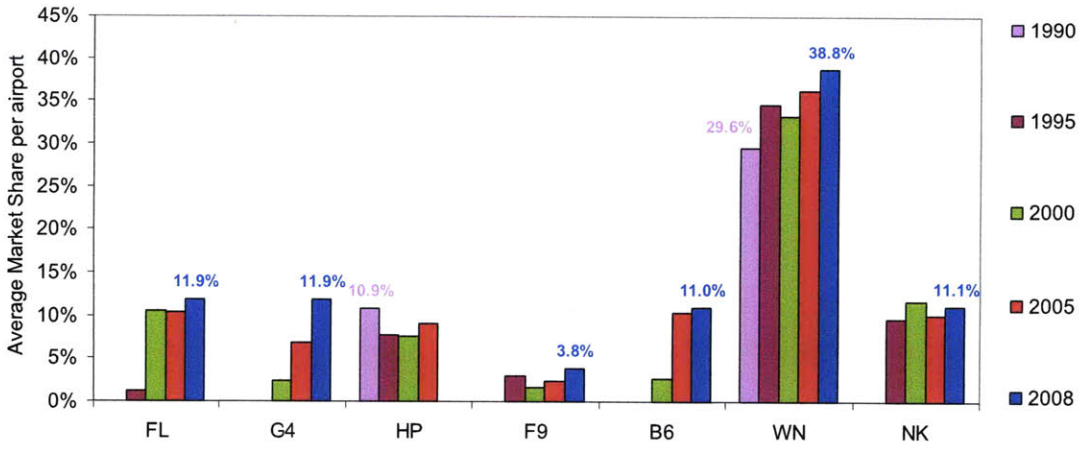


Figure 19: Average Market Share at Airports with Presence by Carrier

In order to realize the extent of Southwest's growth between 1990 and 2008, we represent in Figure 20 the distribution of WN's market share per airport in 1990 and 2008, for all the airports with WN's presence. Thus, we can observe that Southwest expanded its presence in the total sample from 32 airports in 1990 to 64 airports in 2008. More importantly, WN has significantly enhanced its competitive positions at the airports that it served. Specifically, WN had a market share greater than 50% in 18 airports in 2008 compared to seven airports in 1990. In the same way, WN held market shares ranging between 30% and 50% in 22 airports in 2008, up from only six airports in 1990. For instance, WN, which began service to Sacramento Metropolitan/SMF in 1991, carried 45.3% of the total domestic O-D passenger traffic at SMF by 1995, and gained a market share of 54% in 2008.

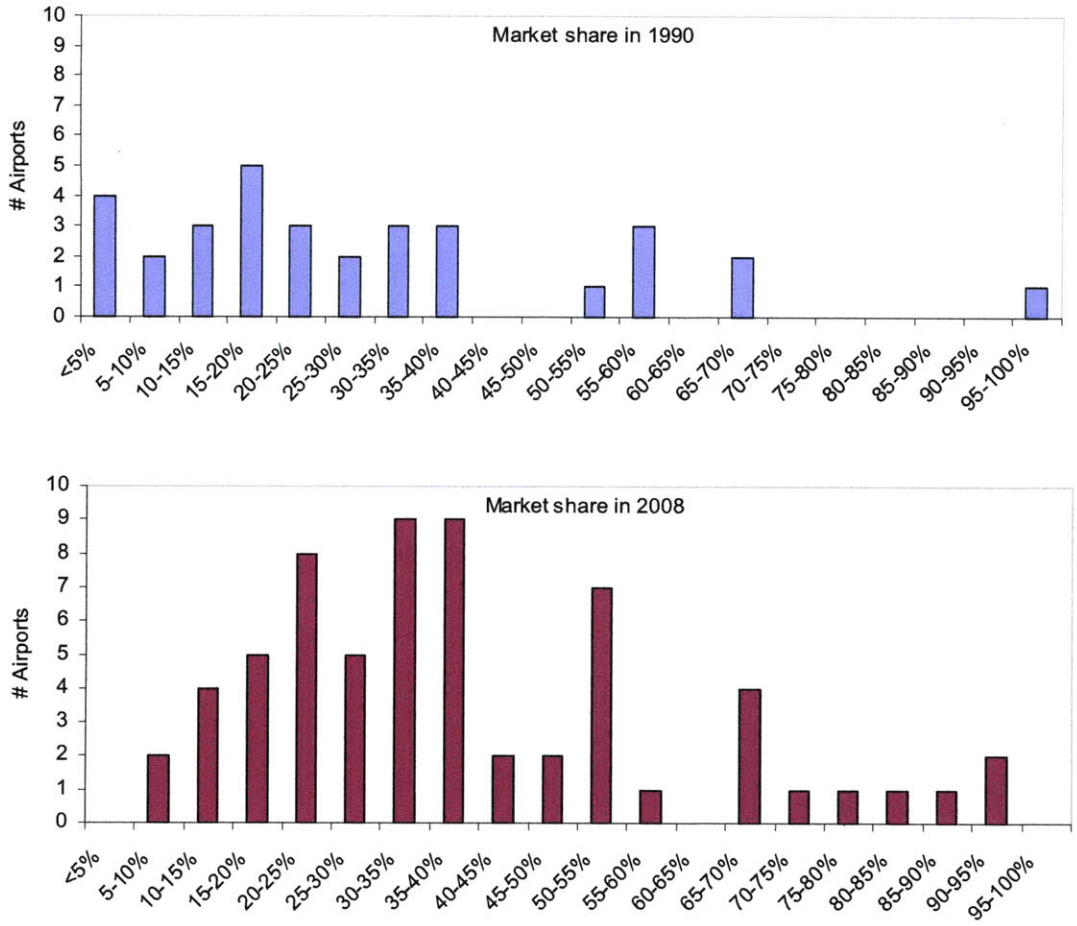


Figure 20: Distribution of Southwest's Market Share per Airport in 1990 and 2008

As we have shown so far, the unrelenting and rapid growth of LCC in the US domestic market led the LCC group to control 33.6% of the total domestic O-D passenger traffic at the Top 200 airports in 2008. The new entrant airlines also took the opportunities to expand their networks and enter new airports, offering more flights to more destinations, thus enhancing the levels of commercial air service at more airports. In particular, individual carriers, such as WN, B6 or FL, gained significant passenger market share at the airports where they competed not only against Network Legacy carriers, but also against other Low Cost carriers. Following these findings, we can aptly ask several questions: What are the implications of LCC's expansion on passenger volumes and fares? Is there clear evidence of market stimulation by low-cost carriers? To what extent are fares impacted by substantial changes in LCC's market share? And to what extent are airfares in an airport impacted by LCC entering the market?

4.3.6 Impacts of Low Cost Carriers' Expansion on Traffic and Fares

In order to analyze the impacts of LCC's expansion on traffic and fares in the Top 200 sample, we need to define "LCC's expansion". Low Cost carriers' penetration of the Top 200 airports studied in this thesis can be decomposed into two distinct phenomena, which we assume to have different impacts on the market dynamics and the level of competition at the airport. The first phenomenon is a LCC effectively entering an airport with no-prior LCC's presence, introducing discounts flights to the local passengers. As in Section 4.3.4, we define LCC's effective entrance into an airport as a growth in LCC aggregated market share from 0% at time 1, to more than 5% at time 2. The second phenomenon is a substantial growth in LCC's market share, which we define as a growth in LCC aggregated market share by more than 10% between time 1 and time 2, given an LCC aggregated market share greater than 5% at time 1. The reader should understand that this last condition is set to prevent overlapping between airports with LCC "substantial growth" and airports with LCC "effective entrance". At airports with LCC substantial growth, the LCC gain visibility and reinforce their competitive position, impacting passenger volumes and average fares.

		1995 v. 1990	2000 v. 1995	2005 v. 2000	2008 v. 2005
Total Sample	# airports	195	196	199	200
	average fare changes	*-2.10%*	*14.85%*	*-11.11%*	*15.75%*
Airports with LCC substantial growth	# airports	23	11	26	19
	average fare changes	*-16.80%**	*2.85%**	*-17.66%**	*10.52%**
Airports w/o LCC substantial growth	# airports	172	185	173	181
	average fare changes	*1.69%**	*16.10%**	*-9.21%**	*16.72%**

		1995 v. 1990	2000 v. 1995	2005 v. 2000	2008 v. 2005
Total Sample	# airports	195	196	199	200
	average fare changes	*-2.10%*	*14.85%*	*-11.11%*	*15.75%*
Airports with LCC effective entrance	# airports	23	15	15	8
	average fare changes	*-5.07%*	*-10.98%**	*-16.65%**	*12.82%*
Airports w/o LCC effective entrance	# airports	172	181	184	192
	average fare changes	*-1.75%*	*15.22%**	*-11.04%**	*15.76%*

Table 3: Impact of LCC "Substantial Growth" and "Effective Entrance" on Average Fares
** means that t-test yields statistically significant difference of means at the 90% confidence level (or 10% significance level)*

It is important to mention that the average fare changes, summarized in Table 3, are weighted averages computed proportionally to passenger traffic at each airport as a proportion of the total traffic in the total sample. This aims to avoid potential distortions engendered by disparity in average fares and passengers volumes between the largest and smaller airports. Analyzing the data in Table 3, we can observe that average fares decreased, on average, by 16.8% in the 23 airports that saw an LCC substantial growth between 1990 and 1995. In contrast, average fares increased by 1.69% in the 172 airports that did not experience an LCC substantial growth during this period. Similarly, average fares declined by 10.98% between 1995 and 2000 in the 15 airports with LCC effective entrance, whereas average fares increased by 15.22% at the remaining 181 airports during the same period. This trend is true for every period represented in Table 3. After performing t-tests, we can conclude that the LCC effective entrance or substantial growth at a particular airport had a statistically significant impact, lowering average fares.

Analyzing the data summarized in Table 4, we can observe that passenger traffic rose on average by 28.54% in the 26 airports with LCC substantial growth between 2000 and 2005, while passenger volumes increased only by 4.38% in the remaining 173 airports. These data lead to the conclusion that LCC effective entrance or substantial growth at an airport stimulated significantly passenger traffic in this market. However, this LCC market stimulation effect is leveling off; passenger volumes grew by 145% at airports with effective LCC entrance between 1995 and 2008, while traffic decreased by 4.73% at airports with LCC entrance between 2005 and 2008.

		1995 v. 1990	**2000 v. 1995**	**2005 v. 2000**	**2008 v. 2005**
Total Sample	# airports	195	196	199	200
	average traffic changes	*22.93%*	*25.59%*	*9.83%*	*-0.15%*
Airports with LCC substantial growth	# airports	23	11	26	19
	average traffic changes	*43.79%**	*50.04%**	*28.54%**	*11.17%**
Airports w/o LCC substantial growth	# airports	172	185	173	181
	average traffic changes	*17.55%**	*23.06%**	*4.38%**	*-2.23%**

		1995 v. 1990	**2000 v. 1995**	**2005 v. 2000**	**2008 v. 2005**
Total Sample	# airports	195	196	199	200
	average traffic changes	*22.93%*	*25.59%*	*9.83%*	*-0.15%*
Airports with LCC effective entrance	# airports	23	15	15	8
	average traffic changes	*32.23%*	*145.38%**	*15.89%*	*-4.73%*
Airports w/o LCC effective entrance	# airports	172	181	184	192
	average traffic changes	*21.83%*	*23.90%**	*9.75%*	*-0.13%*

Table 4: Impact of LCC "Substantial Growth" and "Effective Entrance" on Passenger Volumes
** means t-test yields statistically significant difference of means at the 10% significance level*

4.4 Quantitative Analysis of Competition at the Airport Level

An airport could be defined as a "market" and the airlines that serve it are the competing firms. In this section, we analyze the level of competition between commercial airlines at the airport level. The objective is to understand the evolution of airport market concentration for the Top 200 airports studied in this thesis. In order to quantify the market concentration, we used two metrics— the Concentration Ratio (CR) and the Herfindahl-Hirschman Index (HHI). These two metrics have been described in Section 2.1. We also investigate in this section the evolution of market leader positions by carrier, identifying winners and losers of market shares among US airlines.

4.4.1 Trends in the Number of Effective Competitors

The number of competitors serving a particular airport could be a good first indicator of the level of competition in that marketplace. For example, an airport served by 4 carriers with comparable market shares is theoretically more competitive than a monopoly or a duopoly market. A participant airline in a given market is considered as an effective competitor if it obtains at least 5% of passenger market share in that market. Following this principle, we calculated the number of effective competitors at each airport between 1990 and 2008. Then, we derived the average number of effective competitors per airport as well as the average number of effective competitors by airport group.

After an initial decrease between 1990 and 1995, the average number of effective competitors has been steadily increasing in the total sample, as can be seen in Figure 21. This initial drop in the average number of effective competitors can be explained by the consolidation of hub-and-spoke networks as well as by the mergers between large US airlines during the late 1980s and early 1990s. However, the average number of effective competitors increased as high as 4.62 competitors per airport in 2008, up from 4.01 competitors per airport back in 1995, a fact that can be attributed to the entrance of several new airlines during the 1990s and early 2000s. Among these start-up carriers, we may mention AirTran Airways (FL) which was founded as ValuJet Airlines in 1992, Spirit Airlines (NK) that began operating jet equipment in 1992, and more recently, JetBlue Airways (B6) which started scheduled service in 2000.

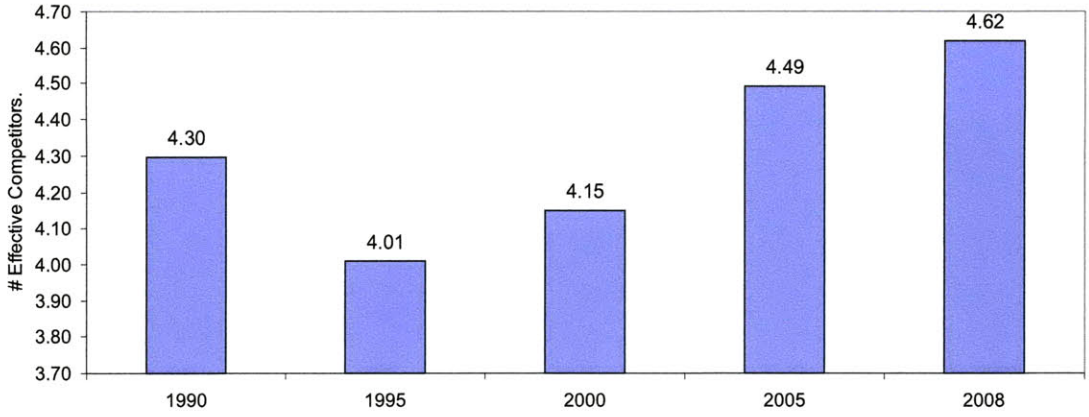


Figure 21: Average Number of Effective Competitors per Airport

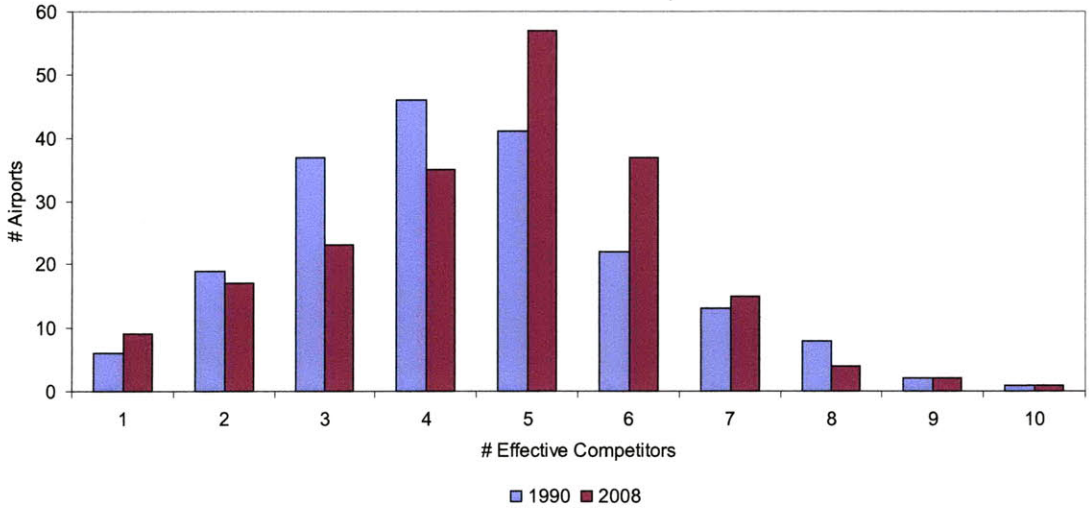


Figure 22: Distribution of the Number of Effective Competitors

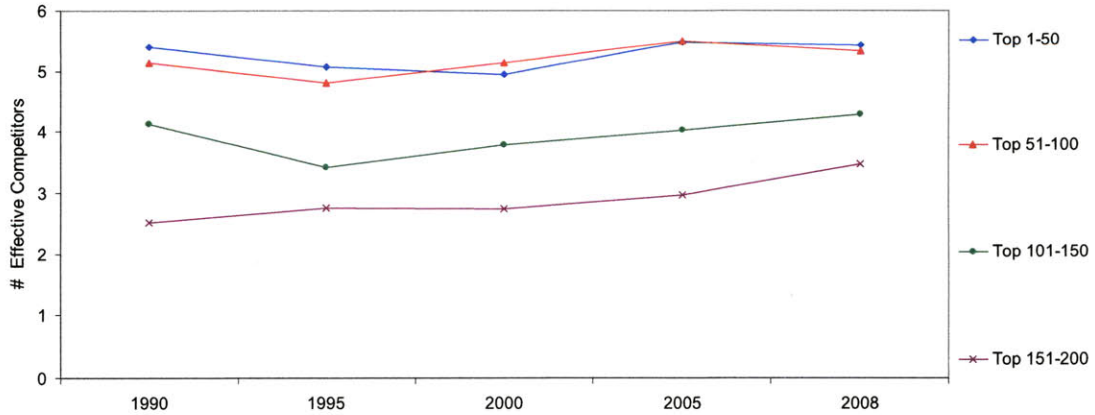


Figure 23: Average Number of Effective Competitors per Airport Group

Comparing the distributions of the number of effective competitors at the Top 200 US airports in 1990 and 2008, as can be seen in Figure 22, we found evidence supporting the pattern just presented. In 2008, there were many less duopoly and markets with 3 or 4 competitors compared to 1990. But, there were significantly more airports with 5, 6 or 7 competitors in 2008 than in 1990, which leads to the conclusion that a number of airports that saw 3 or 4 carriers competing in 1990 have been entered by new competitors, especially low-cost carriers, and hence became airports with 5, 6 or 7 airlines in 2008. Many of the duopoly and 3-competitor airports are Network Legacy carriers' hub airports. The number of monopoly airports increased between 1990 and 2008, as a consequence of LCC dominating some small airports Another very interesting observation is that the standard deviation around the mean number of effective competitors decreased from 1990 to 2008, which means that the distribution of the number of competitors is more concentrated around the mean in 2008 compared to 1990. These findings re-affirm that, in general, the competition increased at the Top 200 US airports between 1990 and 2008.

However, if we take a closer look at the evolution of the average number of effective competitors by airport group, as displayed in Figure 23, we remark that there are profound differences between the largest and smaller airports. As expected, the average number of competitors is significantly higher at the busiest airports compared to the smaller airports. The nation's Top 50 airports account for approximately 75% of the total domestic O-D passenger traffic, attracting carriers' attention. These airports are naturally able to accommodate more competitors than smaller airports not only because they handle a disproportionate share of domestic passenger traffic, but also because they offer the majority of the more profitable international traffic. The Top 50 airports in the Top 200 sample sustained, on average, 5.4 competitors, while airports in the fourth tier have been able to sustain only 3.4 competitors, on average, in 2008.

4.4.2 Airport Concentration levels as measured by the Herfindahl-Hirschman Index

The Herfindahl-Hirschman Index (HHI) measures market concentration. An airport could be defined as a "market" and the airlines that serve it are the competing firms. Hence, we computed the HHI at each airport to measure airport-level market concentration. We derived the

average HHI in the total sample weighted by proportion of passengers per airport relative to the total Top 200 airports' passenger traffic. The result is displayed in Figure 24.

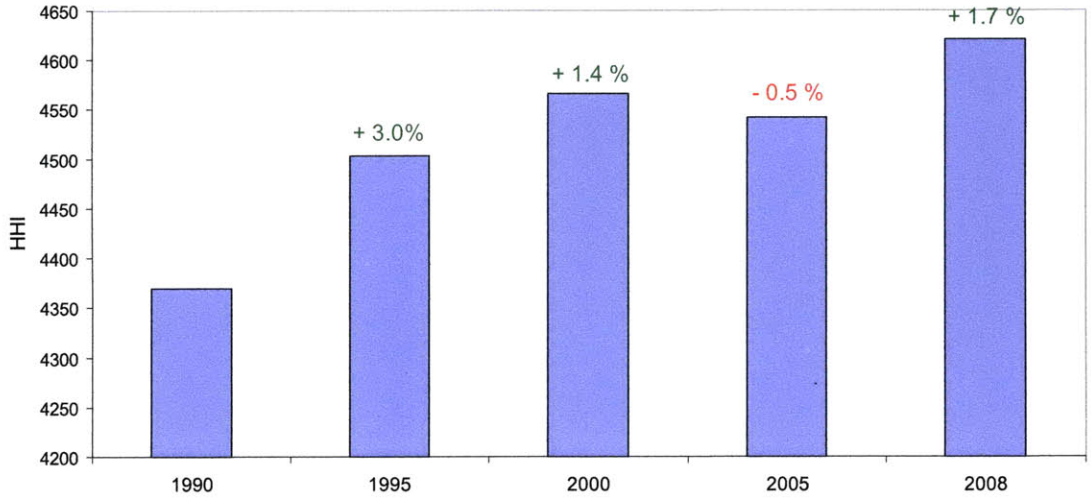


Figure 24: Weighted Average HHI in the Top 200-Airport Sample
(Percentages represent relative changes compared to the previous data point)

By 2008, the average weighted HHI at the Top 200 US airports had increased by 8% compared to 1990; which means that the total sample was more concentrated in 2008 than in 1990. It is interesting to observe that the average HHI increased the most between 1990 and 1995, a consequence of the hub-and-spoke networks' consolidations, and the bankruptcies and mergers that transformed the industry during the late 1980s and early 1990s. More importantly, Figure 25 shows that, since 2000, third and fourth tier airports have seen lower HHIs, while busiest airports increased their average HHI slightly. This trend suggests less concentration and more competition at the airports in the third and fourth tier.

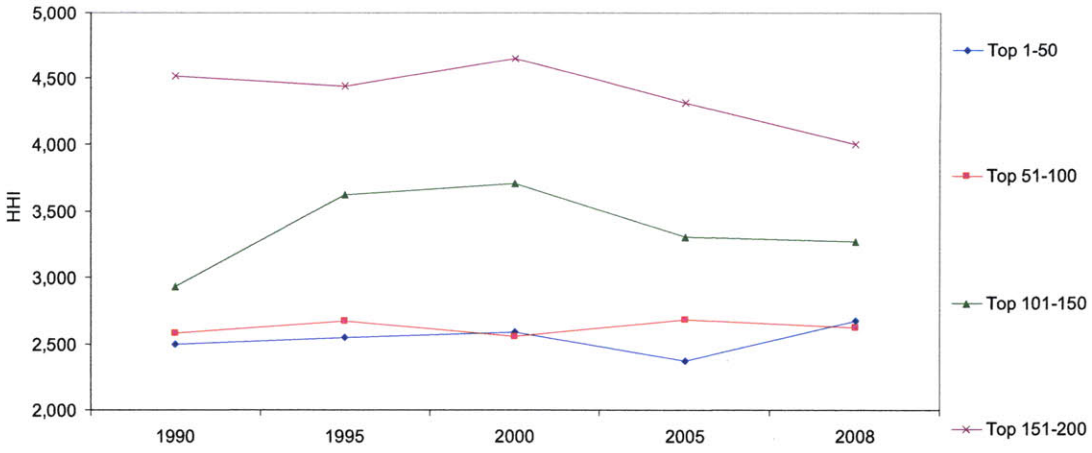


Figure 25: Average Airport Concentration Levels (HHI) by Airport Group

4.4.3 Airport Concentration levels as measured by the Concentration Ratio

The Concentration Ratio (CR), as defined in Section 2.1, is another commonly used measure for market concentration. For example, the 2-firm CR measures the market share of the two main airlines competing in a given airport. We chose to compute the 1-firm and 2-firm CR (CR1 and CR2) at each of the Top 200 US airports. The rationale behind this choice is that in 79.5% of these airports the two main carriers control more than 50% of the passenger traffic. In addition, the CR1 will permit us to analyze the emerging trend where individual carriers are consolidating their capacity to focus on a particular airport. We derived the average 1-firm and 2-firm CR weighted based on proportion of passengers per airport relative to the Top 200 airports' domestic O-D passenger traffic. By according more weight to the busiest airports, we avoid the distortion caused by the difference in passenger volumes among airports; hence we can consider that a randomly chosen passenger in the total sample experienced on average a marketplace characterized by a CR1 and a CR2, as summarized in Figure 26.

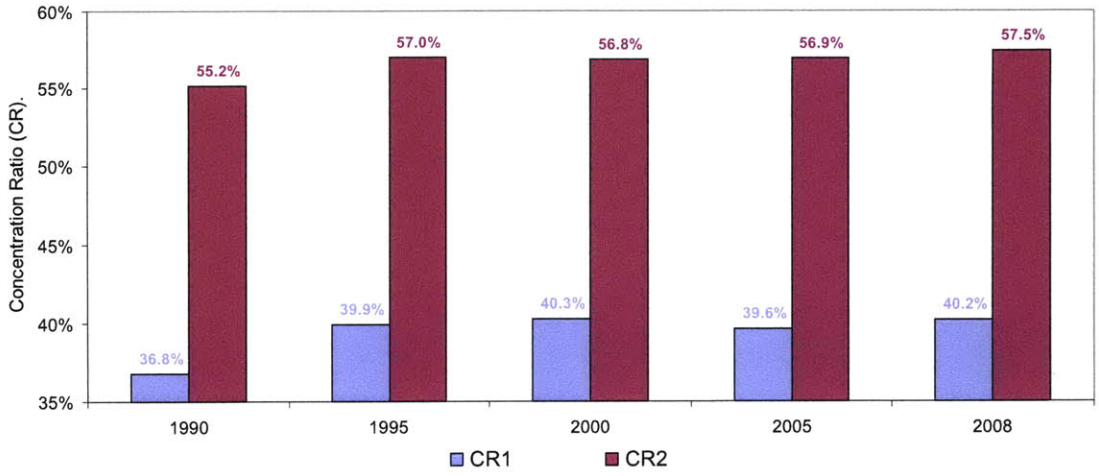


Figure 26: Weighted Average Concentration Ratio (1-firm and 2-firm) in the Total Sample

As we can notice, the weighted average CR1 increased from 36.8% in 1990 to 40.2% in 2008, while the weighted average CR2 rose from 55.2% in 1990 to 57.5% in 2008. These observations lead to the conclusion that the total sample was more concentrated in 2008 compared to 1990. This trend is driven not only by Network Legacy carriers which are consolidating their leader market positions in their hubs and focus cities, but also by LCC which are beginning to dominate a certain number of large, medium and small airports. For example, in 2008, Southwest controlled 70.6% of the domestic traffic in Oakland International/OAK and 79.1% in Chicago's Midway/MDW, while JetBlue dominated the competition at New York's John F. Kennedy/JFK with a domestic passenger market share of 48.8%.

It is worth pointing out that airports in the third and fourth tiers have seen their average CR1 and CR2 decrease since 2000, a fact that confirms previous finding suggesting an increase in the level of competition at the smaller airports. For example, Great Falls International/GTF, which was ranked 189th in the Top 200-airport list in 2008, saw its 1-firm CR drop from 48% in 1990 to 26.8% in 2008 as a consequence of the fierce competition between the two main tenants— Delta (DL) and Northwest (NW), as well as the competition from United Airlines (UA), Alaska Airlines (AS), and the new entrant, low-cost carrier, Allegiant (G4).

At the same time, the nation's busiest airports have experienced an increase in the average concentration ratio mainly due to the reinforcement of market leader positions by NLC at their hubs and focus cities. For example, American Airlines (AA) consolidated its hub presence at

Dallas Fort Worth/DFW, increasing its market share from 55.2% in 1990 to 69.9% in 2008, while Continental Airlines (CO) enhanced its dominant position at New York's Newark/EWR, controlling a market share of 56.3% in 2008, up from 41.4% in 1990. Low Cost carriers have also conquered and reinforced market leader positions at some of the busiest airports. For instance, San Diego International/SAN, which was ranked 17th in 2008, saw its 1-firm CR significantly increase as Southwest (WN) gained 38.6% of passenger traffic in 2008 compared to the 18.1% market share held by US Airlines (US) back in 1990.

4.4.4 Number of Airports with Passenger Market Share Leading Position by Carrier

The fierce competition taking place between Legacy carriers has been brought to a new level by the rapid growth of the Low Cost carriers. One way to figure out which airlines are winning and which ones are losing the competition is to look at the evolution of the number of airports with market share leading position by carrier, over the studied period, as represented in Figure 27 and 28.

It can be observed that LCC, such as WN, B6 and FL, have been very successful because they gained highest passenger market share positions in 62 airports in the Top 200 list. Among the LCC group, WN stood out as it had 48 airports with market share leading position in 2008 compared to 15 back in 1990. Although WN was present in only 64 airports in 2008, it had the highest number of airports with leading market share position among all airlines. On the other hand, Legacy carriers have lost ground to LCC. The decline has been severe for US Airways which lost its leading position in 35 airports from 1990 to 2008.

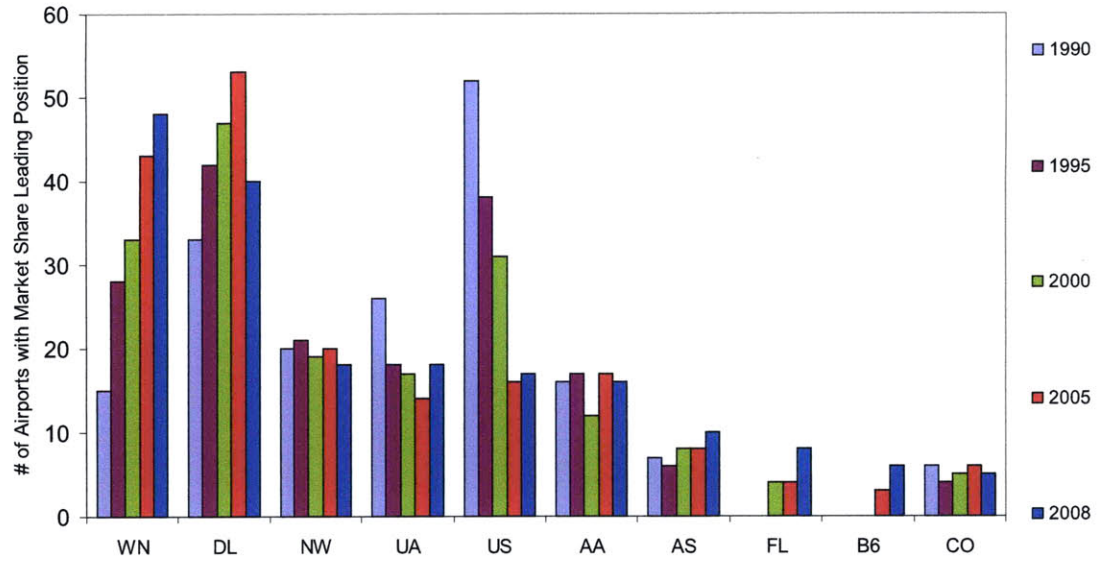


Figure 27: Number of Airports with Market Share Leading Position, by Carrier

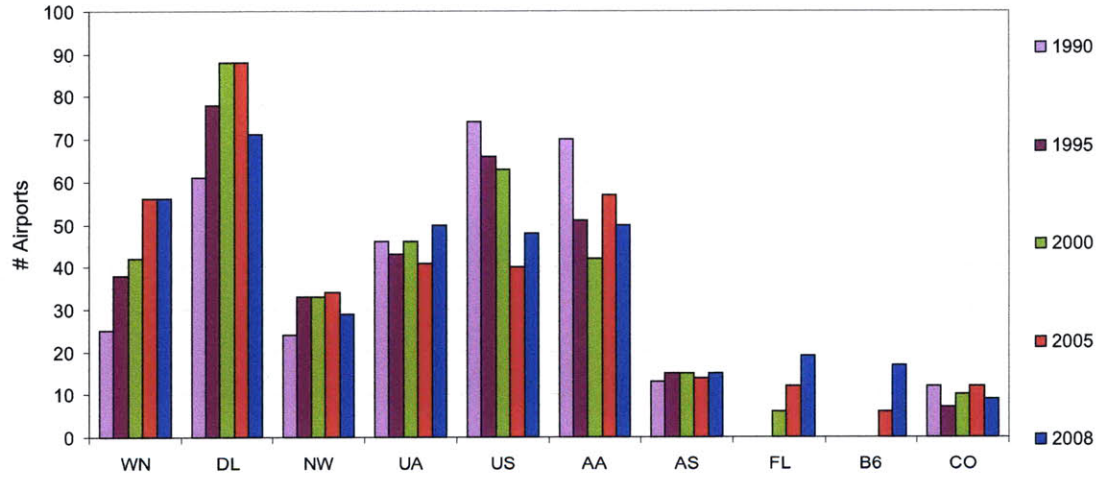


Figure 28: Number of Airports with Either First or Second Highest Market Share, by Carrier

4.4.5 Relationship between Passenger Traffic and Herfindahl- Hirschman Index

In Figure 29, which displays domestic passenger traffic plotted against HHI for the Top 50 US airports in 2008, we can distinguish three outstanding airports categories. To begin with, the first category groups Las Vegas McCarran/LAS, Los Angeles International/LAX and Orlando International/MCO. These airports are ranked respectively first, second and third in terms of

domestic O-D passenger traffic in 2008. These airports are characterized by very low HHIs, a fact that reflects the high level of competition in these "unconcentrated" markets. Passenger traffic at these popular leisure destinations is fragmented between 6 to 9 effective competitors. It is worth mentioning that WN held the highest market share in each of these 3 airports. In particular, WN is still expanding in LAS, controlling 37.5% of the passenger traffic in 2008. As a result, WN located in LAS its eighth and newest crew base in 2007[51].

The second airports category groups 3 large hubs: Chicago O'Hare/ORD, Atlanta Hartsfield/ATL and Dallas Fort Worth/DFW. These airports are characterized by high passenger volumes, but they also have in common relatively high HHIs (between 3,000 and 5,000) due to the fact that they are hub airports, and hence dominated by one or two Legacy carriers. Indeed, ORD, ATL and DFW are hub airports respectively for American Airlines (AA) and United Airlines (UA), Delta (DL), and American Airlines. In 2008, these 3 airports had only 2 to 3 effective competitors, which reflect relatively high levels of market concentration.

Finally, the third airport category shown includes Chicago's Midway/MDW and Oakland Metropolitan/OAK. The singularity of these two airports is that they are both dominated by Southwest Airlines despite relatively high passenger volumes; In 2008, WN controlled 70.6% and 79.1% of the total O-D passenger traffic respectively at OAK (ranked 27th) and MDW (ranked 24th). OAK and MDW are two secondary airports located respectively in the Chicago metropolitan area and the San Francisco bay area. However, a small difference exists between these two Southwest fortresses; In Chicago metropolitan area, WN focused its capacity on MDW and did not serve ORD, whereas WN served all three airports located in the San Francisco multi-airport system: i.e., OAK, San Jose/SJC, and San Francisco International/SFO.

Other than these three notable groups, there is no clear relationship that stands out between the passenger traffic at an airport and the concentration level at this airport, as measured by the HHI. However, in general we can say the "higher the level of passenger traffic at a particular airport, the lower the HHI".

[51] www.southwest.com, last accessed 01/18/2010.

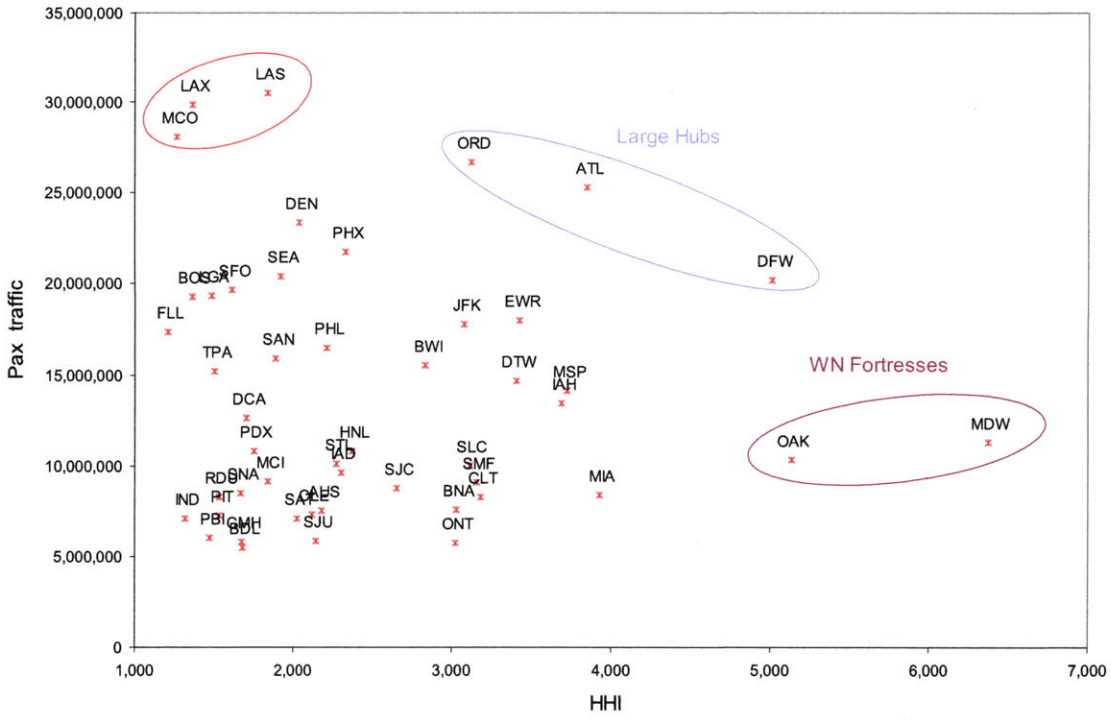


Figure 29: Top 50 US Airports Domestic Passenger Traffic Vs. Herfindahl-Hirschman Index In 2008

Figure 30 and Figure 31 represent the evolution between 1990 and 2008 of the domestic passenger traffic and the Herfindahl-Hirschman Index for the Top 20 airports as ranked by passenger volumes in 2008. As we can observe, 16 out of the Top 20 airports have recorded increases in their HHIs, reflecting augmentation in market concentration at these airports. In 7 out of these 16 airports (ORD, ATL, PHX, DFW, EWR, PHL, DTW), the increase in the level of HHI can be directly attributed to the reinforcement of market leader/dominant position by one Legacy carrier at its hub airport. For instance, the HHI level increased the most at Dallas Fort Worth/DFW— from 3,742 in 1990 to 5,017 in 2008—as American Airlines consolidated its dominant position at its hub, while Delta Airlines abandoned DFW as a hub. In other cases, the increase in the level of HHI at a particular airport is due to the rapid growth of a Low Cost carrier. For example, the HHI in JFK rose from 2,019 in 1990 to 3,077 in 2008 as result of B6 gaining 48.8% of domestic passenger traffic at JFK. Similarly, the increase in the level of HHI at San Diego/SAN is a consequence of WN gaining 38.6% of the total domestic O-D traffic at SAN.

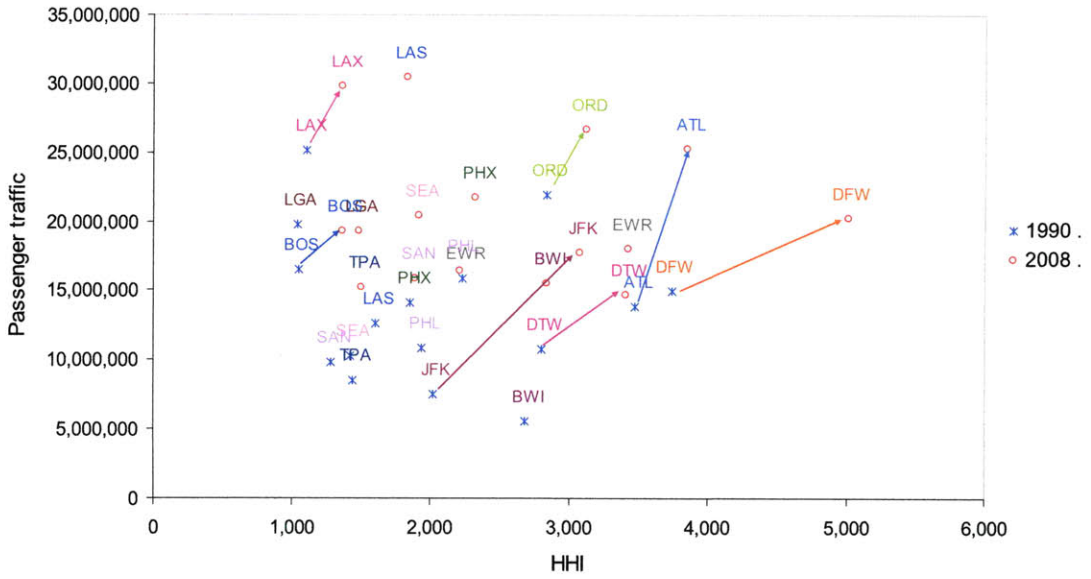


Figure 30: Airports, Ranked in the Top 20 in 2008, that experienced an increase in HHI between 1990 and 2008

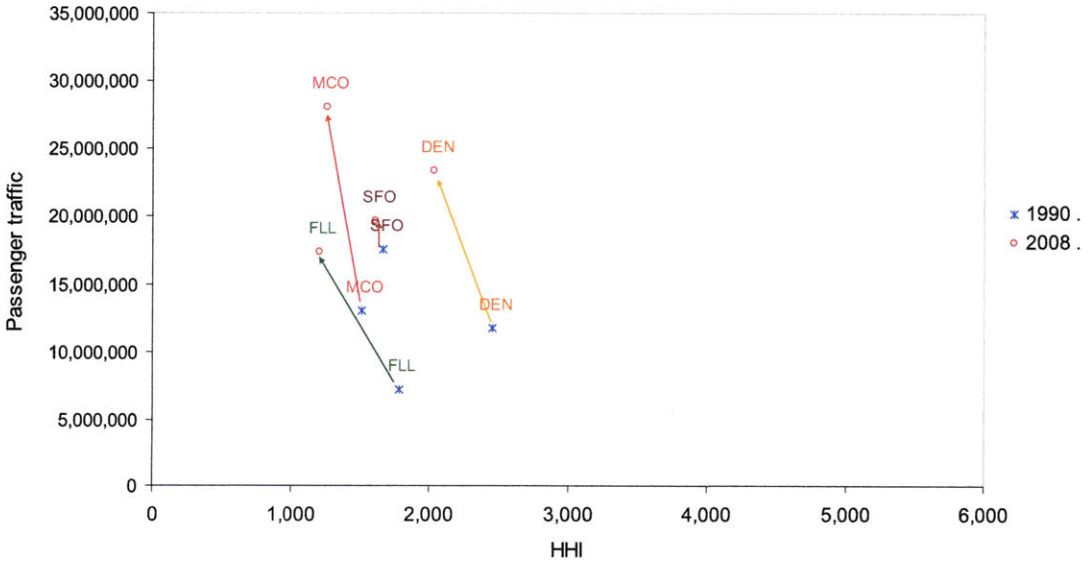


Figure 31: Airports, Ranked in the Top 20 in 2008, that experienced a decrease in HHI between 1990 and 2008

On the other hand, four airports out of the Top 20 have seen a decrease in HHI between 1990 and 2008, as we can observe in Figure 31. These drops highlight an increase in the level of competition at these popular destinations, a fact that can be attributed to several LCC entering

these markets and competing fiercely not only against NLC but also against each other. To illustrate this point, Fort Lauderdale/FLL saw its HHI decrease from 1,784 in 1990 to 1,211 in 2008. This airport, which was essentially divided between DL, US and Eastern Airlines (EA) in 1990, was successively penetrated by new entrant carriers, such as Spirit Air Lines (NK), FL, WN and B6. As a consequence, the number of effective competitors in FLL increased from 5 to 8 carriers between 1990 and 2008, and the competition has been brought to a new level with multiple LCC fiercely competing to gain more passenger market share at this major leisure destination. As a result, WN, B6 and NK, which have significantly increased their market shares at FLL, ranked respectively first, second and fourth in terms of passenger traffic in 2008, totaling 47.3% of the total domestic O-D passenger traffic at this airport.

4.5 Segmentation between Hub and Non-Hub Airports

In this section, we differentiate between the hub airports of the six Legacy carriers and the non-hub airports included in the Top 200-airport list. The objective of this segmentation is to analyze the differences in trends between the hub and non-hub airports. We compare the changes in passenger traffic, revenues and average fare at hub and non-hub airports. As it was discussed in the literature review presented in Chapter 2, all NLC adopted hub-and-spoke network structures realizing the fundamental economics benefits and operational advantages of hubs. In particular, Legacy carriers are able to charge a yield premium for the local traffic in and out of their respective hub markets. This ability of a dominant airline to generate a higher yield than the average within a market or across a set of markets is due to domination and concentration at the airport and intern route level. Thus, the following segmentation analyzes the evolution of hub airports' market concentration as well as the consolidation of domestic hubs between 1990 and 2008.

Airport Code	*Hub Airports*	*Hub Airline*	*Connecting Ratio*[52]
DFW	Dallas/ Fort Worth	American Airlines	59.8%
ORD	Chicago O'Hare	American Airlines	52.9%
STL	St. Louis International	American Airlines	23.2%
IAH	Houston	Continental Airlines	59.9%
EWR	New York/ Newark	Continental Airlines	27.4%
CLE	Cleveland	Continental Airlines	31.3%
ATL	Atlanta	Delta Air Lines	68.0%
CVG	Cincinnati	Delta Air Lines	70.5%
SLC	Salt Lake City	Delta Air Lines	47.5%
DTW	Detroit	Northwest Airlines	51.7%
MSP	Minneapolis/ St. Paul	Northwest Airlines	53.0%
MEM	Memphis	Northwest Airlines	65.8%
ORD	Chicago O'Hare	United Airlines	52.9%
DEN	Denver	United Airlines	49.9%
IAD	Washington/ Dulles	United Airlines	43.7%
CLT	Charlotte	US Airways	74.6%
PHL	Philadelphia	US Airways	39.9%
PHX	Phoenix	US Airways	41.5%
PIT	Pittsburgh	US Airways	12.9%

Table 5: Major Domestic Hubs in the US sorted by Legacy Carrier

[52] Connecting Ratios correspond to YE 1Q 2009, Source: Cassotis, C., *"Airline Bankruptcy: Service Cut Impacts of a Major Carrier at US Airports"*, SH&E, October 2009.

Table 5 lists the 18 airports that were considered as domestic hubs for the six NLC in this analysis. These hub airports were primarily selected according to their connecting ratio during the first quarter of 2009, i.e., the ratio of the number of passengers connecting through the hub (as opposed to local traffic) over the total number of enplanements at this hub, except for St. Louis/STL and Pittsburgh/PIT that were selected for different reasons. Indeed, St. Louis hub is a result of the Trans World Airlines (TWA) acquisition by American Airlines in 2001, while Pittsburgh used to be an important hub for US Airways before it decided in 2004 to concentrate its operations in its Charlotte and Philadelphia hub airports and to drop PIT as a hub. Another important note is that although Phoenix/PHX was not a hub for US Airways until the merger with America West Airlines (HP) at the end of 2005, we have included PHX in the hub list, in order to be consistent with the St. Louis case (since STL was considered as hub for AA). More importantly, this analysis disregarded airports with a high connecting ratio but with very high proportion of international connections, such as Miami international/MIA, hub for American Airlines, because this thesis concentrates on domestic O-D traffic.

The first fact to point out when looking at passenger traffic and revenues in Figure 32 is that the 18 hub airports accounted for 28.9% of the total domestic O-D passengers at the Top 200 airports in 1990, while generating 32.1% of the total revenues. This difference between percentages of traffic and revenues suggests that average fares for local traffic at hub airports are higher than prices on routes where both origin and destination are non-hub airports. This last statement is corroborated by the fact that average fares at hub airports are consistently higher than the average fares at non-hub airports, as displayed in Figure 32. This result is partially due to the fact that average haul at hub airports is longer than average haul at non-hub airports. However, the gap in average fare between hub and non-hub airports has narrowed since 2000 to reach a minimum of $10 in 2008. As a result, the hub airport group handled 28.9% of the total traffic in the total sample and generated 30.2% of the total revenues in 2008.

It is also interesting to observe that the evolution of passenger traffic at the hub and non-hub airports has followed the same trends as passenger traffic in the total sample; That is, a 49% and 54% increase in passenger traffic respectively for hub and non-hub airports between 1990 and 2005, followed by a 2% decrease between 2005 and 2008. The recent drops are due to the global economic crisis that started in 2008, and to the increases in average fares— 15 and 17%— recorded between 2005 and 2008 as a result of the soaring jet fuel prices.

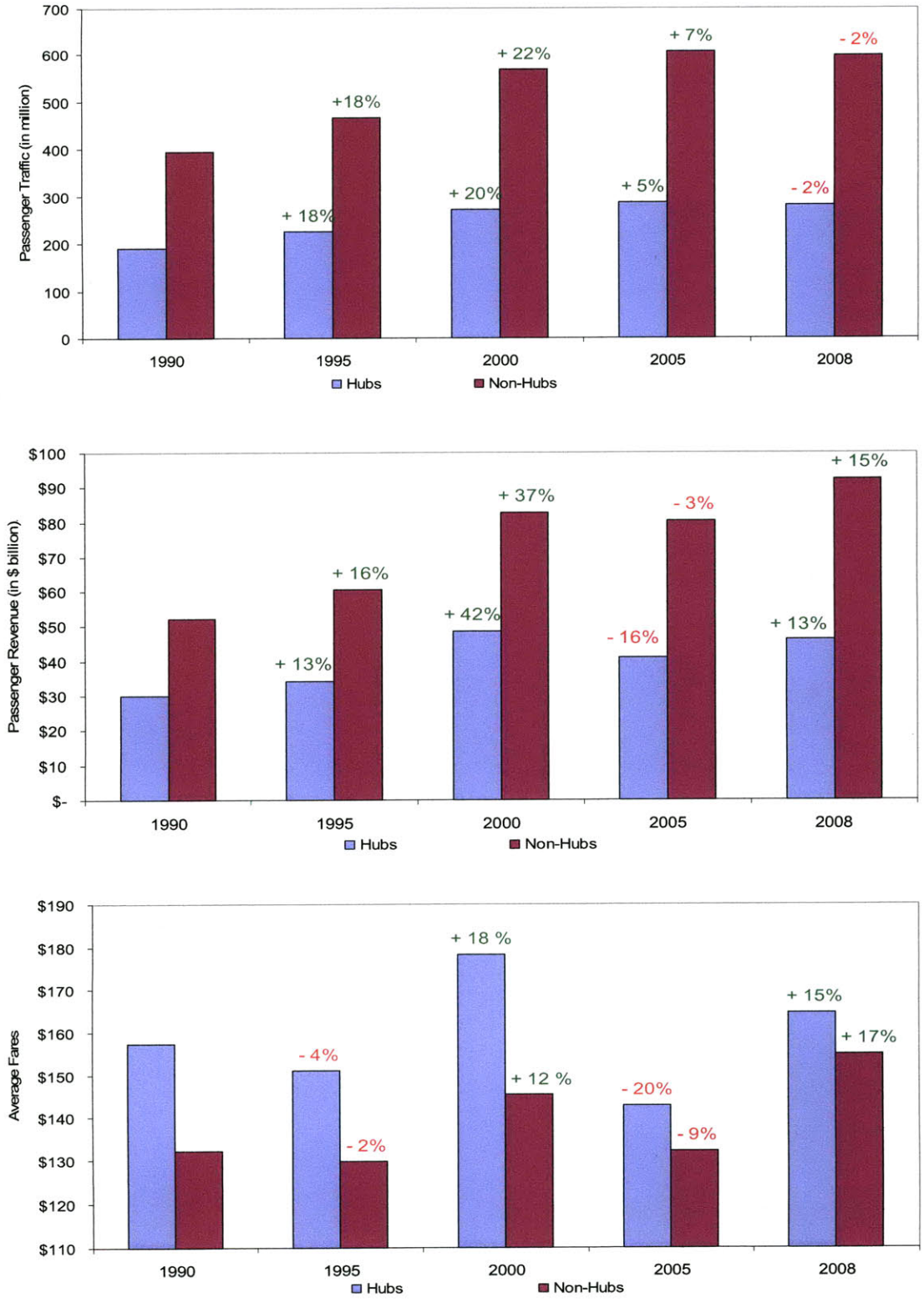


Figure 32: O-D Domestic Passenger Traffic, Revenues and Average Fare at Hub and Non-Hub Airports

During the industry down-cycle that started in 2001 and ended in 2005, we can observe that passenger revenues decreased by 16% and 3% respectively at hub and non-hub airports, following the decreases in average fares. The drop in average fare was more pronounced at hub airports compared to non-hub airports— respectively 20% and 9%, a fact that can be explained by the fiercer competition in hub airports; LCC expanded in priority at the largest 50 airports, as shown in Figure 16. In particular, LCC continued their rapid growth at hub airports between 2000 and 2005. Indeed, LCC share of total domestic O-D passengers at hub airports increased from 13.8% in 2000 to 20.2% in 2005. As a consequence, the increasing level of competition at hub airports obliged Legacy carriers to match LCC lower fares.

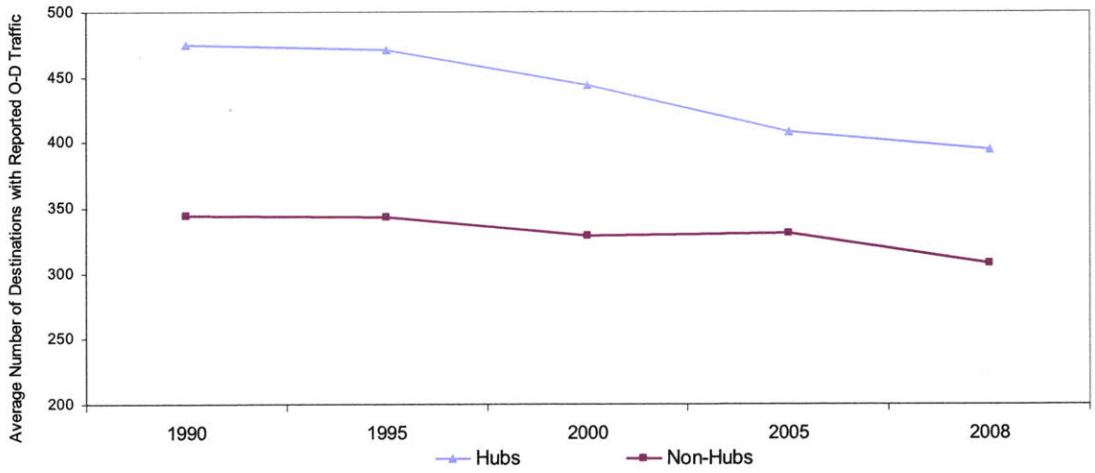


Figure 33: Average Number of Destinations with Reported O-D Traffic for Hub and Non-Hub Airports

Looking at Figure 33, it becomes evident that the average number of destinations with reported O-D traffic decreased by 17% and 11% respectively at hub and non-hub airports between 1990 and 2008. The average number of destinations decreased the most between 2000 and 2005 for hubs— 8%— and between 2005 and 2008 for non-hubs—7%.

Analyzing the evolution of hubs' market concentration between 1990 and 2008, we found that the HHI increased at nine hubs. In particular, the HHI increased the most at DFW and EWR where, respectively, AA and CO consolidated their market dominance. During the same period, nine hub airports saw a decrease in their HHI. PIT and CLT recorded the biggest decreases in HHI, as a consequence of US Airways dropping its PIT hub and losing market share in CLT.

4.6 Airport "Winners" and "Losers" of Traffic

As we study the evolution of domestic passenger traffic at the Top 200 airports in the United States, we observe that some airports have gained traffic, while other airports have lost traffic. Indeed, 152 airports have increased their passenger volumes between 1990 and 2008, whereas 48 airports have lost traffic during this period. In this section, we differentiate airports in the total sample into two groups: growing airports and shrinking airports. Then, we analyze the characteristics and attributes common to airports included in each group; i.e., airport "winners" and airport "losers" of traffic.

4.6.1 Growing Airports

Looking at Figure 34, it becomes evident that leisure destination, such as LAS, MCO and FLL, are the biggest winners in terms of absolute value changes in passenger traffic. LAS, MCO and FLL increased their domestic O-D passenger volumes respectively by 17.8, 15.1 and 10.1 million passengers between 1990 and 2008— increases of 142%, 116% and 142%. This observation highlights the growth in leisure demand for air travel in the US.

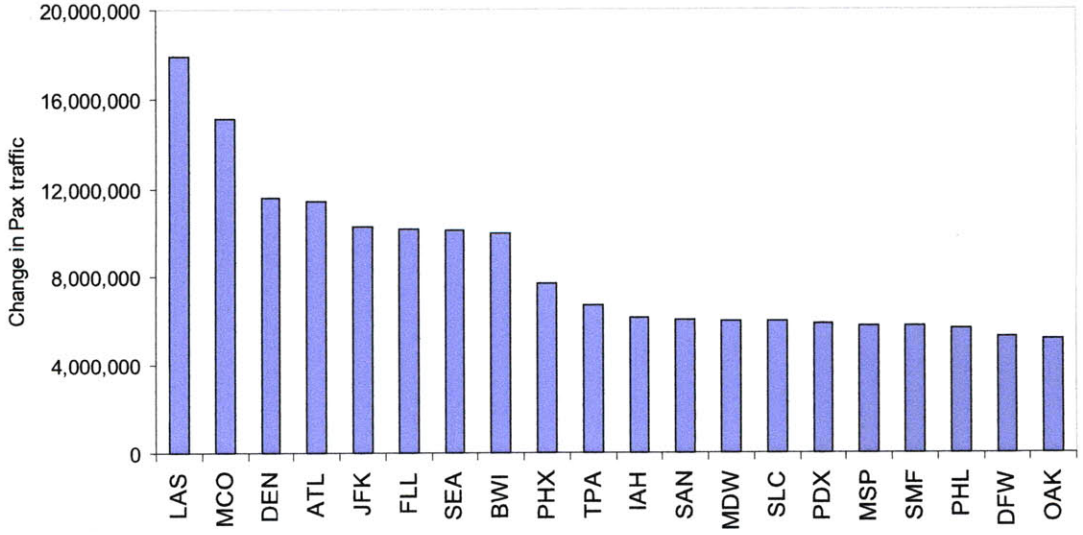


Figure 34: Airports with Greatest Traffic Growth in Absolute Value between 1990 and 2008

Other major airports with large catchment areas and rapidly growing populations, such as Denver international/DEN, ATL and JFK, have also experienced a significant increase in traffic over the studied period. These three airports have in common a significant LCC presence in addition to one Network Legcay carrier's hub. DEN is an important hub for United Airlines as well as a "focus city" for Frontier Airlines (F9) and for Southwest Airlines. In 2008, UA, F9 and WN carried respectively 33.8%, 22.8% and 16.3% of the total domestic O-D passenger traffic at DEN. Furthermore, ATL is the primary hub for Delta and AirTran with respective domestic passenger market share of 56.5% and 24.4% in this airport. Finally, JFK is a "base" for JetBlue, a focus city for Delta and a small hub for American. In 2008, B6, DL and AA controlled respectively 24.8%, 20.6% and 14.9% of the total domestic O-D passenger traffic at JFK.

Concentrating on the period 2000-2008, JFK, DEN and LAS have recorded the biggest passenger traffic increases. It is worth pointing out that Philadelphia International/PHL experienced a rapid growth in traffic between 2000 and 2008; the airport saw its passenger traffic increase by 2.8 million. During this period, WN started service at PHL in 2004 and carried 3.6 million passengers in 2008, which suggests that WN entering the market has significantly stimulated the demand for air travel at PHL.

4.6.2 Shrinking Airports

As mentioned above, 48 airports out of the Top 200 airports experienced a decrease in domestic O-D passenger traffic between 1990 and 2008. The 20 airports in the total sample with the greatest traffic losses in absolute value terms are displayed in Figure 35. Miami International/MIA and Honolulu International/HNL have experienced the biggest drops in traffic during the studied period. MIA suffered from a dramatic passenger shifts to the nearby Fort Lauderdale/FLL, whereas HNL lost a proportion of the leisure travelers starting their trips in the continental United States due to competition from new popular leisure destinations such as Las Vegas or Florida resorts. HNL could also have suffered from the new aircrafts with sufficient range to fly from the mainland to the South Pacific. Other small Florida airports that appear in Figure 35, such as Sarasota/SRQ, Melbourne/MLB and Daytona Beach/DAB have lost significant passenger traffic in favor of Tampa International/TPA and Orlando International/MCO. Finally, it is worth pointing out that Cincinnati International/CVG is the only hub airport that lost traffic between 1990 and 2008 mainly because of Delta's hub realignment in 2006.

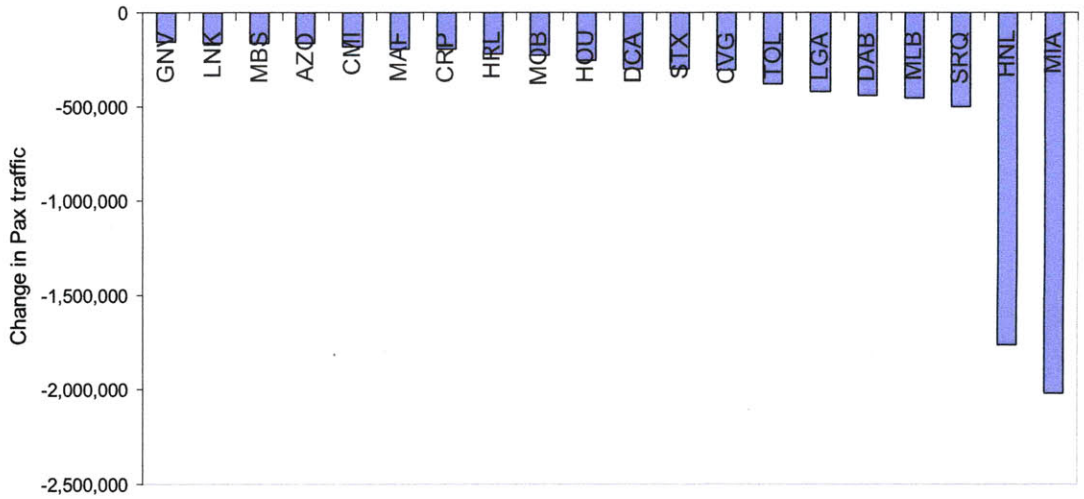


Figure 35: Airports with Greatest Traffic Losses in Absolute Value between 1990 and 2008

Focusing on the period 2000-2008, 90 out of the Top 200 airports experienced a decrease in domestic O-D passenger traffic. That is double the number of airports that saw a traffic reduction between 1990 and 2008, a fact that can be mainly explained by the global economic downturn that started in 2008. Furthermore, it is interesting to observe that Los Angeles International/LAX, San Francisco International/SFO, New York's LaGuardia/LGA, San Jose/SJC and New York's Newark/EWR have recorded the five largest passenger traffic drops, in absolute value terms, between 2000 and 2008. Investigating these drops, we notice a redistribution of traffic between airports located in the same catchment area. For instance, LAX lost 3.4 million passengers between 2000 and 2008, while the nearby Long Beach/LGB, John Wayne International/SNA and Hollywood-Burbank/BUR airports gained respectively 2 million, 1 million and 0.5 million passengers. Similarly, shifts in domestic traffic occurred at the three airports forming the San Francisco multi-airport system. Traffic at SFO and SJC went down respectively by 2.8 and 2.2 million passengers, whereas OAK's passenger volume increased by 0.6 million passengers from 2000 to 2008. Finally, the same redistribution of traffic can be observed in the New York catchment area. LGA and EWR lost respectively 2.3 and 2 million travelers between 2000 and 2008, while JFK, the third primary airport in the New York metropolitan area, saw the largest increase in passenger traffic of all airports in the total sample, with a progression of approximately 8 million passengers— 81%.

4.7 Segmentation between Primary and Secondary Airports

The exceptional growth in demand for air transportation combined with capacity constraints on existing major airports has led to the emergence of secondary airports, and hence Multi-Airport Systems (MAS), in the nation's largest metropolitan areas. In Section 2.1, we defined a multi-airport system as a set of two or more significant airports that serve commercial traffic within a metropolitan region. These significant airports can be differentiated into two categories: primary and secondary airports, based on their relative level of traffic. According to de Neufville (2003)[18], "the typical pattern is that a city has a primary airport that has the most traffic, and one or more secondary airports with between 10 and 50 percent of the traffic of the primary airport." In the following, we built upon this characterization to define primary and secondary airports in a slightly different way. Thus, we consider as "primary" an airport with more than 50% of the traffic of the busiest airport in the multi-airport system, while we define as a secondary airport any commercial airport with between 1 and 50 percent traffic share of the prominent airport in the multi-airport system.

In this section, we study primary airports and secondary airports as two distinct groups: primary and secondary airports have different characteristics. For example, LCC tend to prefer secondary airports because these airports are less congested and have lower facility charges, whereas NLC prefer primary airports, which concentrate international traffic, handle a significant level of connecting passengers, and serve a disproportionate share of total passenger enplanements in the metropolitan region. For this reasons, we based the segmentation of airports into secondary and primary airports not on domestic O-D passenger traffic, but on total passenger enplanements. The objective is to analyze the evolution of passenger traffic, revenues, average fare and market concentration for each of these 2 groups. For example, we hypothesize that secondary airports are handling an increasing share of the total domestic O-D passenger traffic served in the multi-airport systems. In order to verify our assumptions, we concentrated on 15 major multi-airport systems distributed within the United States: New York, Los Angeles, San Francisco, Chicago, Washington, Orlando, Boston, Dallas, Miami, Houston, Philadelphia, Tampa, Detroit, Cleveland, and Norfolk. Table 6 presents the multi-airport systems analyzed in this section and enumerates the 39 airports that are located in these MAS. Each of these 39 airports was categorized as either primary or secondary based on the definition previously adopted and applied to the passenger enplanement figures in 2006. As a result, we obtained a primary group including 20 airports and a secondary group consisting of 19 airports.

Metropolitan Region	Airport Code	Airport name	Passenger traffic enplanements in 2006	Passenger traffic in the MAS	traffic share relative to the airport with most traffic	Airport Type
New York	JFK	New York/Kennedy	40,900,000	104,202,000	-	Primary
New York	EWR	New York/Newark	35,257,000	104,202,000	86%	Primary
New York	LGA	New York/La Guardia	25,791,000	104,202,000	63%	Primary
New York	ISP	New York/Islip	2,253,000	104,202,000	6%	Secondary
Los Angeles	LAX	Los Angeles/Intl	58,603,000	83,366,000	-	Primary
Los Angeles	SNA	Los Angeles/Santa Ana	9,497,000	83,366,000	16%	Secondary
Los Angeles	ONT	Los Angeles/Ontario	6,847,000	83,366,000	12%	Secondary
Los Angeles	BUR	Los Angeles/Burbank	5,675,000	83,366,000	10%	Secondary
Los Angeles	LGB	Los Angeles/Long Beach	2,742,000	83,366,000	5%	Secondary
San Francisco	SFO	San Francisco/Intl	32,355,000	56,943,000	-	Primary
San Francisco	OAK	San Francisco/Oakland	13,991,000	56,943,000	43%	Secondary
San Francisco	SJC	San Francisco/San Jose	10,597,000	56,943,000	33%	Secondary
Chicago	ORD	Chicago/O'Hare	73,851,000	91,581,000	-	Primary
Chicago	MDW	Chicago/Midway	17,729,000	91,581,000	24%	Secondary
Washington	IAD	Washington/Dulles	22,291,000	60,436,000	-	Primary
Washington	BWI	Washington/Baltimore	20,344,000	60,436,000	91%	Primary
Washington	DCA	Washington/Reagan	17,800,000	60,436,000	80%	Primary
Orlando	MCO	Orlando/Intl	33,748,000	35,761,000	-	Primary
Orlando	SFB	Orlando/Stanford	1,662,000	35,761,000	5%	Secondary
Boston	BOS	Boston/Logan	26,841,000	36,113,000	-	Primary
Boston	PVD	Boston/Providence	5,300,000	36,113,000	20%	Secondary
Boston	MHT	Boston/Manchester	3,971,000	36,113,000	15%	Secondary
Dallas	DFW	Dallas/Fort Worth	57,232,000	63,719,000	-	Primary
Dallas	DAL	Dallas/Love Field	6,487,000	63,719,000	11%	Secondary
Miami	MIA	Miami/Intl	30,939,000	51,241,000	-	Primary
Miami	FLL	Miami/Fort Lauderdale	20,302,000	51,241,000	66%	Primary
Houston	IAH	Houston/Intercontinental	40,477,000	48,669,000	-	Primary
Houston	HOU	Houston/Hobby	8,191,000	48,669,000	20%	Secondary
Philadelphia	PHL	Philadelphia/Intl	30,604,000	31,482,000	-	Primary
Philadelphia	ACY	Philadelphia/Atlantic City	877,000	31,482,000	3%	Secondary
Tampa	TPA	Tampa/Intl	18,321,000	20,046,000	-	Primary
Tampa	SRQ	Tampa/Sarasota	1,348,000	20,046,000	7%	Secondary
Tampa	PIE	Tampa/St Petersburg	376,000	20,046,000	2%	Secondary
Detroit	DTW	Detroit/Metropolitan	34,646,000	35,726,000	-	Primary
Detroit	FNT	Detroit/Bishop	1,080,000	35,726,000	3%	Secondary
Cleveland	CLE	Cleveland/Hopkins	10,871,000	12,311,000	-	Primary
Cleveland	CAK	Cleveland/Akron-Canton	1,440,000	12,311,000	13%	Secondary
Norfolk	ORF	Norfolk/Intl	3,733,000	4,766,000	-	Primary
Norfolk	PHF	Norfolk/News Williamsburg	1,032,000	4,766,000	28%	Secondary

Table 6: Multi-Airport Systems in the United States

The first observation is that these multi-airport systems constitute 47% of the total domestic O-D passenger traffic of the Top 200-airport sample in 2008. Hence, MAS are an important component of the commercial airport system. MAS are a characteristic of the metropolitan areas with the greatest amount of originating and terminating traffic such as New York, Chicago or Los Angles.

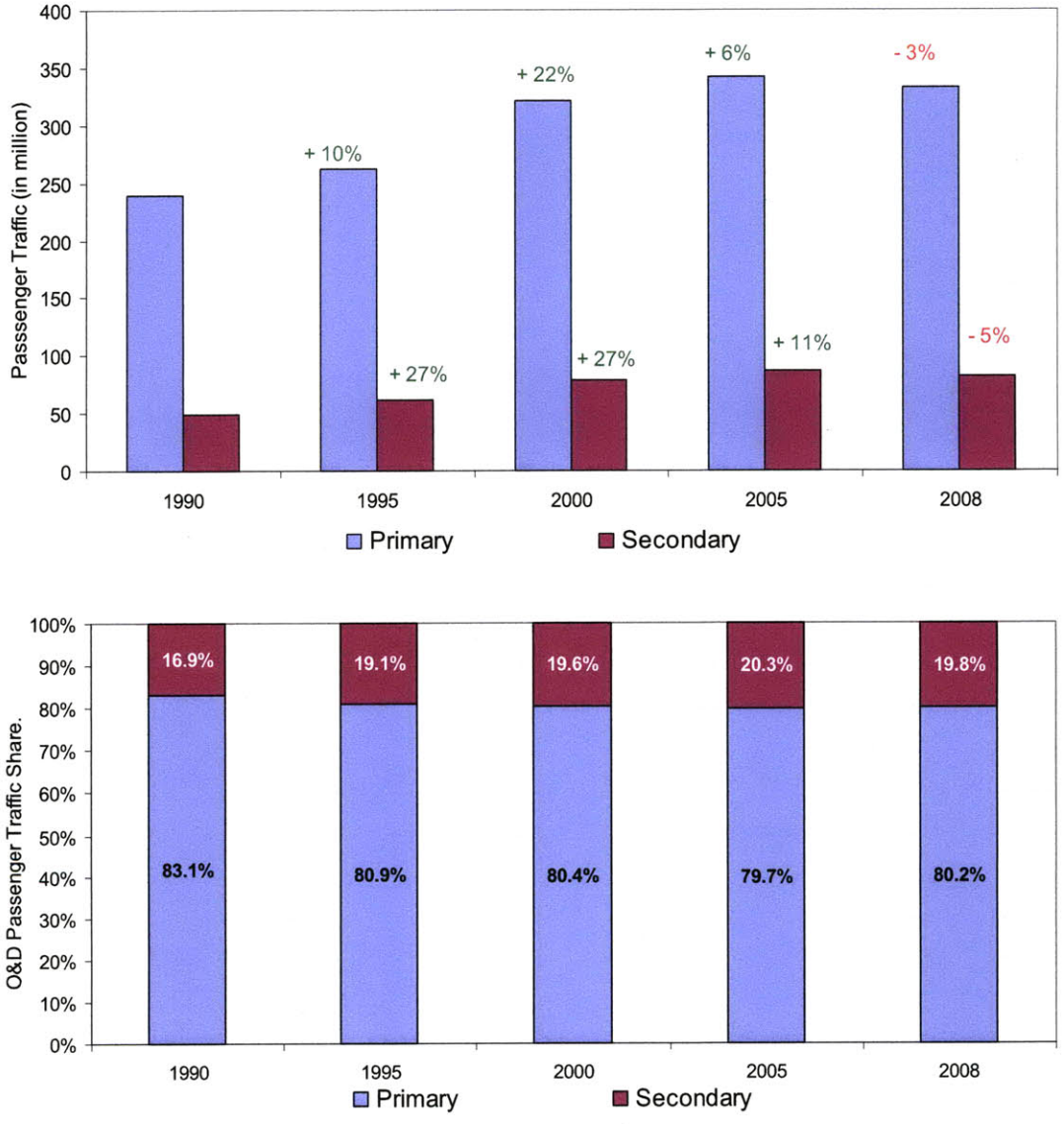


Figure 36: Evolution of Domestic O-D Passenger Traffic at Primary and Secondary Airports

Figure 36 shows that the proportion of passengers handled at secondary airports increased significantly between 1990 and 2005; in fact, secondary airports served 20.3% of the total domestic O-D passengers in the 15 multi-airports systems in 2005, compared to 16.9% in 1990, a fact that can be explained by the higher growth in domestic O-D passenger traffic recorded at secondary airports relative to primary airports. However, the proportion of passengers served at secondary airports slightly decreased between 2005 and 2008, reflecting a stronger impact of the 2008 global economic downturn on secondary airports. Traffic went down at both primary and secondary airports, making primary airports less congested and hence more attractive.

The airports in each multi-airport system compete with each other for passenger traffic and airline services. Table 7 presents the evolution of multi-airport system domestic O-D Traffic shares for each of the 39 airports between 1990 and 2008. As we can observe, the competition between airports situated in the same MAS leads to concentration of traffic at the primary airports and volatile traffic at the secondary facilities. The level and distribution of traffic among airports in a multi-airport system is driven by market forces. For example, Southwest and AirTran make up more than 64% of the market share at Washington-Baltimore International/BWI, and the airport, which recorded a 14% decrease in average fare during the studied period, had the 23rd-least expensive average airfare among the 200 largest US airports in 2008. As a result, the proliferation of discount flights generated by the low-fare competition at BWI made the airport look very attractive to passengers originating or terminating their trips in the Washington D.C. metropolitan area, diverting traffic from the historically dominant Washington Reagan/DCA. In addition, we can observe that 15 out of the 19 secondary airports increased their share of the domestic O-D passenger traffic in their respective MAS between 1990 and 2008. This observation corroborates previous findings suggesting a reinforcement of secondary airports in the multi-airport systems in the United States. For instance, Chicago's Midway/MDW, a secondary airport, served 30% of the total O-D domestic passengers in the Chicago metropolitan area in 2008, up from 19% in 1990.

Metropolitan Region	Airport Code	Airport name	Airport Type	Multi-Airport System Domestic O-D Traffic Share				
				1990	1995	2000	2005	2008
New York	JFK	New York/Kennedy	Primary	17%	19%	18%	30%	31%
New York	EWR	New York/Newark	Primary	36%	39%	37%	30%	31%
New York	LGA	New York/La Guardia	Primary	45%	39%	40%	37%	34%
New York	ISP	New York/Islip	Secondary	2%	3%	4%	4%	4%
Los Angeles	LAX	Los Angeles/Intl	Primary	64%	62%	64%	56%	57%
Los Angeles	SNA	Los Angeles/Santa Ana	Secondary	11%	14%	14%	17%	16%
Los Angeles	ONT	Los Angeles/Ontario	Secondary	13%	13%	12%	12%	11%
Los Angeles	BUR	Los Angeles/Burbank	Secondary	9%	10%	9%	10%	10%
Los Angeles	LGB	Los Angeles/Long Beach	Secondary	3%	0%	1%	5%	5%
San Francisco	SFO	San Francisco/Intl	Primary	63%	53%	52%	42%	51%
San Francisco	OAK	San Francisco/Oakland	Secondary	19%	24%	22%	34%	27%
San Francisco	SJC	San Francisco/San Jose	Secondary	18%	22%	26%	24%	23%
Chicago	ORD	Chicago/O'Hare	Primary	81%	74%	69%	70%	70%
Chicago	MDW	Chicago/Midway	Secondary	19%	26%	31%	30%	30%
Washington	IAD	Washington/Dulles	Primary	22%	22%	25%	31%	25%
Washington	BWI	Washington/Baltimore	Primary	24%	34%	42%	36%	41%
Washington	DCA	Washington/Reagan	Primary	55%	44%	33%	33%	33%
Orlando	MCO	Orlando/Intl	Primary	100%	100%	100%	99%	96%
Orlando	SFB	Orlando/Stanford	Secondary	0%	0%	0%	1%	4%
Boston	BOS	Boston/Logan	Primary	84%	86%	71%	67%	70%
Boston	PVD	Boston/Providence	Secondary	12%	10%	18%	19%	16%
Boston	MHT	Boston/Manchester	Secondary	4%	4%	11%	14%	13%
Dallas	DFW	Dallas/Fort Worth	Primary	76%	76%	78%	82%	77%
Dallas	DAL	Dallas/Love Field	Secondary	24%	24%	22%	18%	23%
Miami	MIA	Miami/Intl	Primary	59%	57%	40%	33%	33%
Miami	FLL	Miami/Fort Lauderdale	Primary	41%	43%	60%	67%	67%
Houston	IAH	Houston/Intercontinental	Primary	52%	58%	63%	68%	67%
Houston	HOU	Houston/Hobby	Secondary	48%	42%	37%	32%	33%
Philadelphia	PHL	Philadelphia/Intl	Primary	97%	97%	96%	96%	95%
Philadelphia	ACY	Philadelphia/Atlantic City	Secondary	3%	3%	4%	4%	5%
Tampa	TPA	Tampa/Intl	Primary	82%	83%	89%	91%	88%
Tampa	SRQ	Tampa/Sarasota	Secondary	18%	12%	9%	7%	8%
Tampa	PIE	Tampa/St Petersburg	Secondary	0%	4%	3%	2%	4%
Detroit	DTW	Detroit/Metropolitan	Primary	97%	98%	96%	93%	94%
Detroit	FNT	Detroit/Bishop	Secondary	3%	2%	4%	7%	6%
Cleveland	CLE	Cleveland/Hopkins	Primary	90%	95%	91%	85%	84%
Cleveland	CAK	Cleveland/Akron-Canton	Secondary	10%	5%	9%	15%	16%
Norfolk	ORF	Norfolk/Intl	Primary	90%	88%	86%	79%	77%
Norfolk	PHF	Norfolk/News Williamsburg	Secondary	10%	12%	14%	21%	23%

Table 7: Evolution of Multi-Airport System Domestic O-D Traffic Shares between 1990 and 2008

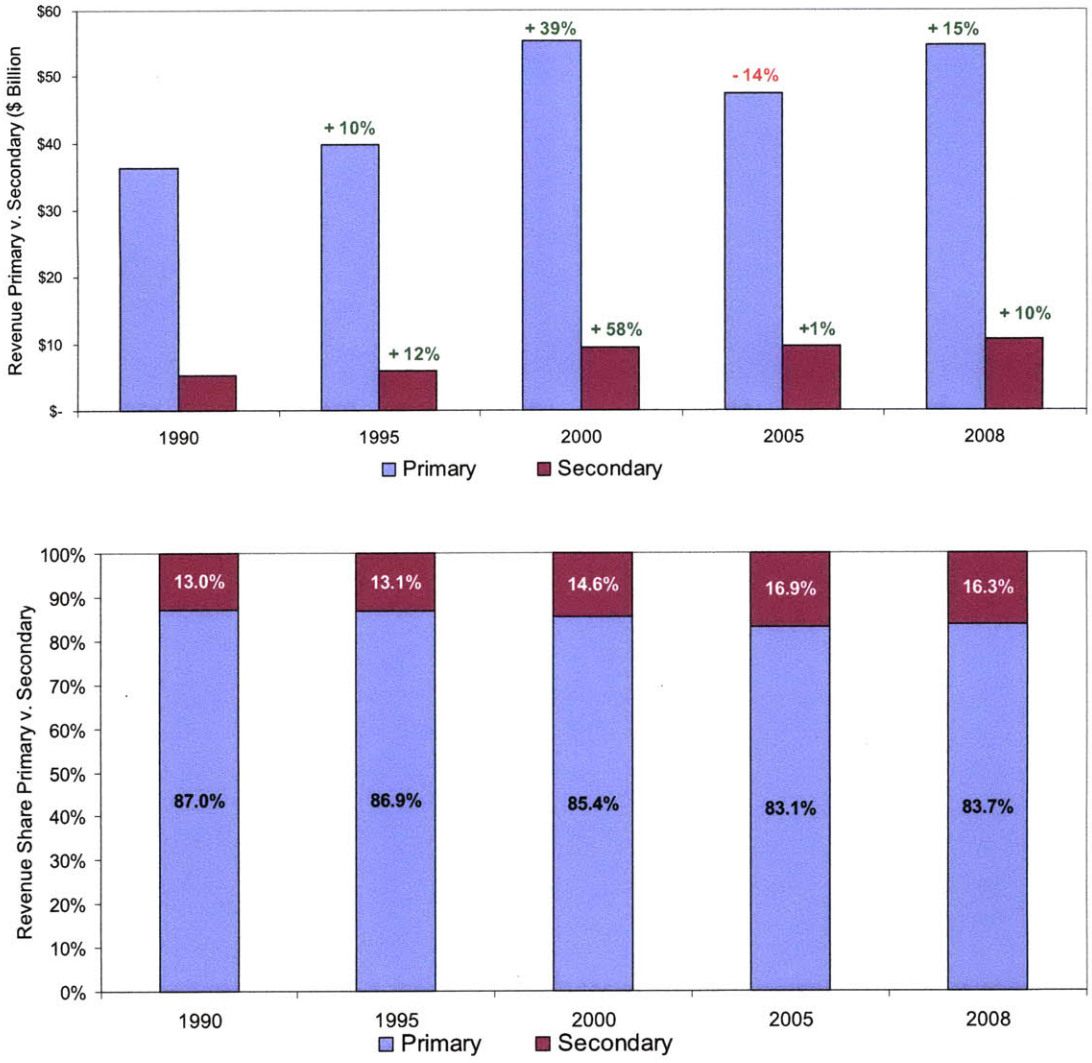


Figure 37: Domestic O-D Passenger Revenues at Primary and Secondary Airports

Looking at Figure 37, it becomes evident that the proportion of passenger revenues generated at secondary airports increased from 13% in 1990 to 16.9% in 2005, highlighting a higher growth rate at secondary airports compared to primary airports. For example, domestic passenger revenues generated at secondary airports increased by 1% between 2000 and 2005, whereas the revenues generated at primary airports declined by 14% during the same period. Nevertheless, revenues collected at primary airports rebounded by 15% between 2005 and 2008, surpassing the growth in revenues at secondary airports. Another interesting observation is the difference between the proportion of passenger handled at secondary airports and the associated revenues for a given period. For instance, secondary airports served 19.8% of the passengers in

the multi-airports systems in 2008, but only were able to collect 16.3% of the total passenger revenues, a fact that can be explained by the lower average fares at secondary airports.

Figure 38 represents the evolution of average fares at primary and secondary airports between 1990 and 2008. It shows that primary airports consistently had higher average fare than secondary airports. But, the reader should keep in mind that this result is partially due to the fact that average haul (the average distance traveled by passengers in the airport market) at primary airports is longer than average haul at secondary airports. Another plausible reason is the difference in business/ leisure passenger mix between primary and secondary airports, as well as the propensity of price-sensitive passengers to seek out lower fares at secondary airports.

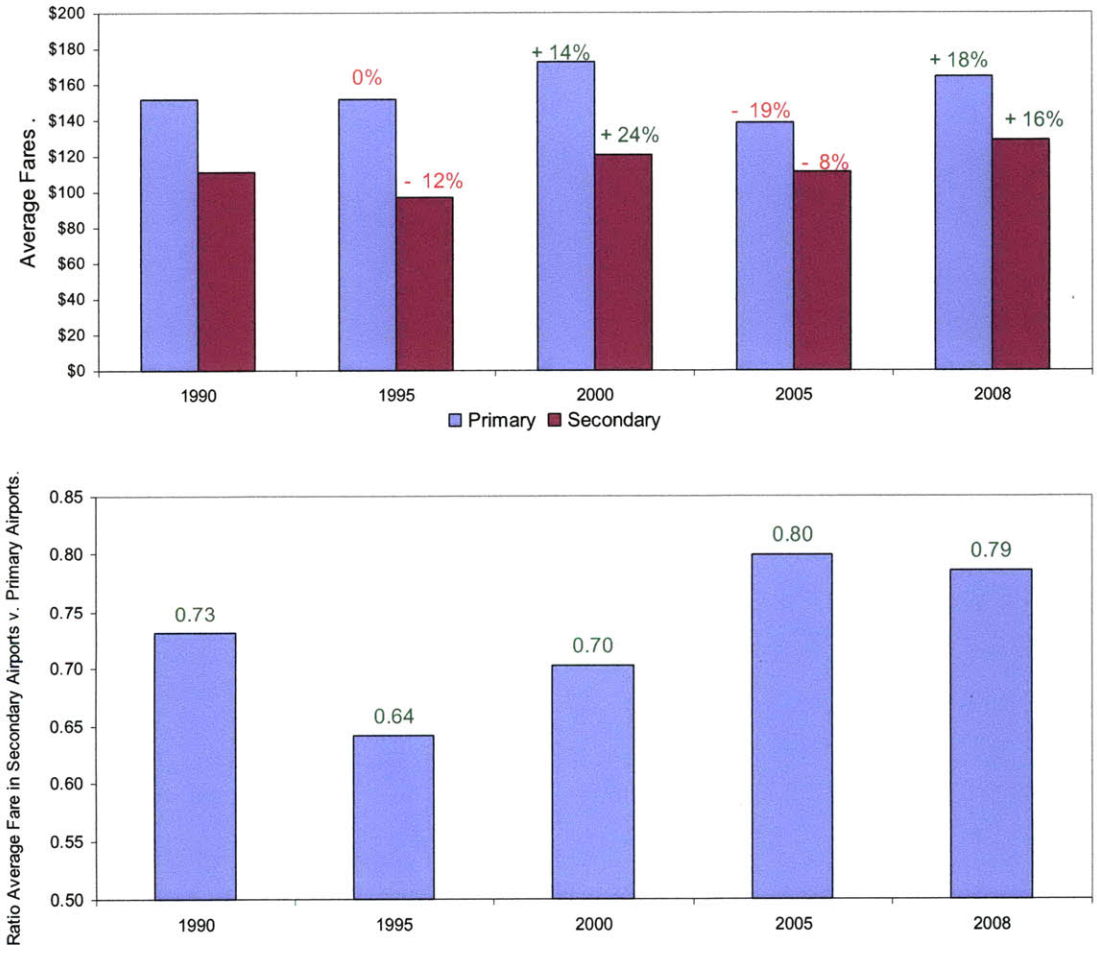


Figure 38: Average Fares at Primary and Secondary Airports, and Evolution of the Ratio of Average Fare in Secondary Airports to Average Fare in Primary Airports

It is worth pointing out that the gap in average fares between primary and secondary airports significantly narrowed between 1995 and 2005, as shown in Figure 38. This phenomenon can be attributed to the fact that LCC, generally very present at secondary airports, increased their fares as they expanded their networks. Meanwhile, NLC, which are the generally the main tenants of primary airports, decreased their average fares in order to compete with the new entrant airlines. Analyzing the variations in average fares in Figure 38, it is interesting to note that average fares at secondary airports grew by 24% between 1995 and 2000, while average fares decreased the most at primary airports between 2000 and 2005—a 19% decline at primary airports compared to a decline by 8% at secondary airports.

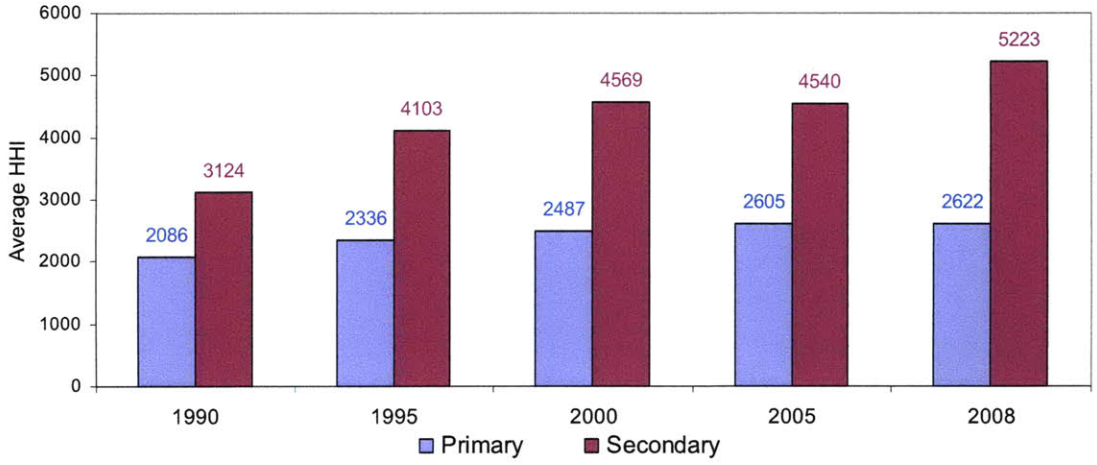


Figure 39: Average Herfindahl-Hirschman Index at Primary and Secondary Airports

The evolution of the average HHI for primary and secondary airports, as plotted in Figure 39, shows that secondary airports are significantly more concentrated compared to primary airports. This leads to the conclusion that primary airports have a higher level of competition than secondary airports. In fact, this result is intuitive and makes sense, since the more attractive primary airports handle the lion's share of passenger traffic in the multi-airport systems, and hence more carriers are fiercely competing at primary airports relative to the number of carriers that are serving secondary airports. Moreover, primary airports concentrate the more lucrative international traffic, another reason for the fiercer competition at primary airports. Another important observation is that the HHI level increased for both primary and secondary airports between 1990 and 2008, a fact that highlights the increase of market concentration and the decrease in the level of competition at these 39 airports.

Concerning the evolution of the network coverage in these 15 multi-airport systems, we found that the number of airports with reported O-D traffic decreased at most of the studied airports from 1990 to 2008. Dallas Love Field/DAL, Orlando Stanford/SFB, Tampa's St Petersburg/PIE and Norfolk-News Williamsburg/PHF are the four exceptions to this trend; these airports saw their number of destinations with reported O-D traffic increase during the studied period. Furthermore, it is interesting to mention that Los Angeles Long Beach/LGB saw an initial decrease in the number of destinations with reported O-D traffic between 1990 and 1995 because of restrictive ordinances adopted to minimize noise in the residential neighborhoods near LGB. But, the number of destinations rebounded after 1995 with the entrance of American Airlines and the arrival of the low-cost carrier JetBlue Airways in 2001.

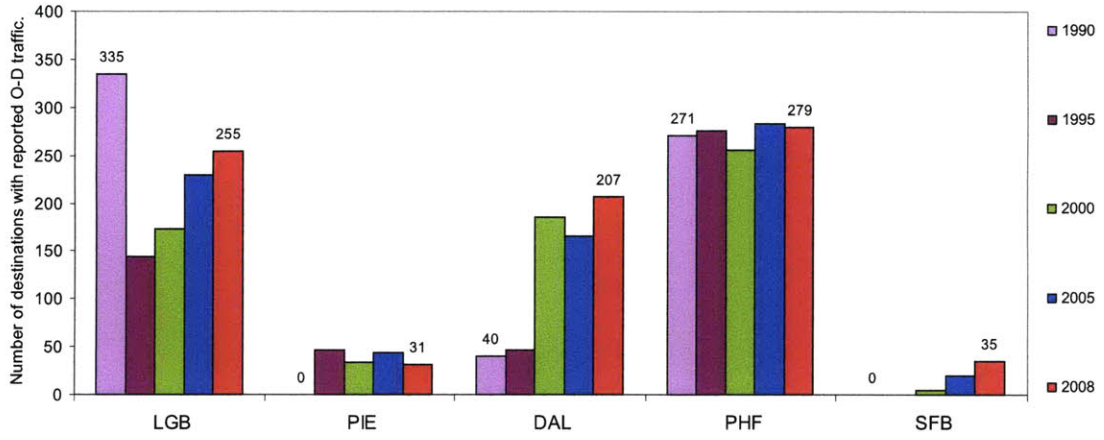


Figure 40: Number of Destinations with Reported O-D Traffic between 1990 and 2008

4.8 Summary

Looking at the evolution of traffic at the Top 200 commercial airports in the United States, we showed that the domestic O-D passenger volumes increased by more than 52% between 1990 and 2005, but dropped by 2% from 2005 to 2008 because of the global economic downturn. In contrast, revenues declined by 8% between 2000 and 2005, and then rebounded by 14% between 2005 and 2008. More importantly, average fares at the Top 200 airports decreased by 13% during the period 2000-2005 corresponding to the severe crisis that affected the US airline industry. Thus, lower average fares contributed to higher passenger volumes but lower revenues in 2005. Soaring jet fuel prices in 2008 resulted in average fare to increase by 16% between 2005 and 2008.

We have also analyzed the distribution of changes in average fares, which led to the conclusion that 83.5% of the Top 200 airports saw higher average fares in 2008 compared to 1990. However, the biggest decreases in average fares occurred from 2000 to 2005: 77% of airports had recorded a decrease in average fare as a result of the airlines' will to stimulate demand after the 2001-2002 passenger volumes' decline, as well as the fierce competition by LCC which, by offering more attractive fares to more markets, obliged the NLC to match their lower fares. In contrast, 72% of the airports had overall increases in average fares between 2000 and 2008, driven by the peak in crude oil prices.

The average number of domestic destinations per airport with reported O-D traffic has been decreasing since 1995, dropping by more than 9% from 1995 to 2008. This trend has been more pronounced for the biggest airports— a 15% drop— while the smallest 50 airports have increased by 7% their number of destinations. The busiest airports have consistently maintained a higher average number of destinations than the smaller airports.

We demonstrated that LCC's share of the total domestic O-D traffic is still growing but leveling off, reaching 34% in 2008. The average number of LCC per airport increased from 0.47 per airport in 1990 to 2.84 per airport in 2005, but has recently dropped in 2008. It was interesting to observe that LCC were not only spared, but even boosted during the industry down-cycle that started in 2001. In addition, LCC's presence is greatest at the biggest airports, where they compete not only against NLC but also against each other. Our analysis found that LCC focused first on largest airports, then grew rapidly in second and third airport tiers. As a result, in 2008, 95

of the Top 200 airports had an LCC aggregated market share greater than 20%, up from 27 in 1990. In particular, individual carriers, such as Southwest, JetBlue and AirTran, have significantly expanded their presence in the Top 200-airport list, and reinforced their competitive position in their markets by increasing their market shares. For instance, Southwest, which has increased its number of airports with a leading passenger market share position from 15 airports in 1990 to 48 airports in 2008, surpassed all other airlines in terms of market share leadership in 2008. As a consequence of LCC's expansion, our analysis showed that LCC effective entrance or substantial growth at a particular airport had a significant impact lowering average fares. We also demonstrated that LCC effective entrance or substantial growth at an airport stimulates significantly passenger volumes at the affected airport. But, this LCC market stimulation effect is leveling off in recent years, as the gap in average fares between LCC and NLC narrowed.

The analysis of the competition at the airport level showed that the average number of effective competitors increased to 4.62 competitors per airport in 2008, up from 4.01 competitors per airport back in 1995. Still, the airport market concentration levels, as measured by the average weighted Herfindahl-Hirschman Index, increased by 8% between 1990 and 2008. Similarly, the weighted average CR1 increased from 36.8% in 1990 to 40.2% in 2008, while the weighted average CR2 rose from 55.2% in 1990 to 57.5% in 2008. These observations led to the conclusion that the Top 200 sample is more concentrated in 2008 relative to 1990.

In addition, the segmentation of the total sample into hub and non-hub airports showed that the 18 hub airports concentrated 28.9% of the total domestic O-D traffic at the Top 200 airports in 1990, while generating 32.1% of the total revenues; average fares for local traffic at hub airports are higher than prices on routes where both origin and destination are non-hub airports. However, this gap has narrowed since 2000 to reach a minimum point of $10 in 2008. Average fare increased by 18% at hub airports between 1995 and 2000, but dropped by 20% between 2000 and 2005. The evolution of passenger traffic at the hub and non-hub airports has followed the same trends as passenger traffic in the total sample. That is, a 49% and 54% increase in passenger traffic respectively for hub and non-hub airports between 1990 and 2005, followed by a 2% decrease between 2005 and 2008. Finally, the average number of destinations with reported O-D traffic decreased by 17% and 11% respectively at hub and non-hub airports between 1990 and 2008.

We found that JFK, DEN and major leisure destinations (LAS, MCO and FLL) have seen the greatest traffic growth during the studied period. In contrast, Honolulu/HNL, MIA and small Florida airports, such as Sarasota/SRQ, Melbourne/MLB and Daytona Beach/DAB, have lost the most traffic between 1990 and 2008. We also found evidence of traffic redistributions between airports located in the same catchment area. Indeed, airports, which used to be natural monopolies, are now competing with other primary and secondary airports belonging to the same multi-airport system. In Chapter 5, five case-study analyses of multi-airport systems situated in some of the nation's major metropolitan catchment areas will be conducted to capture the fundamental processes that govern the distribution of traffic and air services in multi-airport systems.

Finally, we showed that multi-airport systems accounts for 47% of the total domestic O-D passenger traffic in the Top 200 sample, and hence are an important component of the commercial airport system. MAS are a characteristic of the metropolitan areas with the greatest amount of originating and terminating traffic. The analysis showed that secondary airports served 19.8% of the total domestic O-D passenger traffic in the 15 studied multi-airport systems in 2008, compared to 16.9% in 1990. Similarly, Secondary airports collected 16.3% of the total revenues generated in MAS in 2008, compared to 13% in 1990, a fact that can be attributed to the lower average fares at secondary airports. This result can be explained by the shorter average haul at secondary airports compared to primary airports, as well as the difference in business/ leisure passenger mix between primary and secondary airports, and the propensity of price-sensitive passengers to seek out lower fares at secondary airports. However, the gap in average fares between primary and secondary airports narrowed between 1995 and 2005. In particular, average fares decreased the most at primary airports between 2000 and 2005—a 19% decline. The HHI level increased for both primary and secondary airports between 1990 and 2008, a fact that highlights the increase of market concentration and the decrease in the level of competition at these 39 airports.

Chapter 5
Case Study Analyses of Multi-Airport Systems

In this chapter, we conduct five case-study analyses of multi-airport systems located within major U.S. metropolitan regions. Each case is analyzed within a basic framework: First, we analyze the distribution of domestic O-D passenger traffic, revenues and average fare by airport, and in aggregate for the metropolitan catchment area. In addition, we perform an average fare comparison in a sample of domestic O-D markets between competing airports included in the same multi-airport system. Furthermore, we break down passenger market shares by airline for each airport. We monitor the evolution of airport concentration levels for each primary and secondary airport located in the catchment area. Finally, we record the number of destinations with reported O-D traffic for each airport. These analyses emphasize the unique characteristics and competition dynamics of each multi-airport system. The case studies include the Boston area multi-airport system, New York area multi-airport system, Washington D.C. area multi-airport, San Francisco area multi-airport system, and Miami area multi-airport system. The objective is to capture the fundamental processes that govern the distribution of traffic and air services in multi-airport systems.

5.1 Boston Metropolitan Region Multi-Airport System

As depicted in Figure 41, the multi-airport system serving the greater Boston metropolitan region is composed of one primary airport, Boston Logan/BOS, and two secondary airports, Providence/PVD and Manchester/MHT, which are located respectively at 49 and 46 miles from the Boston Logan airport.

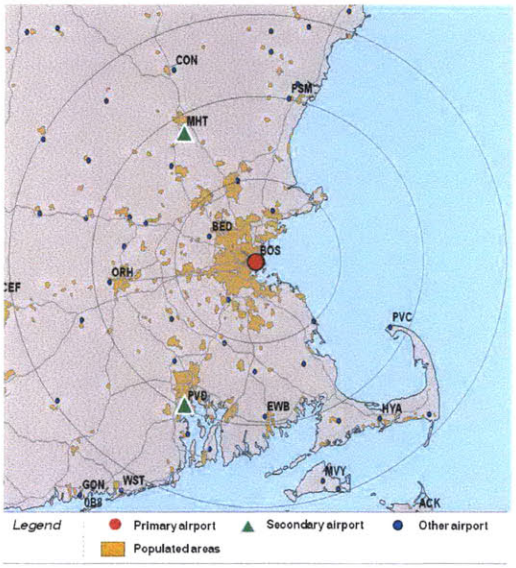


Figure 41: Boston Area Multi-Airport System[53]

Figure 42 shows that the Boston area's total domestic O-D passenger traffic jumped by 51% between 1990 and 2005, but decreased by 8% by 2008. In particular, Boston area's passenger volumes increased by 37% between 1995 and 2000, driven by the 153% and 263% increases in passenger traffic respectively at PVD and MHT. These dramatic increases in passenger traffic can be attributed to the entry of Southwest at PVD and MHT respectively in 1996 and 1998. This phenomenon is commonly known as the "Southwest effect" and corresponds to the significant increase in passenger traffic associated with the entry of Southwest into an airport. At the primary airport, BOS, passenger volumes increased by 21% from 1990 to a peak in 2000, but decreased by 5% by 2008. At the secondary airports, passenger volumes increased by 133% and 463%, between 1990 and 2005, respectively at PVD and MHT, but decreased by 18% and 15% between 2005 and 2008. The relatively large increase in average fares at the secondary airports and the decline in traffic at the primary airport, reducing the congestion, made Boston Logan airport more attractive in the region.

[53] Bonnefoy, P., *"Scalability of the Air Transportation System and Development of MAS: A worldwide Perspective"*, MIT, Report No. ICAT-2008-02, May 2008.

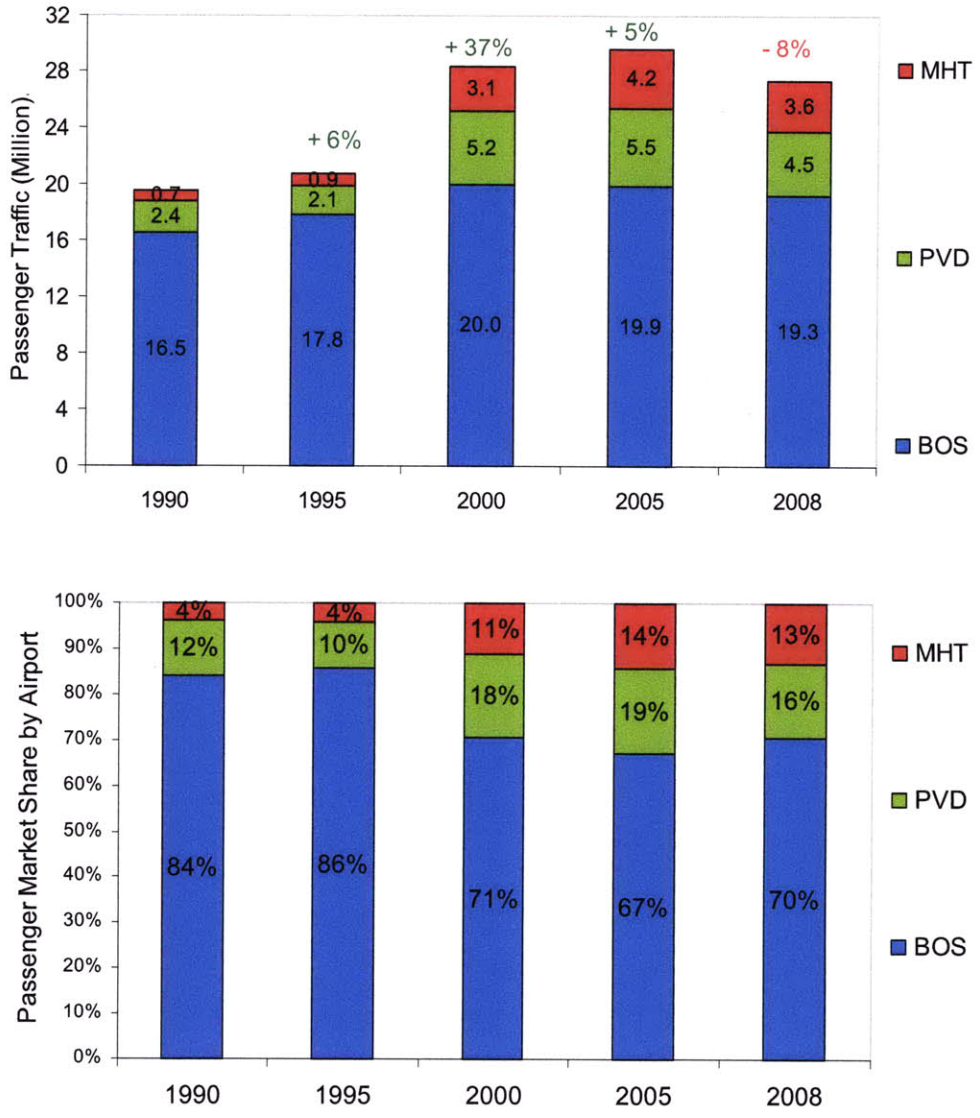


Figure 42: Domestic Passenger Traffic by Airport in the Boston Multi-Airport System

The PVD and MHT combined domestic traffic share of the Boston metropolitan region's total O-D traffic peaked at 33% in 2005 compared to 16% in 1990. The increasing contribution of PVD and MHT to the total domestic O-D passenger traffic shows the importance of secondary airports in accommodating growing demand in the greater Boston catchment area. It also highlights the role of low-cost carriers, such as Southwest, in the emergence of MHT and PVD as successful secondary airports. However, Boston Logan's passenger share of domestic traffic recently rebounded to 70% in 2008, after reaching a minimum of 67% in 2005.

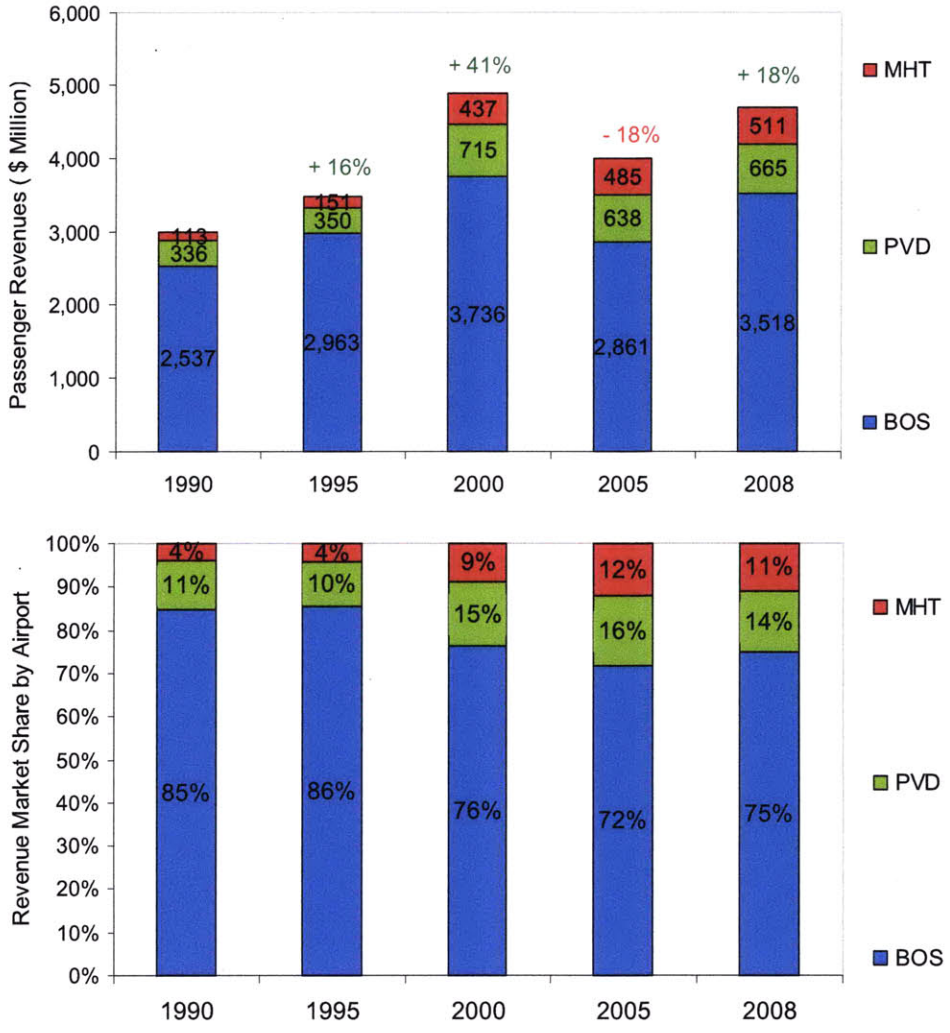


Figure 43: Revenues by Airport in the Boston Multi-Airport System

In Figure 43, we can observe that the Boston area's total domestic passenger revenue increased by 64% between 1990 and 2000. But during the airline industry's crisis that started in 2001, revenue declined by 18%; BOS recorded a steeper decrease in domestic revenue. But by 2008, the Boston area's passenger revenue grew by 18% compared to 2005 levels, but was still 4% below the 2000 peak. At BOS, total domestic passenger revenue rebounded to 23% above 2005 levels, after dropping by 23% from 2000 to 2005. At PVD, total domestic revenue jumped by 105% from 1995 to 2000 (i.e., upon the entry of Southwest in 1996) but dropped by 11% between 2000 and 2005. Finally, MHT's total domestic passenger revenue jumped by 190% between 1995 and 2000, and has continued to grow since. By 2005, PVD and MHT combined

domestic revenue share of the total Boston area's domestic revenue grew to 28%, up from 15% in 1990. But Boston Logan's revenue share increased to 75% in 2008.

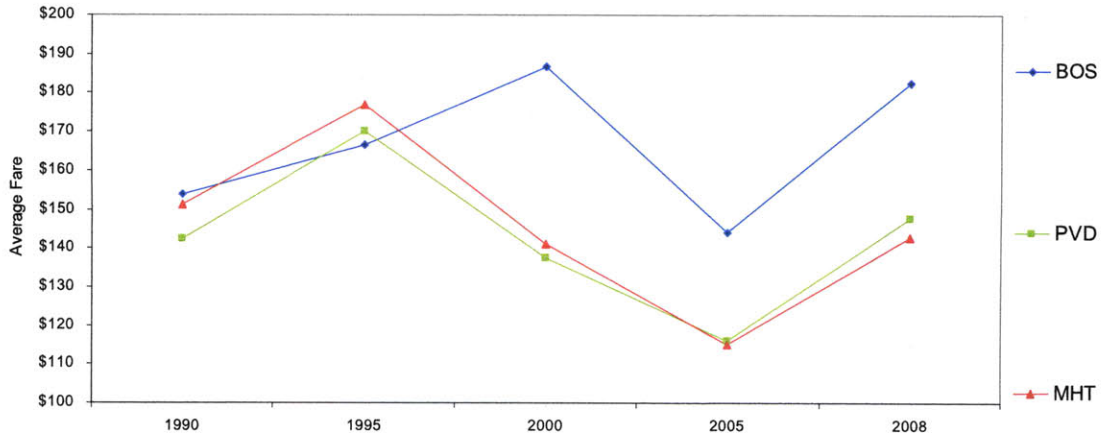


Figure 44: Average Fares at the Airports in the Boston Metropolitan Region

Figure 44 represents the evolution of average fare at each of the airports in the Boston metropolitan area. It clearly shows that BOS's average fare increased by 12% during "the golden 90s", whereas average fares at PVD and MHT decreased by 19% and 20% between 1995 and 2000. This can be explained by the fact that WN entered these markets respectively in 1996 and 1998, offering significantly lower fares in primarily shorter haul O-D markets. WN has a significant impact at these airports because they are relatively small. The decrease in average fare at PVD and MHT persisted during the industry's turmoil between 2000 and 2005. In contrast, average domestic fares at PVD increased by 27% by 2008, but were still 13% lower than in 1995, and average domestic fares at MHT jumped by 24% by 2008, but were still 19% lower than in 1995. Similarly, BOS's average domestic fares increased by 27% from 2005 to 2008, but were still 2% lower than in 2000.

In addition, we compared average fares at these three airports, in a sample of O-D markets: Baltimore, Orlando, Philadelphia, Tampa, Chicago, Las Vegas and Phoenix. We found that in 2008, MHT reported slightly lower average fares than PVD (2% lower), while this gap jumps to 24% compared to BOS. Similarly, PVD reported in 2008 12% lower average fares than BOS. PVD and MHT continue to report 15-20% lower average fares than BOS, a result of business/leisure mix and propensity of price-sensitive passengers to seek out lower fares at secondary airports.

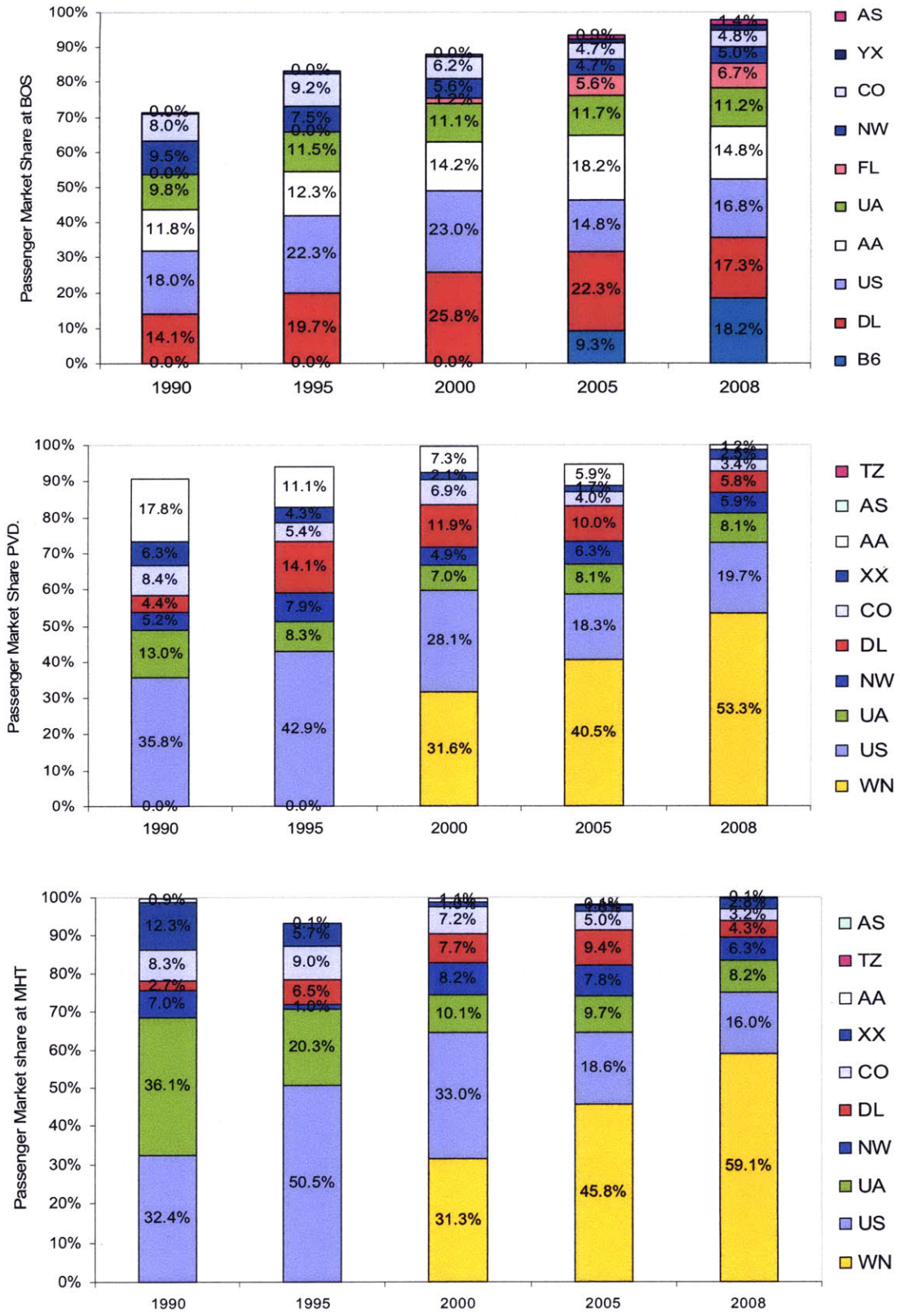


Figure 45: Passenger Market Share per Carrier at BOS, PVD and MHT

Looking at Figure 45, it becomes obvious that JetBlue has gained significant domestic passenger market share at BOS since 2000 at the expense of Legacy carriers, and that Southwest gained significant market shares at both PVD and MHT, hurting primarily US Airways. Southwest and JetBlue successfully competed against Legacy carriers at the airport level despite reporting relatively modest numbers of destinations with reported O-D traffic. Other carriers, such as Northwest or Continental, followed the entry of WN at PVD and MHT, increasing their numbers of destinations with reported O-D traffic at these two airports.

It is worth pointing out that Southwest expanded and grew at PVD and MHT, the two secondary airports, while JetBlue focused on the primary airport in the region. This observation makes sense when we know that WN historically designed its network using uncongested and less expensive secondary airports, targeting price-sensitive customers. Southwest's reliance on secondary airports turns out to be a competitive advantage in terms of higher aircraft productivity due to shorter turnaround times, and lower airport fees that can be translated into lower unit costs and average fares. In contrast, JetBlue and AirTran designed their networks mainly around primary airports, targeting the existing high volume of traffic at the primary facilities.

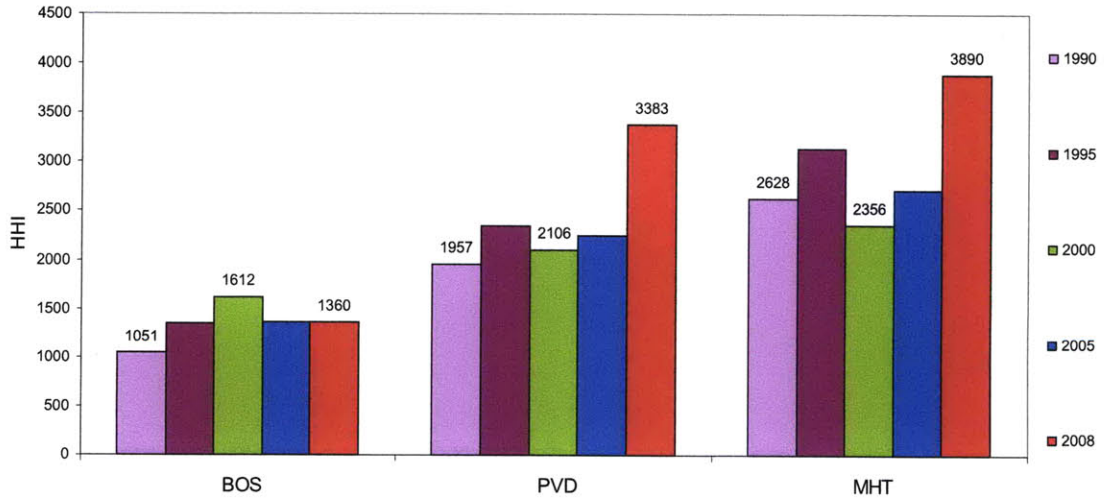


Figure 46: Airport Concentration Level as Measured by the HHI at BOS, PVD and MHT

Using Department of Justice (DOJ) standards and data displayed in Figure 46, we can conclude that Boston Logan is a moderately concentrated airport market (HHI between 1,000 and 1,800). BOS's HHI has decreased since 2000, with the arrivals of B6, FL and other carriers. In

contrast, PVD had an HHI result above 1,800, and hence is a concentrated airport market. Recent increases in HHI at PVD were driven essentially by Southwest's market share growth. Analogously, MHT is a concentrated airport, with recent increases driven by Southwest growing to dominate the market. These observations are corroborated by the concentration ratio results; the CR1 at PVD increased from 35.8% in 1990 to 53.3% in 2008, while the CR1 at MHT increased from 36.1% in 1990 to 59.1% in 2008, as a result of Southwest's market share growth.

Once again, evidence suggests that LCC are more present at secondary airports than at primary airports. Four low-cost carriers were serving PVD and MHT in 2008, whereas only two low-cost carriers were competing at BOS. In the same way, PVD and MHT recorded respectively an LCC aggregated market share of 53.3% and 59.1% in 2008, while the aggregated LCC market share at BOS was 24.9%. These findings support the fact that LCC tend to prefer uncongested and less expensive secondary airports.

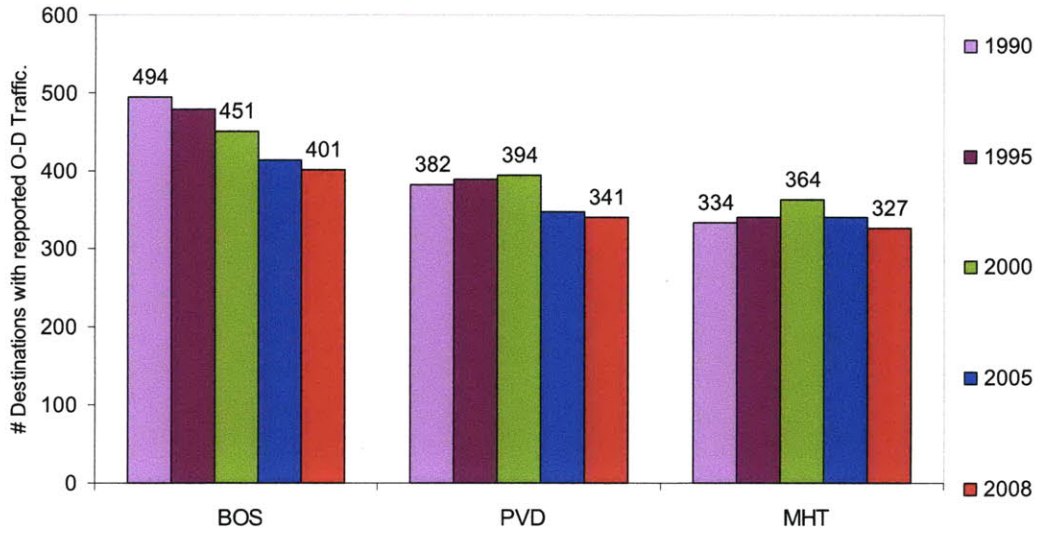


Figure 47: Number of Destinations with Reported O-D Traffic at BOS, PVD and MHT

Figure 47 shows the difference in trends between primary and secondary airports concerning the number of destinations with reported O-D traffic. Through 2000, PVD and MHT saw an increase in the number of reported O-D pairs, but after this peak all three airports have seen reduction in their numbers of destinations with reported O-D traffic. For example, the total reported O-D destinations at BOS continue to decrease, driven by reduction in Network Legacy carriers' network coverage. For instance, NW had 200 airports with reported domestic passenger

traffic out of BOS in 2008, compared to 288 in 1990. Similarly, AA carried passenger traffic between BOS and 202 airports in 2008, down from 267 destinations back in 1990. In addition, PVD has also seen a reduction in domestic O-D pairs since a peak in 2000. Finally, total O-D destinations have also dropped in MHT since peaking in 2000, but individual carrier reductions are not as apparent as it is the case in BOS or PVD.

5.1.1 Summary

Boston Logan's domestic O-D passenger volume increased by 21% in 2000 compared to 1990 levels, but has decreased by 5% since then. On the revenue side, Boston Logan's total domestic passenger revenue rebounded in 2008 by 23% above 2005 levels, after dropping from 2000 to 2005. However, total revenue in 2008 remained below the 2000 peak levels.

JetBlue and Southwest have gained significant domestic passenger shares over their Network Legacy peers at all three Boston-area airports, despite relatively modest numbers of cities with reported O-D traffic. In particular, Southwest Airlines' business model played a key role in the emergence of PVD and MHT as successful secondary airports in the Boston metropolitan region. Southwest stimulated the traffic at these airports by offering appealing low fares to attract passengers that would have otherwise never considered travelling.

PVD and MHT have become important secondary airports, but their growth has slowed. By 2005, PVD and MHT combined domestic passenger traffic had grown to 33% of the Boston area total traffic, while it only accounted for 16% in 1990. All three Boston-area airports have lost domestic passenger volumes since 2005, with PVD and MHT recording relatively steeper decreases than BOS.

Finally, Both PVD and MHT continue to report 15% to 20% lower average fares than BOS, a result of business/leisure mix and propensity of price-sensitive passengers to seek out lower fares at the secondary airports.

5.2 New York Metropolitan Region Multi-Airport System

As depicted in Figure 48, the New York area's MAS is composed of three primary airports: LaGuardia/LGA, Newark Liberty international/EWR and John F. Kennedy international/JFK, and one secondary airport, Long Island MacArthur/ISP, which is located 41 miles from LGA. In 2008, New York area's MAS served 57,145,000 domestic O-D passengers and 106 million passengers[54] including international and connecting traffic.

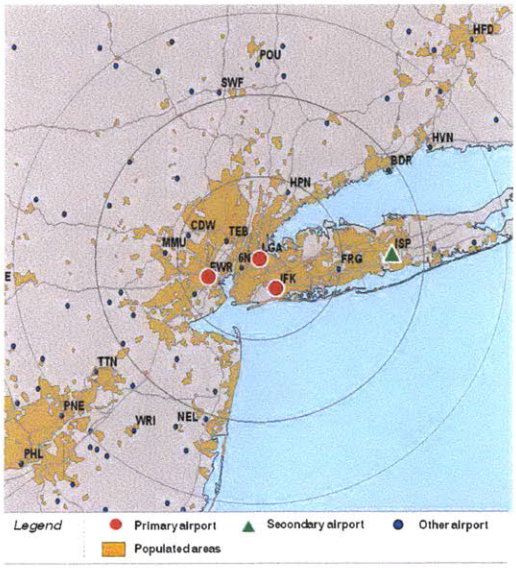


Figure 48: New York Area Multi-Airport System[53]

Figure 49 shows that the New York area's total domestic O-D passenger traffic jumped by 35% between 1990 and 2005, but decreased by 5% between 2005 and 2008. Between 1990 and 1995, passenger volumes decreased by 14% at LGA, but increased respectively by 9%, 14% and 2% at EWR, JFK and ISP. Then during the "golden 90s", passenger volumes grew at all four New York airports, with a remarkable 99% jump at ISP, a fact that can be attributed to Southwest entering the market in 1999. Despite the industry crisis that started in 2001, domestic O-D passenger traffic increased by 81% at JFK between 2000 and 2005, a result of JetBlue entering the airport and stimulating the market with discounted airfares. In the meantime, domestic O-D traffic dropped by 11% at EWR, by 5% at ISP, and increased by 2% at LGA. Between 2005 and 2008, passenger volumes decreased by 13% at LGA, and by 1% at ISP between 2005 and 2008, while domestic traffic at JFK and EWR remained flat.

[54] Airports Council International, www.aci.aero, last accessed 03/04/2010.

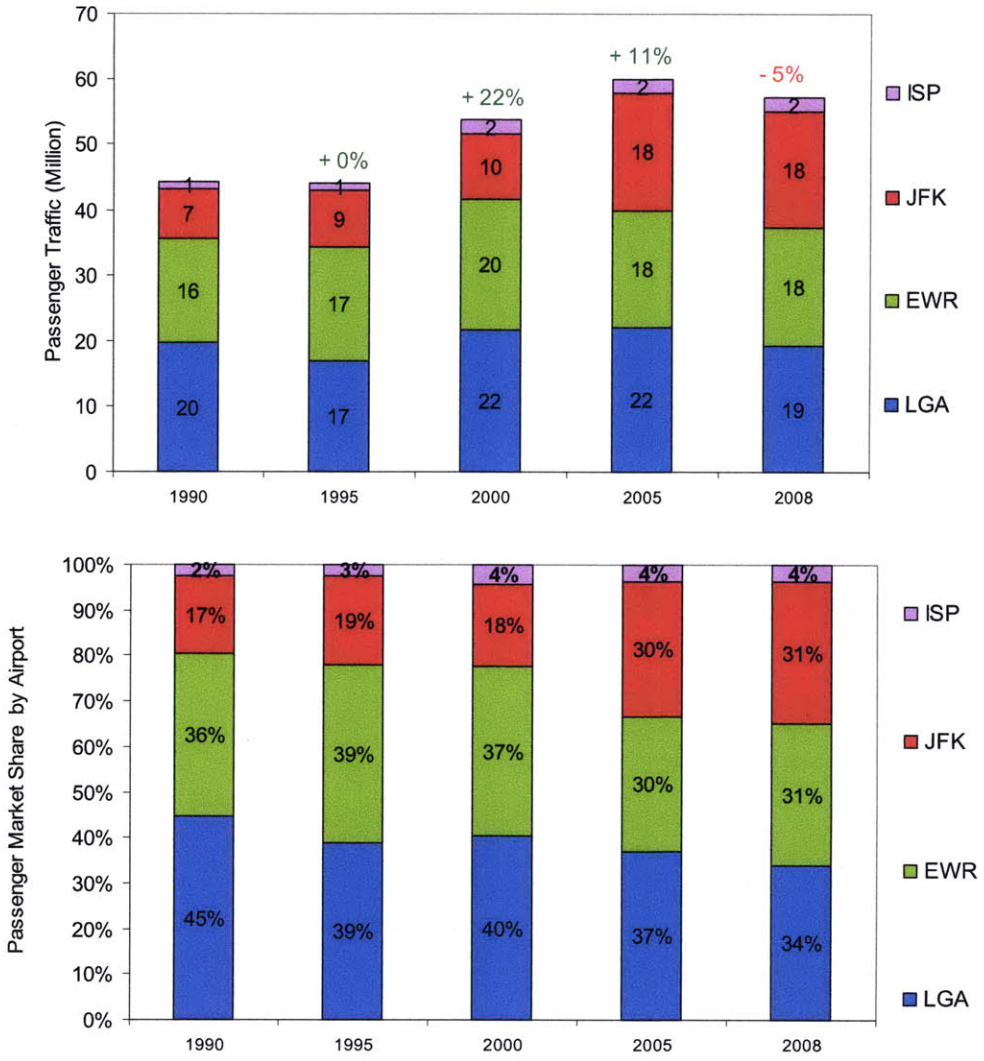


Figure 49: Domestic Passenger Traffic by Airport in the New York Multi-Airport System

JFK is clearly the big winner of the competition between the three primary airports over domestic passenger traffic in the New York metropolitan region. By 2008, JFK domestic passenger traffic share grew to 31%, while it only accounted for 17% in 1990, hurting primarily LGA which relies exclusively on domestic traffic. JetBlue using JFK as a "base" for its operations played a key role in this success. We can observe that although ISP passenger share doubled during the studied period, the secondary airport's traffic share remains marginal compared to the traffic handled at the three primary competitor airports.

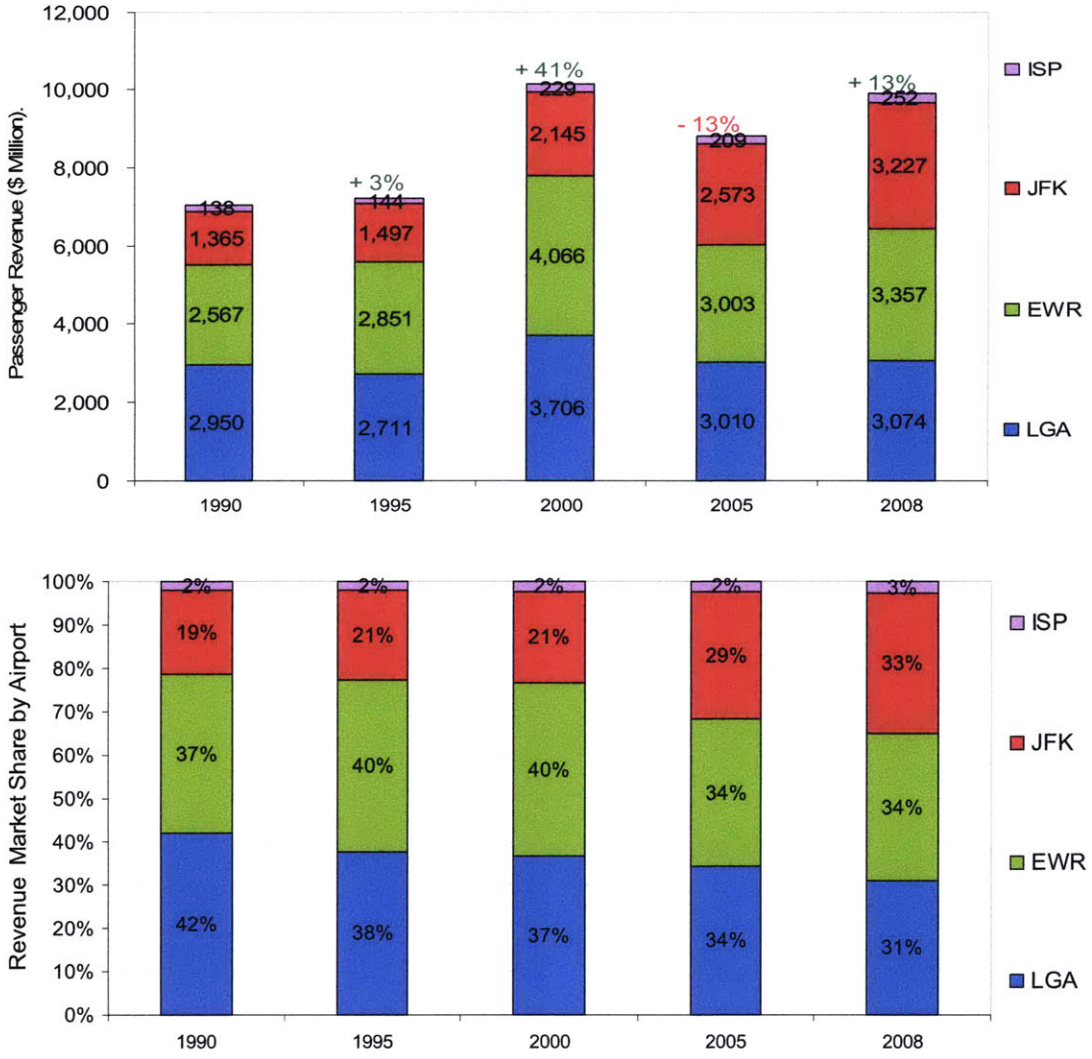


Figure 50: Revenue by Airport in the New York Multi-Airport System

Looking at Figure 50, we observe that the New York area's total domestic passenger revenue increased by 45% between 1990 and 2000, but declined by 13% by 2005; with a 26%-drop, EWR recorded a steeper decrease in domestic revenue, followed by LGA which lost 19%. In contrast, JFK recorded a 20% increase in domestic passenger revenue during the same period, and grew further— by 25%— between 2005 and 2008. Moreover, EWR, LGA and ISP domestic revenues rebounded respectively by 12%, 2% and 20% between 2005 and 2008. JFK domestic revenue share of the total New York area's domestic revenue grew to 33% in 2008, up from 19% in 1990, while LGA domestic revenue share dropped from 42% in 1990 to 31% in 2008.

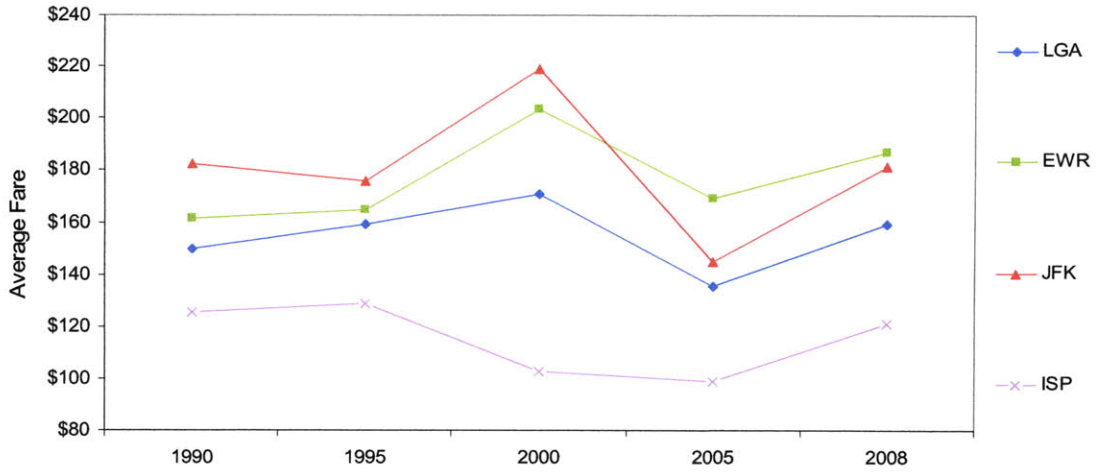
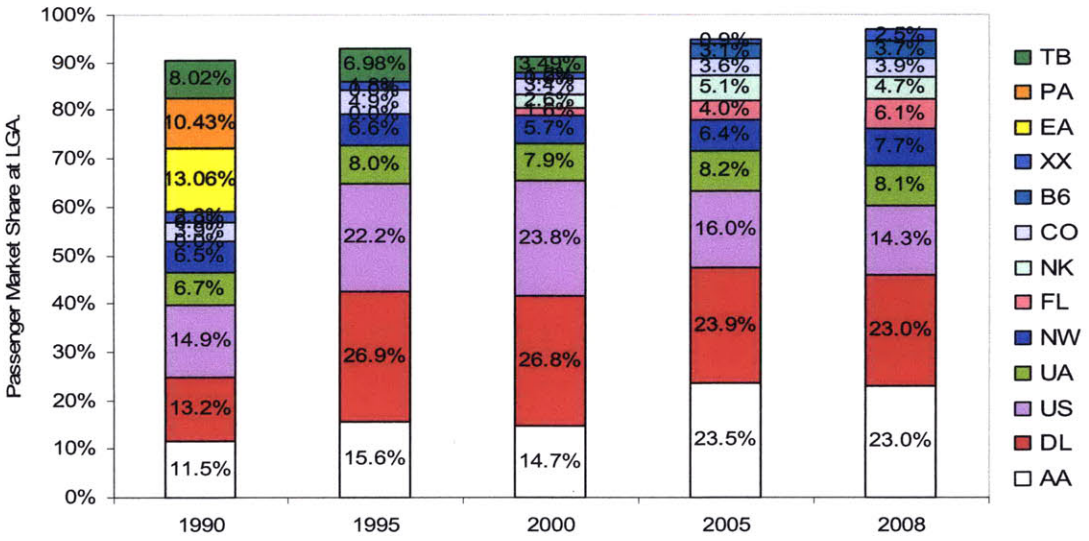


Figure 51: Average Fares at the Four Airports in the New York Metropolitan Region

The first trend highlighted in Figure 51 is that ISP average fare decreased by 20% between 1995 and 2000; this can be explained by Southwest starting service to the ISP market in 1999, offering significantly lower fares in order to stimulate the traffic. This is especially important for WN given that ISP was its only access to the New York catchment area. The fact that ISP is a relatively small airport is another reason for WN's impact on average fare at ISP. Average fares decreased at all four New York airports between 2000 and 2005. The steepest decrease— 34%— was recorded at JFK, a fact that can be clearly attributed to JetBlue entering the market in 2000. Average fares rebounded by 17%, 11%, 25% and 22% respectively at LGA, EWR, JFK and ISP between 2005 and 2008, essentially as a result of the soaring jet fuel prices.

We compared average fares between these four airports, in a sample of O-D markets: Fort Lauderdale, Orlando, Chicago, Los Angeles, Atlanta, San Francisco, Las Vegas, Miami, West Palm Beach, Tampa, Boston, Dallas and San Juan. We found that in 2008, EWR recorded, on average, 11% higher average fares than LGA, 16% higher average fares than JFK, and 21% higher average fares than ISP. Similarly in 2008, JFK reported on average 13% higher average fares than ISP, while LGA recorded 10% higher average fares than ISP. ISP is a secondary airport targeting price-sensitive customers through 10% to 21% lower average fares.


Passenger Market Share at LGA
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1990
1995
2000
2005
2008
8.02%
10.43%
13.06%
6.5%
6.7%
14.9%
13.2%
11.5%
6.98%
6.6%
8.0%
22.2%
26.9%
15.6%
5.7%
7.9%
23.8%
26.8%
14.7%
3.6%
5.1%
4.0%
6.4%
8.2%
16.0%
23.9%
23.5%
3.7%
3.9%
4.7%
6.1%
7.7%
8.1%
14.3%
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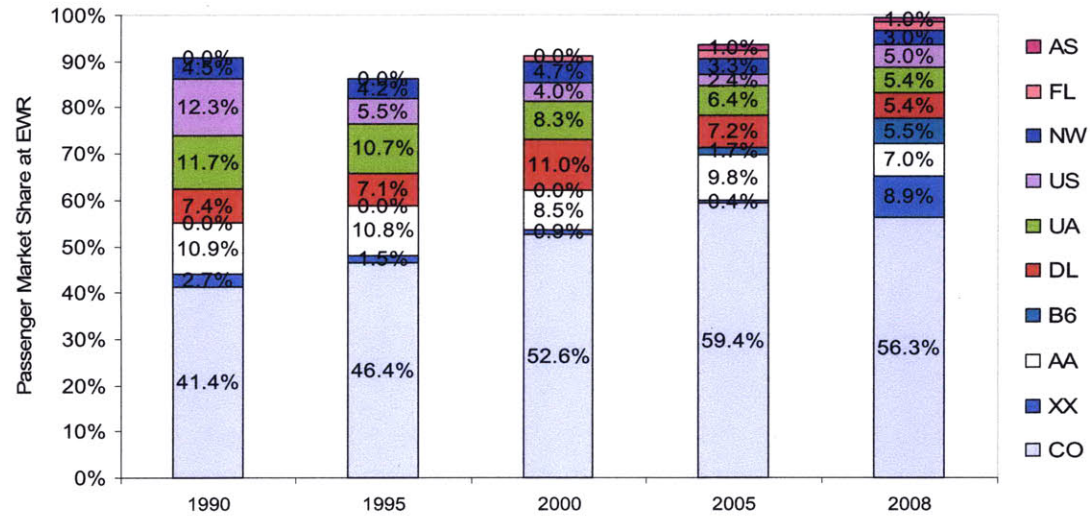
Passenger Market Share at EWR
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1990
1995
2000
2005
2008
4.5%
12.3%
11.7%
7.4%
10.9%
2.7%
41.4%
4.2%
5.5%
10.7%
7.1%
10.8%
46.4%
4.7%
4.0%
8.3%
11.0%
8.5%
52.6%
6.4%
7.2%
9.8%
59.4%
5.0%
5.4%
5.4%
5.5%
7.0%
8.9%
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AS
FL
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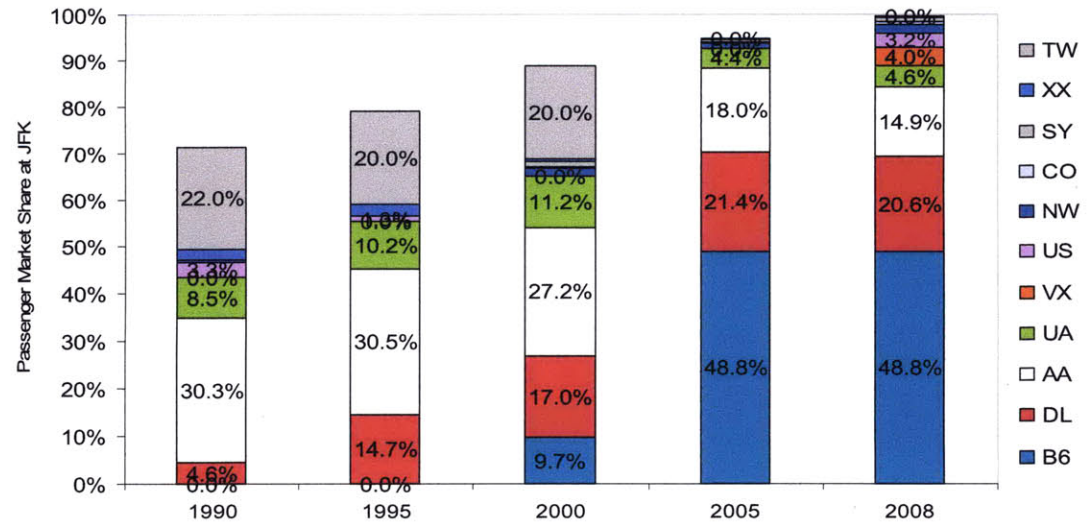
Passenger Market Share at JFK
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1990
1995
2000
2005
2008
22.0%
8.5%
30.3%
4.6%
20.0%
10.2%
30.5%
14.7%
20.0%
11.2%
27.2%
17.0%
9.7%
18.0%
21.4%
48.8%
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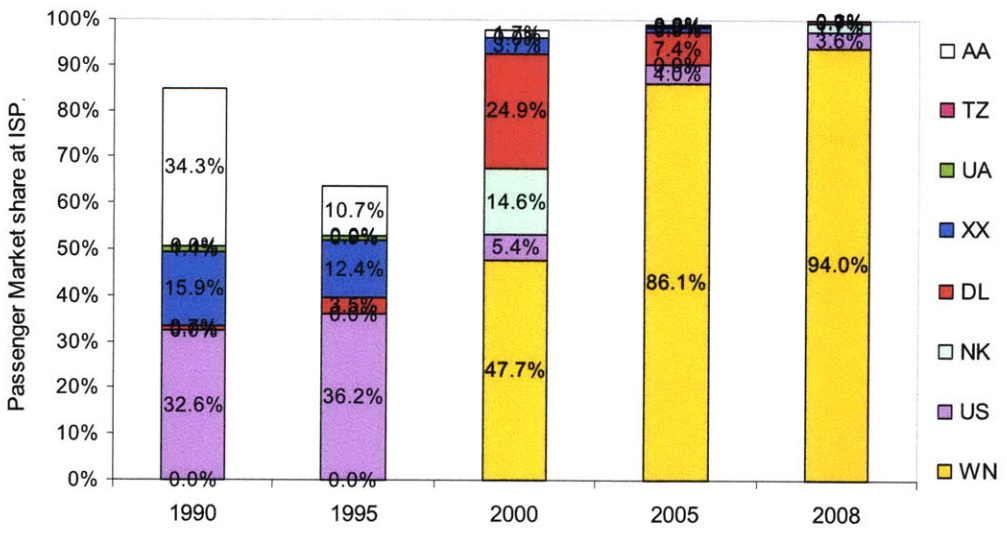

Figure 52: Passenger Market Share per Carrier at LGA, EWR, JFK and ISP

Analyzing the data displayed in Figure 52, it becomes obvious that American Airlines and Delta Airlines gained significant market shares over their competitors at LGA. These gains were not only made at the expense of defunct carriers, such as Eastern Airlines (EA) and Pan American Airways (PA), but also at the expense of US Airways (US) and US Airways Shuttle (TB). At the same time, at EWR, Continental passenger market share increased from 41.4% in 1990 to 56.3% in 2008, consolidating its market leader position at EWR and reinforcing its hegemony at its hub.

Figure 52 shows that JetBlue has gained significant domestic passenger market share over Network Legacy carriers at JFK since 2000, hurting primarily AA and UA. It also demonstrates that Southwest is dominating passenger market shares at ISP, hurting primarily US Airways, Spirit and Delta. These observations highlight, once again, the difference between Southwest and JetBlue business models; while WN chose to expand at ISP which is the only secondary airport in the New York metropolitan region, JetBlue focused on the primary airports, dominating the competition at JFK. In addition, Southwest and JetBlue competed against Legacy carriers at the airport level, despite reporting relatively modest numbers of destinations with reported O-D traffic. For instance in 2008, JetBlue served 48.8% of the domestic O-D passenger traffic at JFK reporting only 47 O-D destinations, compared to 217 destinations for Delta.

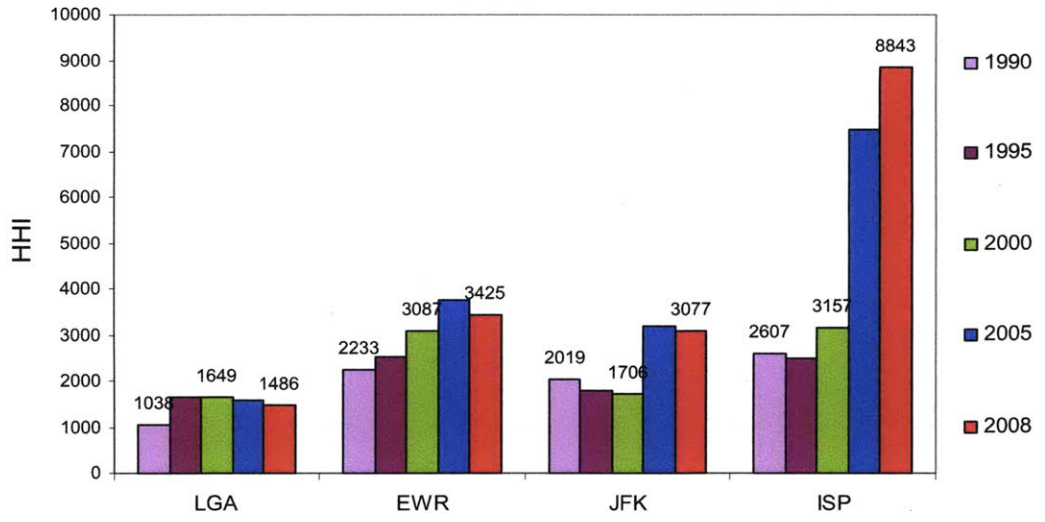

Figure 53: Airport Concentration Level as Measured by the HHI at LGA, EWR, JFK and ISP

Figure 53 shows that the level of market concentration, as measured by the HHI, increased at all four New York area airports between 1990 and 2008. The HHI increased the least at LGA, perhaps because there is no room for significant expansion for a dominant carrier at LGA, since the airport is highly congested and slot restricted. According to the US Department of Justice's standards, LGA, with an HHI between 1,000 and 1,800, is a moderately concentrated marketplace. With six effective competitors including four low-cost carriers (AirTran, Spirit, JetBlue and Frontier) serving the airport, LGA has a high level of competition. At EWR, the HHI increased from 2,233 in 1990 to 3,425 in 2008. This increase is primarily due to Continental Airlines consolidating its passenger market share hegemony at its Newark hub. With an HHI above 1,800, EWR is a concentrated marketplace. At JFK, the HHI level jumped to 3,077, after dropping from 2,019 to 1,706 between 1990 and 2000. The recent increase in HHI at JFK is due to the rapid growth of JetBlue, since it entered the airport in 2000. Finally, ISP saw the largest progression in HHI— from 3,157 in 2000 to 8,843 in 2008. Southwest, which began service at ISP in 1999, grew rapidly to become the dominant carrier at this airport. This observation is corroborated by the concentration ratio results; the CR1 at ISP increased from 34.3% in 1990 to 94.0% in 2008, as a result of Southwest's market share growth.

Figure 54 shows that the numbers of destinations with reported O-D traffic have steadily decreased between 1990 and 2008 at the four New York area airports. In particular, although the NLC have maintained a stable number of airports with reported O-D traffic at LGA, the total

number of destinations at LGA decreased sharply over the studied period. Similarly, although carriers like CO, DL and UA have increased significantly their number of destinations at EWR, the total number of destinations dropped sharply, suggesting more over-lapping services.

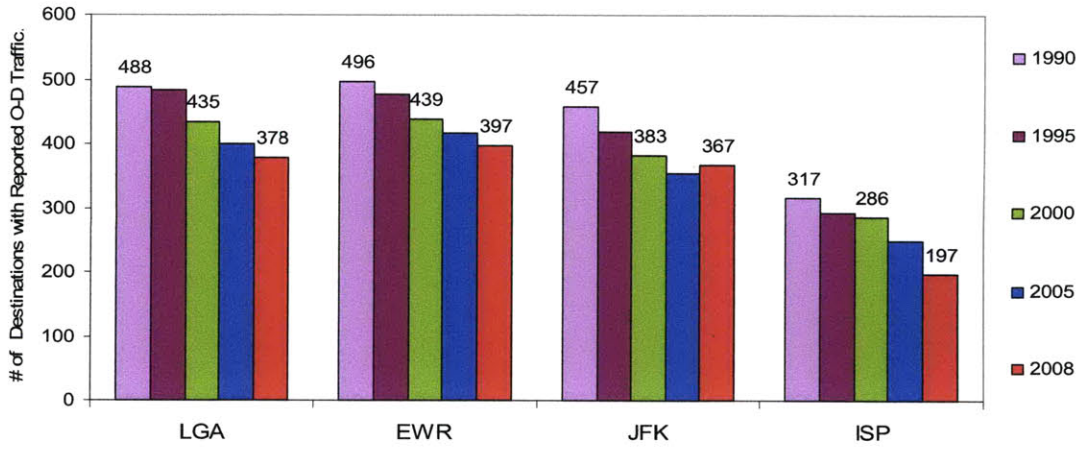

Figure 54: Number of Destinations with Reported O-D Traffic at LGA, EWR, JFK and ISP

5.2.1 Summary

By 2005, the New York area's total passenger traffic jumped by 35% compared to 1990 levels, but decreased more recently by 5%. In particular, LGA domestic passenger volume increased by 12% between 1990 and 2005, but has decreased by 13% since then. EWR domestic passenger traffic increased by 26% between 1990 and 2000, but then dropped by 11% by 2005. JFK domestic passenger volume increased by 108% by 2005 compared to 1995 levels, but remained flat between 2005 and 2008. ISP domestic passenger traffic jumped by 99% in 2000 compared to 1995 levels, but has dropped by 7% since then. Finally, New York area's total domestic passenger revenues grew by 13% between 2005 and 2008, but were still 2.3% below the 2000 peak levels. Overall, Jet Blue and Southwest have gained significant domestic passenger traffic shares over their Network Legacy peers at JFK and ISP airports respectively, despite relatively modest numbers of cities with reported O-D traffic.

Over the studied period, JFK is the big winner of the passenger traffic redistribution in the New York metropolitan area; in 2008, JFK domestic passenger traffic grew to 31% of the New York area's total domestic passenger traffic, while it only accounted for 17% in 1990.

5.3 Washington DC Metropolitan Region Multi-Airport System:

As depicted in Figure 55, the multi-airport system serving the Washington DC metropolitan area is composed of three primary airports: Ronald Regan Washington National/DCA, Washington Dulles International/IAD and Baltimore-Washington International/BWI. In 2008, Washington metropolitan area's MAS served 37,791,300 domestic O-D passengers and 62.6 million passengers[54] including international and connecting traffic.

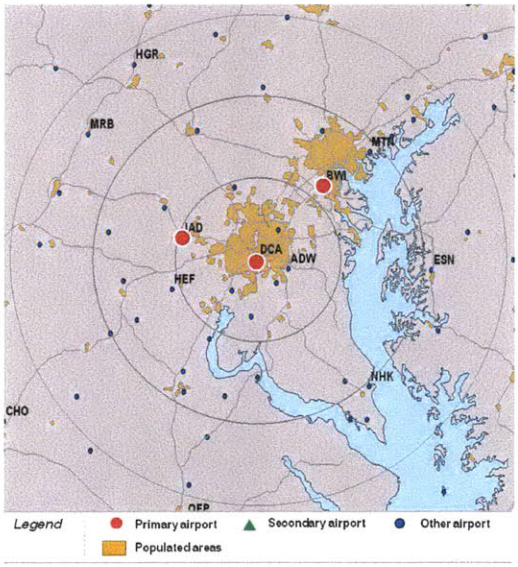

Figure 55: Washington DC Area Multi-Airport System[53]

Figure 56 shows that the Washington DC area's total domestic O-D passenger traffic jumped by 77% between 1990 and 2005, but decreased by 10% by 2008. Between 1990 and 1995, domestic passenger volumes decreased by 6% at DCA, but increased respectively by 19% and 67% at IAD and BWI. The significant passenger traffic growth at BWI can be attributed to Southwest entering the airport in 1993 as its first East Coast gateway airport, stimulating the local demand with appealing airfares. Between 1995 and 2000, passenger volumes grew by 57% at IAD and 67% at BWI. But by 2005, domestic O-D passenger traffic increased by 40% at IAD and by 13% at DCA because LCC entered these airports, stimulating traffic. Between 2000 and 2005, domestic O-D traffic dropped by 2% at BWI. Finally between 2005 and 2008, domestic passenger volume dropped by 8% at DCA and by 21% at IAD. In contrast, BWI remarkably withstood the traffic downturn, increasing its domestic passenger volumes by 2% between 2005 and 2008, and diverting traffic from the nearby IAD and DCA airports.

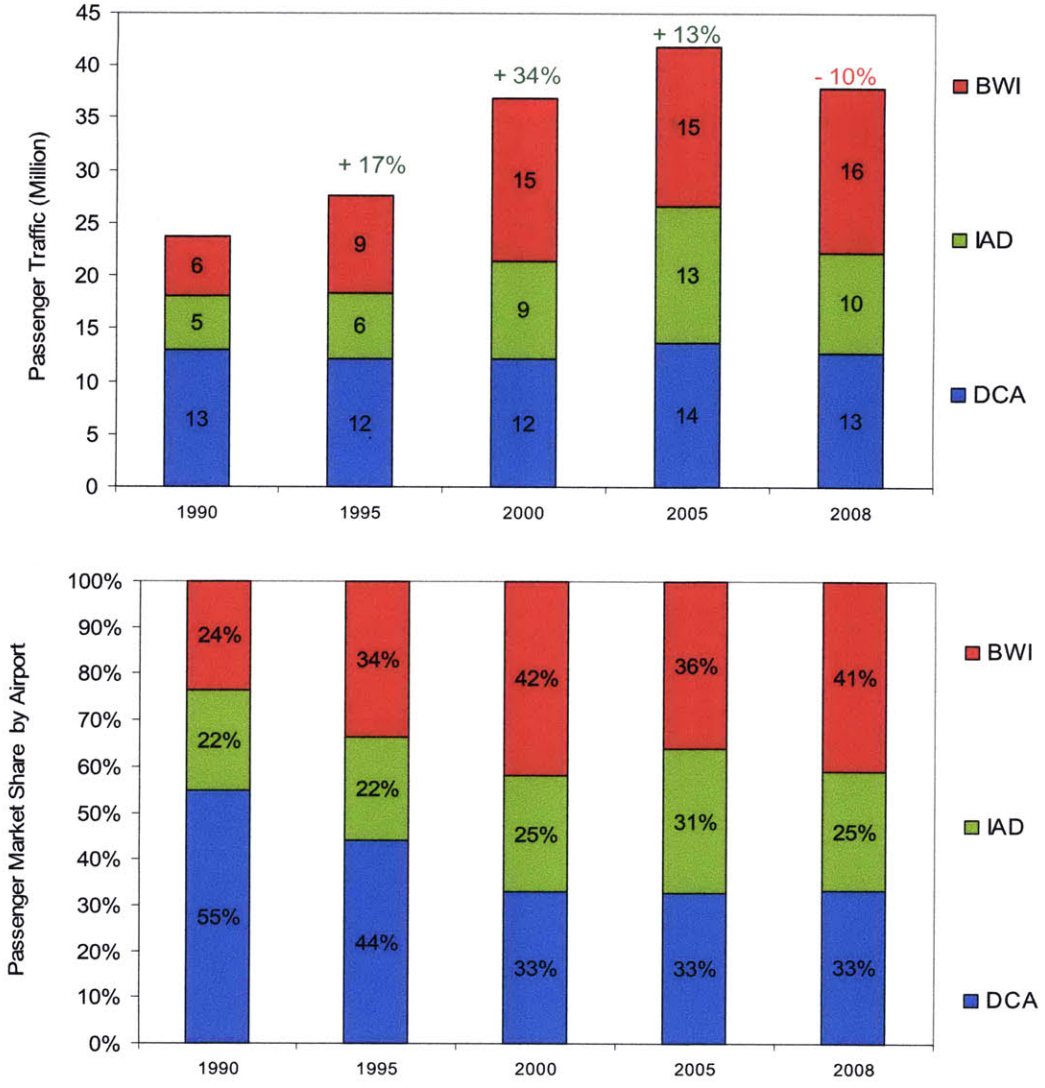

Figure 56: Domestic Passenger Traffic by Airport in the Washington DC Multi-Airport System

From Figure 56, we can conclude that BWI is the big winner of the competition between the three primary airports over the distribution of passenger traffic in the Washington DC metropolitan area: In 2008, BWI passenger traffic share of total passengers in the Washington MAS grew to 41%, while it only accounted for 24% in 1990. The airport's success can be explained by the high level of low-fare competition, and hence the prevalence of discounted airfares. It is interesting to point out that IAD passenger share increased from 22% in 1990 to 31% in 2005 because of JetBlue entering the airport, but recently dropped to 25% due to increasing BWI competition. Finally, DCA passenger share decreased from 55% in 1990 to 33% in 2008.

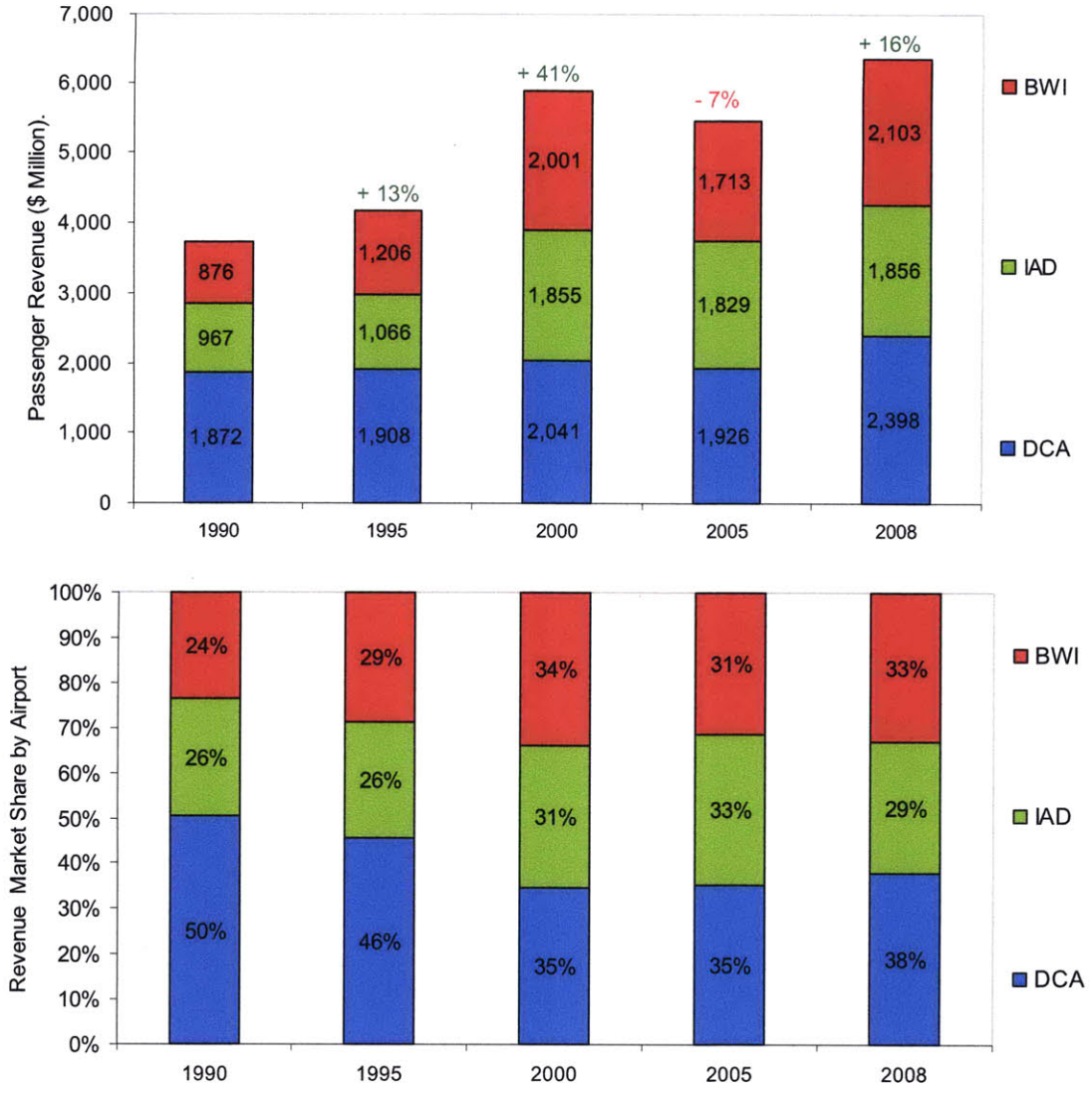

Figure 57: Revenues by Airport in the Washington DC Multi-Airport System

In Figure 57, we observe that the Washington area's total domestic O-D passenger revenue increased by 59% between 1990 and 2000, but declined by 7% by 2005, then rebounded by 16% between 2005 and 2008, exceeding the 2000 levels by 8%. With a 129% growth, BWI recorded the largest increase in domestic revenue between 1990 and 2000, followed by IAD with a 92% gain. However, BWI recorded a steeper decrease in domestic passenger revenue between 2000 and 2005— 14%, a fact that can be attributed to the high concentration of LCC at BWI. By 2008, domestic passenger revenue rebounded at both DCA and BWI. BWI domestic revenue share of the total Washington area's domestic revenue grew to 33% by 2008, up from 24% in 1990, while DCA domestic revenue share dropped from 50% in 1990 to 38% in 2008.

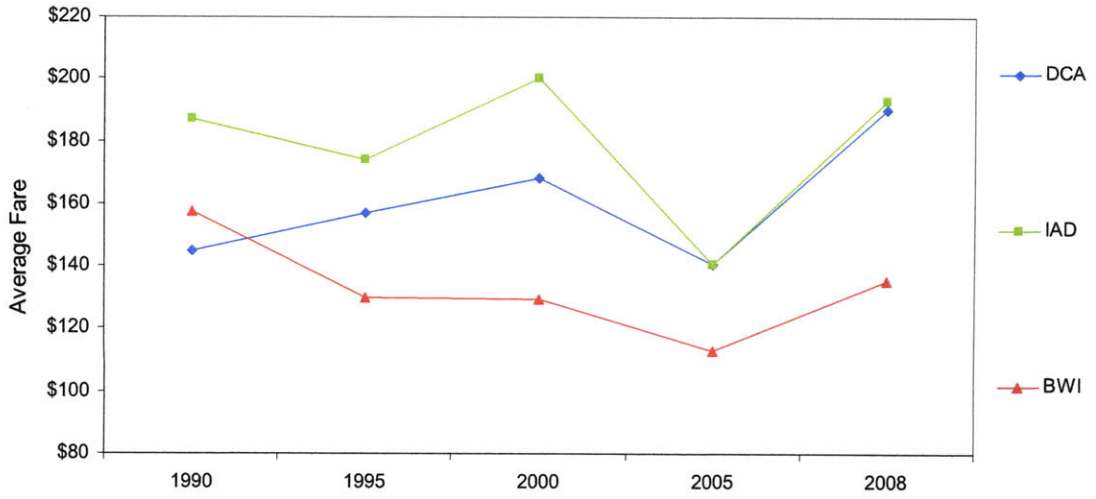

Figure 58: Average Fares at the three Airports in the Washington DC Metropolitan Region

The first trend highlighted by Figure 58 is that average fare at BWI decreased by 28% between 1990 and 2005. This can be explained by Southwest's rapid growth at BWI since 1993, and by AirTran entering the airport in 2001, reinforcing LCC presence at the airport. As a result, average fare at BWI has been consistently lower than average fares at IAD and DCA, which can also be explained by the difference in average haul. A second observation is that average fares decreased at all three Washington DC airports between 2000 and 2005; the steepest decrease—30%— was recorded at IAD, a fact that can be attributed to both Independence Air and JetBlue entering the airport and offering attractive low fares. As seen in the previous cases, skyrocketing jet fuel prices in 2008 resulted in average fare to rebound by 35%, 37% and 20% respectively at DCA, IAD and BWI, compared to 2005 levels.

We compared average fares at these three airports, in a sample of O-D markets: Chicago, New York, Boston, Atlanta, Los Angeles, Orlando, San Francisco, Denver, Dallas, Fort Lauderdale, Tampa, Detroit and Las Vegas. We found that in 2008, IAD recorded, on average, 2% lower average fares than DCA, while BWI had 16% lower average fares than DCA. Similarly in 2008, BWI reported on average 13% lower average fares than IAD. For instance, in 2008, the average one-way airfare to Chicago (O'Hare/ORD or Midway/MDW) was $162 from DCA, $146 from IAD and $127 from BWI. BWI is a primary airport, with a high level of low-fare competition, targeting price-sensitive local customers in the Washington DC area.

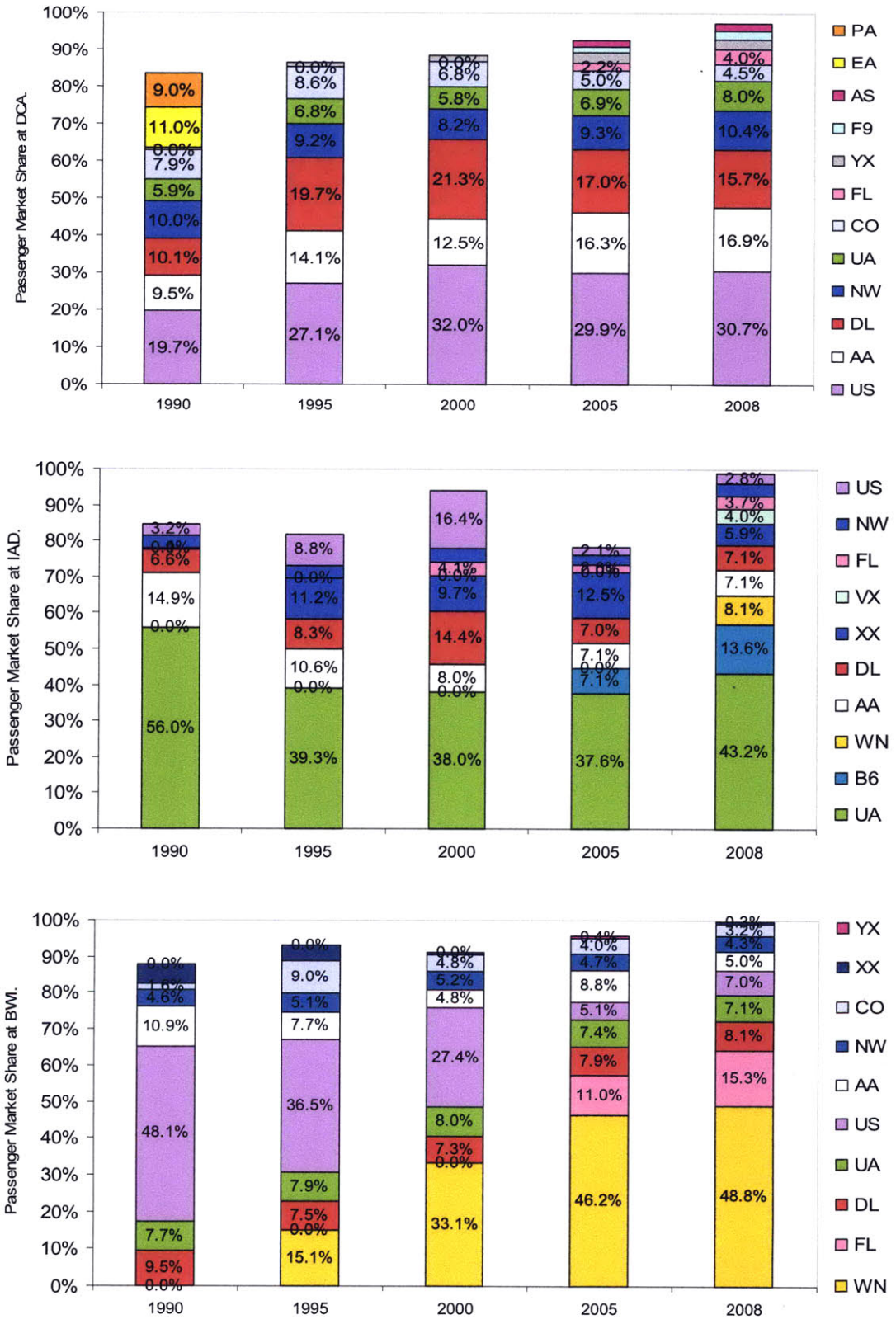

Figure 59: Passenger Market Share by Carrier at DCA, IAD and BWI

Figure 59 shows that US Airways and American Airlines gained significant market shares over their competitors at DCA. These gains were not only made at the expense of defunct carriers, but also at the expense of several Legacy carriers, including Delta and Continental. At the same time, AirTran (FL), Frontier (F9) and Spirit (NK) gained marginal market shares at the slot-controlled DCA airport. The aggregated LCC domestic O-D passenger market share at DCA barely reached 7.7% in 2008.

At IAD, LCC gained significant domestic passenger market share, hurting primarily United Airlines and American Airlines. In fact, JetBlue, which entered the airport in 2001, served 13.6% of the total domestic O-D passengers at IAD in 2008, while Southwest, which began service at Washington-Dulles in 2006, handled 8.1% of the passengers in 2008. This resulted in United Airlines to lose domestic passenger market share— from 56% in 1990 to 37.6% in 2005, but recently rebounded to 43.2%.

Figure 59 also shows that Southwest gained significant domestic passenger market share over Network Legacy carriers at BWI since it entered the airport in 1993, as part of its early-stage expansion east of the Mississippi; Southwest passenger market share jumped from 15.1% in 1995 to 48.8% in 2008. Since 2001, AirTran was also expanding rapidly at BWI, serving 15.3% of the total domestic passengers at the airport in 2008. Thus, Southwest and AirTran make up more than 64% of the market share at BWI, and the airport, which recorded a 14% decrease in average fare during the studied period, had the 23rd-least expensive average airfare among the 200 largest US airports in 2008. The proliferation of discount flights generated by the low-fare competition at BWI made the airport look very attractive to passengers originating or terminating their trips in the Washington DC metropolitan area, diverting traffic from the historically dominant DCA airport.

It is worth pointing out that Southwest and JetBlue increased their traffic market shares despite reporting relatively modest numbers of destinations with reported O-D traffic. For example in 2008, Southwest served 48.8% of the domestic O-D passenger traffic at BWI reporting only 65 O-D destinations, whereas Delta carried 8.1% of the O-D passengers at the airport to a total of 199 destinations.

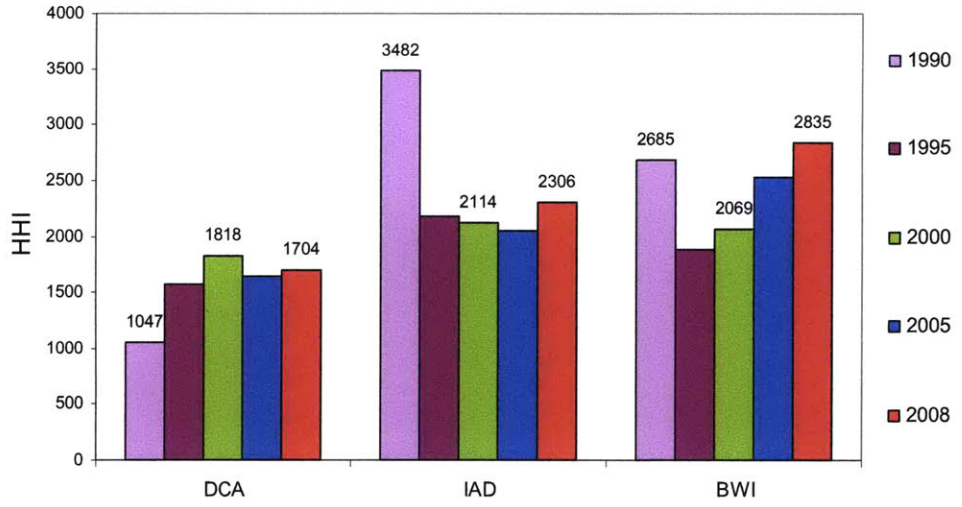

Figure 60: Airport Concentration Level as Measured by the HHI at DCA, IAD and BWI

In Figure 60, we can observe that the level of market concentration, as measured by the HHI, increased at DCA and BWI over the studied period, while it dropped at IAD. DCA is a moderately concentrated marketplace; the airport is highly congested and slot restricted, which inhibits significant expansion by new start-up airlines. In contrast, the HHI decreased at IAD from 3,482 in 1990 to 2,306 in 2008. This decrease is primarily due to the rapid growth of LCC, which controlled 29.9% of domestic O-D passenger traffic at IAD in 2008. Hence, IAD is considered as a concentrated marketplace, but was less concentrated in 2008 compared to 1990. At BWI, the HHI level increased to 2,835 in 2008, after dropping from 2,685 to 1,886 between 1990 and 1995. The increase in HHI at BWI is due to the rapid growth of Southwest since 1993, dominating domestic passenger traffic at the airport.

Figure 61 shows that the numbers of destinations with reported O-D traffic dropped between 1995 and 2008 at the three Washington DC airports. As seen in the two previous case studies, evidence suggests that the decrease in number of destinations with reported O-D traffic at DCA, IAD and BWI is due to network reduction despite more over-lapping services between the competing carriers.

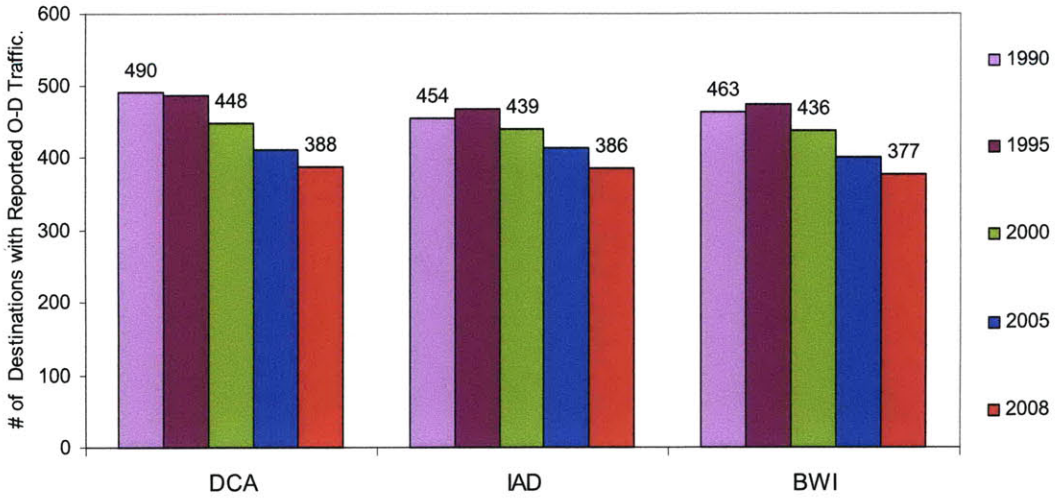

Figure 61: Number of Destinations with Reported O-D Traffic at DCA, IAD and BWI

5.3.1 Summary

In Washington DC, passenger traffic pattern was very similar to both passenger traffic patterns in Boston and New York metropolitan areas: Washington DC area's total domestic O-D passenger traffic jumped by 77% between 1990 and 2005, but decreased by 10% by 2008. Between 2005 and 2008, BWI remarkably withstood the financial crisis, increasing its domestic passenger volumes and diverting traffic from the nearby IAD and DCA airports, a fact that can be attributed to the high level of low-cost competition at BWI.

Jet Blue and Southwest have gained significant domestic passenger traffic shares over their Network Legacy peers at IAD and BWI airports, despite relatively modest numbers of cities with reported O-D traffic.

Over the studied period, BWI became the largest airport in the Washington DC metropolitan region, surpassing the historical DCA primary airport; in 2008, BWI domestic passenger traffic grew to 41% of the Washington area's total domestic passenger traffic, while it only accounted for 24% in 1990.

5.4 San Francisco Metropolitan Region Multi-Airport System

As depicted in Figure 62, the multi-airport system serving the San Francisco metropolitan region is composed of one primary airport, San Francisco International/SFO, and two secondary airports, Oakland International/OAK and San Jose International/SJC, which are located respectively at 11 and 31 miles from SFO. In 2008, San Francisco area's MAS served 38,728,970 domestic O-D passengers and 58.6 million passengers[54] including international/connecting traffic.

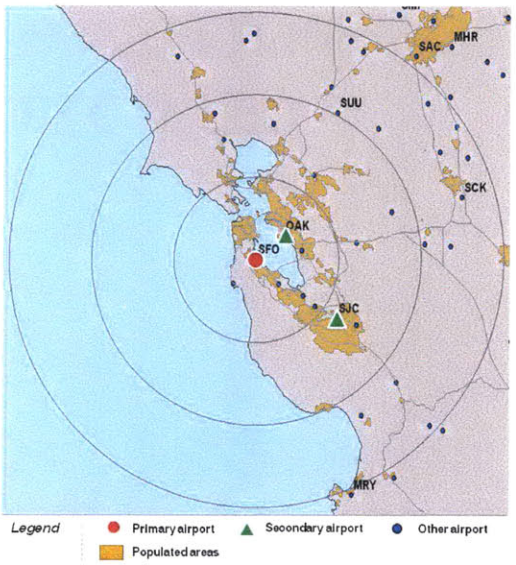

Figure 62: San Francisco Bay Area Multi-Airport System[53]

Figure 63 shows that the San Francisco area's total domestic O-D passenger traffic jumped by 55% between 1990 and 2000, but decreased by 10% by 2005 because of the 2001-2005 industry crisis and the dot-com bubble burst that has shaken the Silicon Valley. Between 1990 and 2000, domestic passenger volumes increased by 28% at SFO, but grew more dramatically at OAK and SJC— respectively by 87% and 117%. The significant passenger traffic growth at OAK and SJC can be attributed to Southwest entering these airports in 1989 and 1993 respectively, stimulating the demand with low fares. After 2000, domestic O-D passenger traffic decreased by 28% at SFO and by 14% at SJC, while passenger volume increased by 35% at OAK, as a result of JetBlue launching service at SJC in 2004. Between 2005 and 2008, domestic passenger volume dropped by 21% at OAK and by 7% at SJC: Secondary airports which succeeded in good times, suffered in bad times. In contrast, domestic passenger volumes increased by 21% at SFO by 2008, revealing the return of traffic to the region's primary airport.

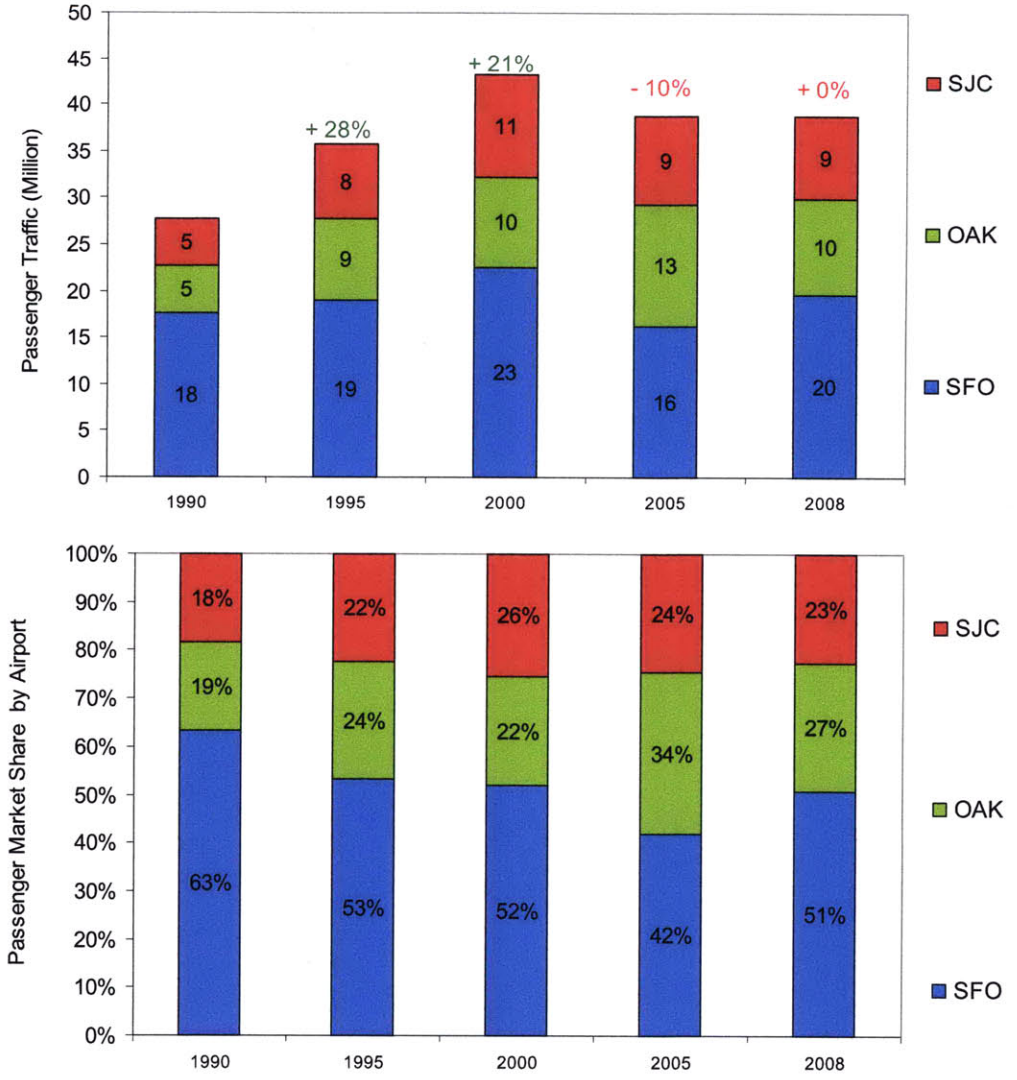

Figure 63: Domestic Passenger Traffic by Airport in the San Francisco Multi-Airport System

From Figure 63, we can observe that OAK and SJC combined domestic traffic share of the San Francisco metropolitan region's total O-D traffic peaked at 58% in 2005 compared to 37% in 1990. The increasing contribution of OAK and SJC to the total domestic O-D passenger traffic shows the importance of secondary airports in accommodating growing demand in the San Francisco bay area. It also highlights the role of low-cost carriers, such as Southwest, in the emergence of OAK and SJC as successful secondary airports. But, the two secondary airports suffered the global economic downturn and SFO's passenger share of domestic traffic rebounded to 51% by 2008, after reaching a minimum of 42% in 2005.

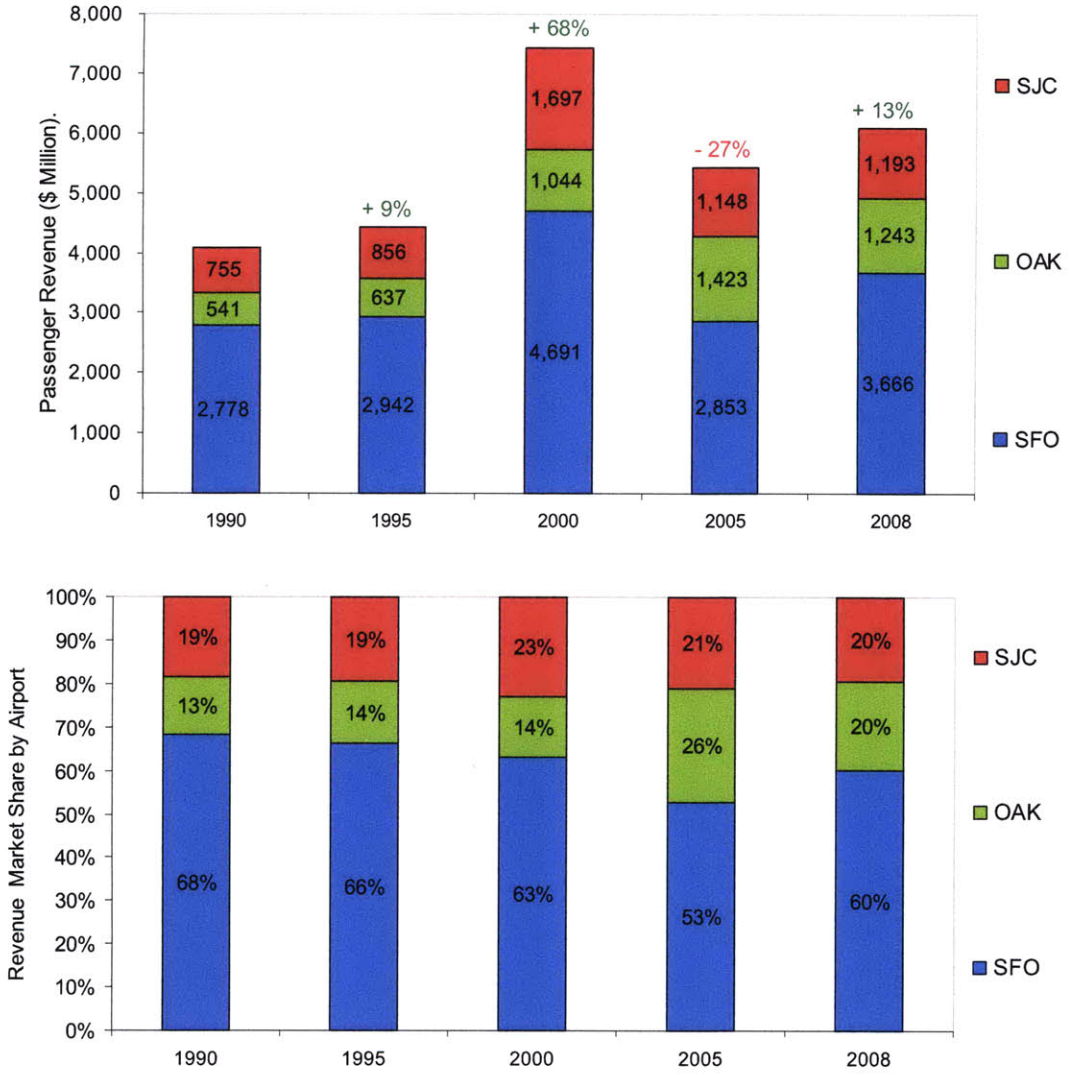

Figure 64: Revenues by Airport in the San Francisco Multi-Airport System

Figure 64 shows that the San Francisco area's total domestic passenger revenue increased by 82% between 1990 and 2000. But after the dot-com bubble burst in 2000, revenue declined by 27%. With a 39%-decrease, SFO recorded the steepest decrease in domestic revenue between 2000 and 2005. By 2008, the San Francisco area's passenger revenue rebounded by 13% compared to 2005 levels, but was still 18% below the 2000 peak. At SFO, total domestic passenger revenue rebounded to 29% above 2005 levels, after dropping by 39% from 2000 to 2005. At OAK, total domestic revenue jumped by 123% from 1995 to 2005, but dropped by 13% between 2005 and 2008. Finally, SJC's total domestic passenger revenue jumped by 98% between 1995 and 2000, but has dropped by 32% since then. By 2005, OAK and SJC combined

domestic revenue share of the total San Francisco area's domestic revenue grew to 40%, up from 32% in 1990.

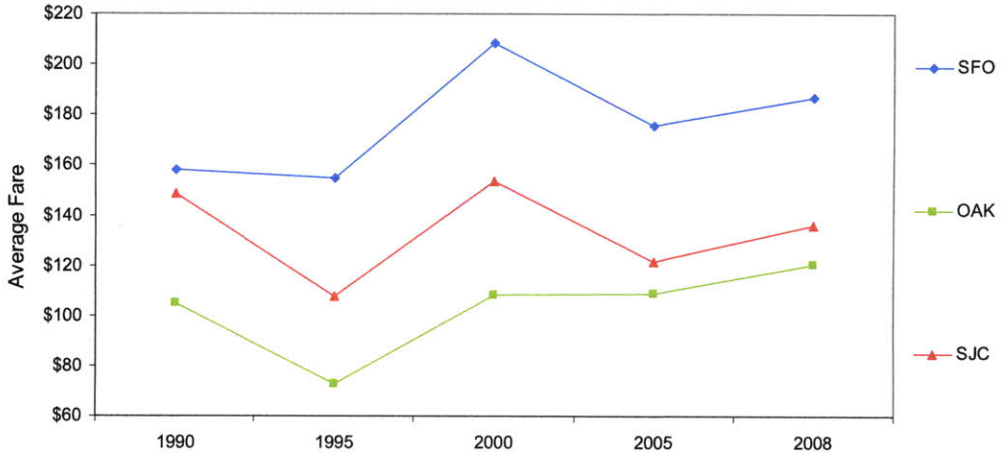

Figure 65: Average Fares at the Airports in the San Francisco Metropolitan Region

Figure 65 represents the evolution of average fare at each of the airports in the San Francisco metropolitan area. It clearly shows that average fare decreased by 30% at OAK and by 28% at SJC between 1990 and 1995. This can be explained by the fact that WN entered these markets in 1989 and 1993 respectively, offering significantly lower fares in primarily shorter haul O-D markets. WN has a significant impact at these airports because they are relatively small. During "the golden 90s", average fares at SFO, OAK and SJC increased respectively by 35%, 48% and 43%. The increase in average fare persisted at OAK between 2000 and 2005. In contrast, average fare at SFO and SJC decreased respectively by 16% and 21% during this period because of the fierce LCC competition. Finally, as we have seen in all three previous case studies, average fare increased at the three San Francisco airports from 2005 to 2008.

In addition, we compared average fares at these three airports, in a sample of O-D markets: New York, Los Angels, Las Vegas, Chicago, Seattle, Boston, Denver, Atlanta, San Diego, Washington, Honolulu, and Portland. We found that in 2008, OAK reported on average 11% lower average fares than SFO, while SJC reported on average 6% lower average fares than SFO. For instance, in 2008, the average one-way airfare to New York (LGA, EWR, JFK or ISP) was $276 from SFO, $193 from OAK and $205 from SJC. OAK and SJC continue to report 6-11% lower average fares than SFO, a result of business/leisure, first/economy mix and propensity of price-sensitive passengers to seek out lower fares at secondary airports.

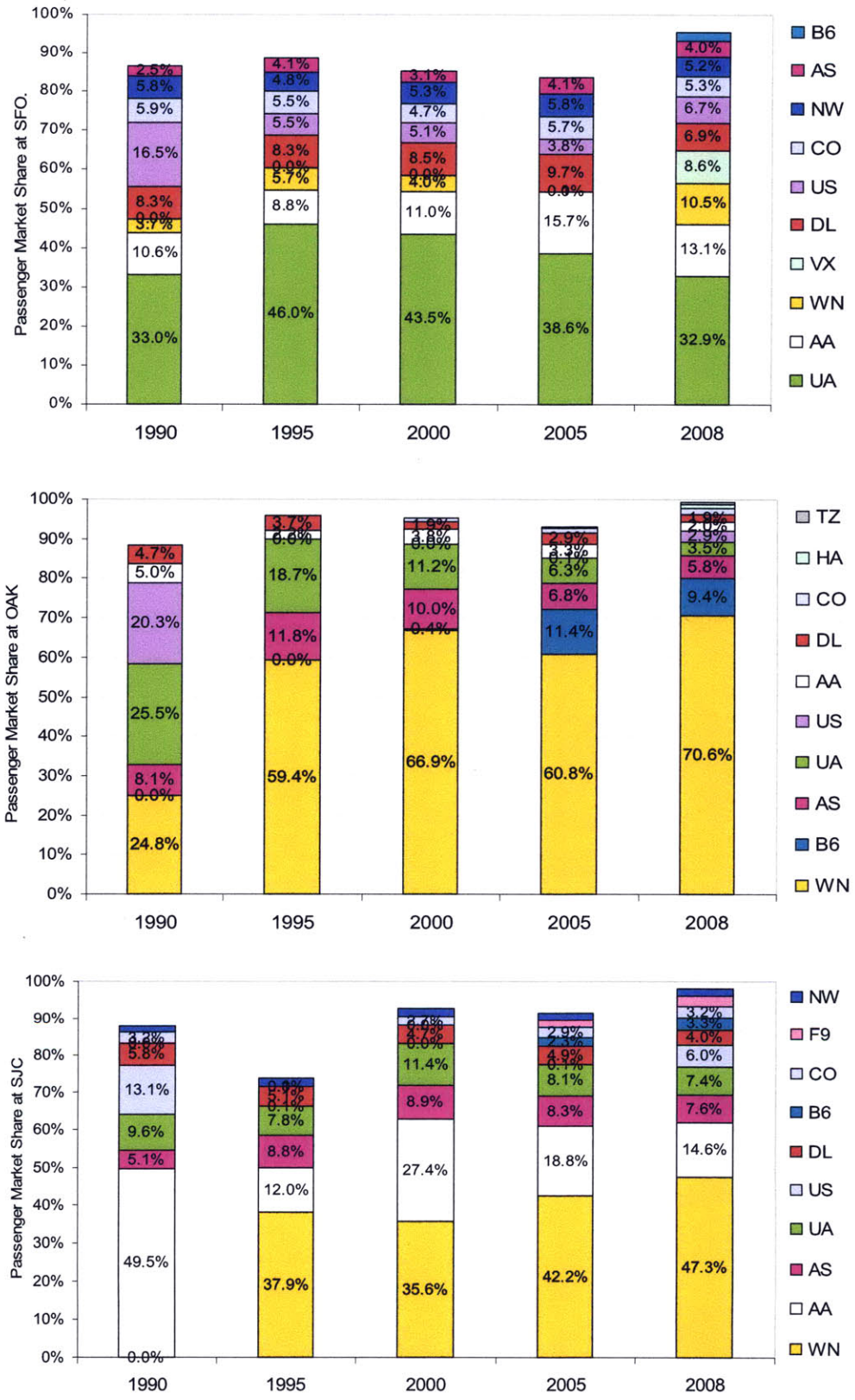

Figure 66: Passenger Market Share by Carrier at SFO, OAK and SJC

Figure 66 shows that UA Airlines reinforced its dominant position at SFO between 1990 and 1995, but has steadily lost market share since then in favor of American Airlines, Southwest and new entrant airlines, such as Virgin America and JetBlue. Southwest, which ceased service at SFO in 2001 because of high costs and delays, returned to the airport in 2007 and carried 10.5% of the domestic O-D passengers at SFO by 2008. In the same time, Virgin America (VX), which started service in 2007, gained 8.6% of the domestic market share at its principal base of operations— SFO. As a consequence, the aggregated LCC domestic O-D passenger market share at SFO jumped from 11.2% in 2005 to 24.4% in 2008.

At OAK, Southwest gained significant domestic passenger market share—70.6%, hurting primarily United Airlines, US Airways and Alaska Airlines. JetBlue, which entered the airport in 2006, served 9.4% of the total domestic O-D passengers at OAK in 2008. LCC expansion resulted in United Airlines losing passenger market share— from 25.5% in 1990 to 3.5% in 2008. Similarly, US Airways market share went from 20.3% in 1990 to 2.9% in 2008. Southwest and JetBlue make up more than 80% of the market share at OAK in 2008, and the airport, which recorded a 30% decrease in average fare between 1990 and 1995, had the 8th-least expensive average airfare among the 200 largest US airports in 2008. The generalization of discount flights generated by the low-fare competition at OAK made the airport looks very attractive to passengers in the San Francisco metropolitan area, diverting traffic from the historically dominant SFO airport.

Figure 66 also shows that Southwest gained significant domestic passenger market share over Network Legacy carriers at SJC since it entered the airport in 1993; Southwest passenger market share at the airport level reached 47.3% in 2008, hurting primarily American Airlines and Continental Airlines. New start-up airlines, such as JetBlue and Frontier, have entered the airport since 2004.

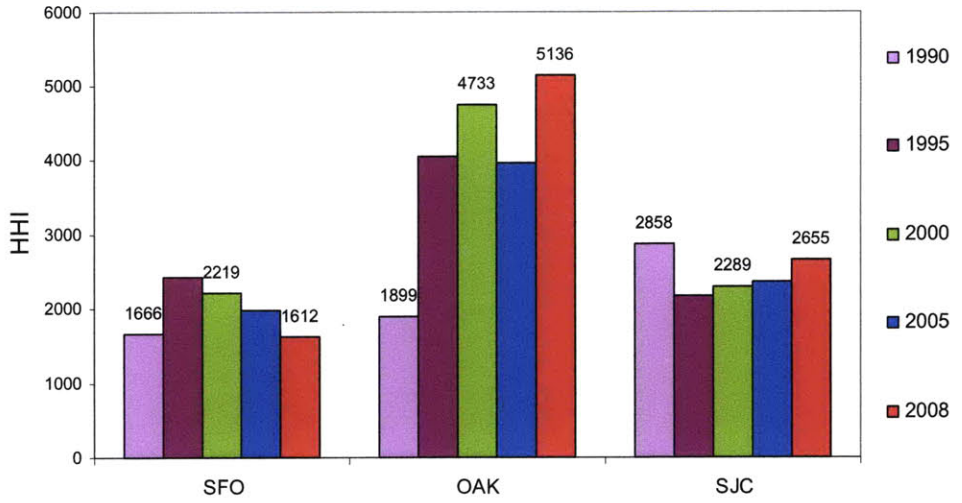

Figure 67: Airport Concentration Level as Measured by the HHI at SFO, OAK and SJC

In Figure 67, we can observe that the level of market concentration, as measured by the HHI, decreased slightly at SFO and SJC over the studied period, while it increased significantly at OAK. SFO is a moderately concentrated marketplace. In contrast, the HHI at OAK recorded a dramatic increase from 1,899 in 1990 to 5,136 in 2008. This progression is primarily due to the rapid growth of LCC, which controlled 70.6% of domestic O-D passenger traffic at OAK in 2008. Hence, OAK is considered as a concentrated marketplace, much more concentrated in 2008 compared to 1990. Finally at SJC, the HHI level increased to 2,655 in 2008, after dropping from 2,858 to 2,161 between 1990 and 1995. While the initial decrease in HHI at SJC is due to AA losing its dominant position between 1990 and 1995, the subsequent increase in HHI is due to the rapid growth of Southwest since 1993.

Figure 68 shows that the numbers of destinations with reported O-D traffic decreased between 1990 and 2008 at the three San Francisco airports. As seen in the three previous case studies, this decrease highlights the shrinking airlines' network coverage, affecting the largest US airports between 1990 and 2008.

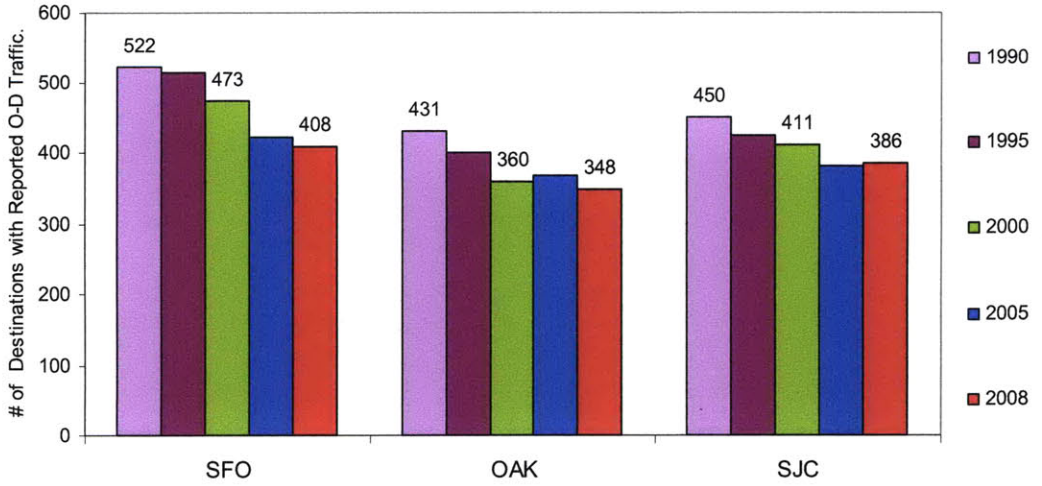

Figure 68: Number of Destinations with Reported O-D Traffic at SFO, OAK and SJC

5.4.1 Summary

Unlike the three previous case studies, the San Francisco metropolitan area's total domestic O-D passenger traffic increased significantly between 1990 and 2000, but decreased by 10% after the dot-com bubble burst that shook the Silicon Valley in 2000 and the 2001-2005 industry's crisis. In particular, the two secondary airports— SJC and OAK— which grew dramatically in good times, suffered the consequences of the global economic downturn between 2005 and 2008. At the same time, domestic passenger traffic at SFO increased by 21%, revealing the return of traffic to the historical primary airport in the region.

Southwest has gained significant domestic passenger traffic shares over its Network Legacy peers at OAK and SJC, dominating the competition at its OAK's "fortress". Southwest returned successfully at SFO in 2007, serving 10.5% of the domestic O-D passengers at SFO by 2008. Thus, Southwest is competing effectively at the three San Francisco area airports in 2008.

OAK and SJC have become important secondary airports, but their growth has slowed. By 2005, OAK and SJC combined domestic passenger traffic had grown to 58% of the San Francisco bay area total traffic, while it only accounted for 37% in 1990. However, these two secondary airports have lost domestic passenger volumes by 2008.

5.5 Miami Metropolitan Region Multi-Airport System

Figure 69 represents the multi-airport system serving the Miami metropolitan region. It is composed of two primary airports, Miami International/MIA and Fort Lauderdale/FLL. FLL is situated 21 miles north of Miami. In 2008, Miami area's MAS served 25,685,140 domestic O-D passengers and 56,685,229 million passengers[54] including international and connecting traffic.

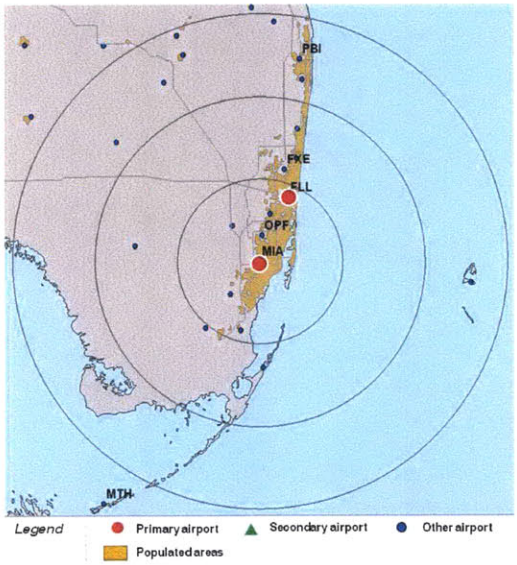

Figure 69: Miami Area Multi-Airport System[53]

Figure 69 shows that the Miami area's total domestic O-D passenger traffic jumped by 54% between 1990 and 2005, but decreased by 5% by 2008. Between 1990 and 2000, domestic passenger volumes decreased by 12% at MIA, but increased by 89% at FLL. The significant passenger traffic growth at FLL can be attributed to Southwest entering the airport in 1996, stimulating the local demand with discounted airfares. Several other Low-cost carriers have followed the entry of Southwest; Spirit in 1999, and JetBlue and AirTran in 2000. During the industry's crisis that started in 2001 and ended in 2005, domestic O-D passenger volume dropped by 2% at MIA, while it jumped by 34% at FLL. Finally between 2005 and 2008, domestic passenger volume decreased at both MIA and FLL, with MIA recording a steeper decrease relative to FLL— 6% at MIA against 4% at FLL.

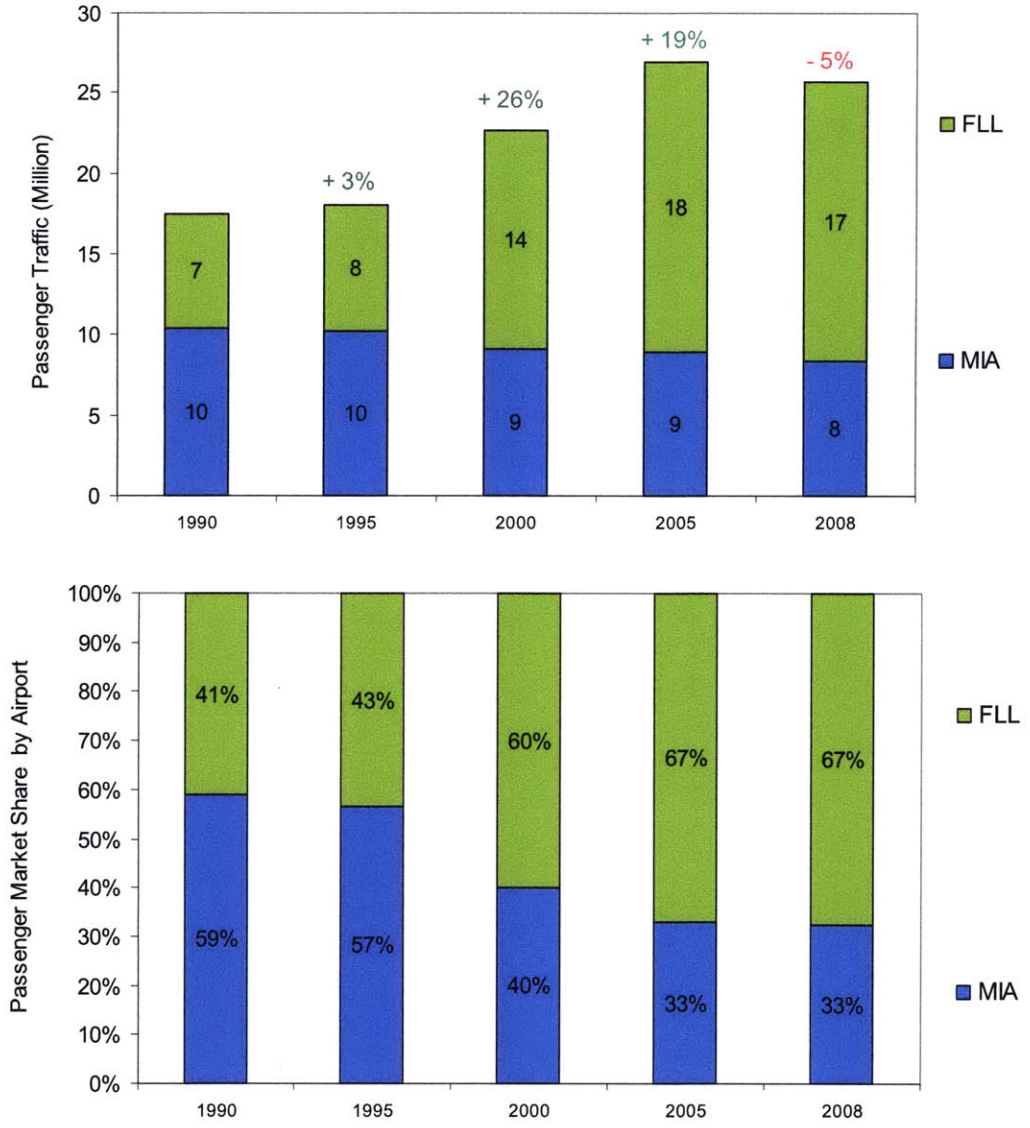

Figure 70: Domestic Passenger Traffic by Airport in the Miami Multi-Airport System

From Figure 70, we can observe that FLL, which use to be a secondary airport to MIA, has emerged as a successful primary airport in the region, diverting traffic from the original airport in the region—Miami International/MIA. In 2008, FLL passenger traffic share of total domestic O-D passengers in the Miami area grew to 67%, while it only accounted for 41% in 1990. The airport success can be explained by the relative high level of low-fare competition (Southwest, JetBlue, Spirit and AirTran), and hence the prevalence of discounted airfares. The aggregated LCC market share at FLL reached 56.9% in 2008, up from 10.5% in 1995, whereas MIA had an LCC aggregated market share of only 3.8% in 2008.

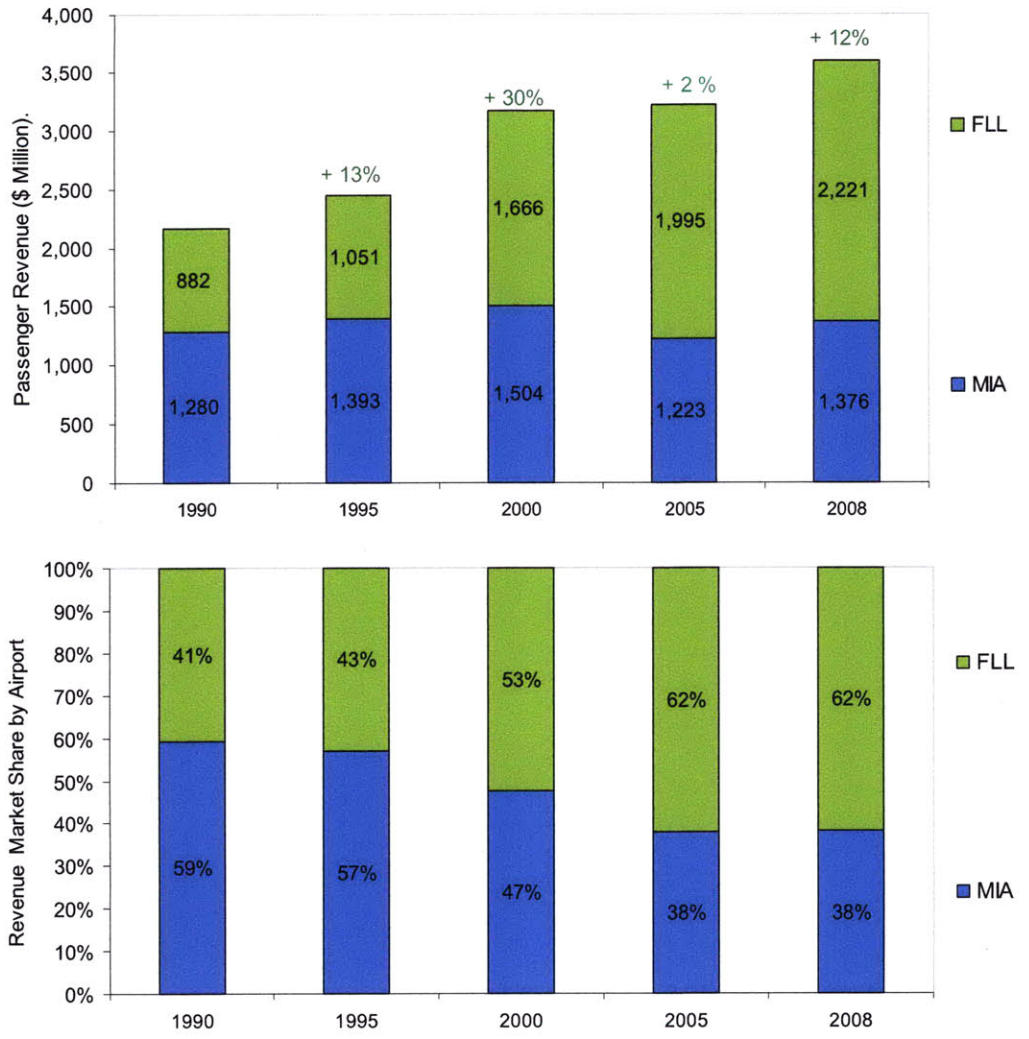

Figure 71: Revenues by Airport in the Miami Multi-Airport System

Figure 71 shows that the Miami area's total domestic passenger revenue increased steadily over the studied period; revenue increased by 30% during the "golden 90s", by 2% by 2005, and by 12% between 2005 and 2008. In particular, FLL's domestic revenue increased by 59% between 1995 and 2000 (i.e., upon the entry of Southwest and Spirit). At MIA, total domestic passenger revenue rebounded to 12% above 2005 levels, after dropping by 19% from 2000 to 2005. At FLL, total domestic passenger revenue increased by 20% between 2000 and 2005, and increased further by 11% between 2005 and 2008. By 2008, FLL domestic revenue share of the total Miami area's domestic revenue grew to 62%, up from 41% in 1990, a fact that can be explained by the shift in focus at MIA toward international and connecting traffic. In 2009,

MIA ranked first in the United States by percentages of international flights and second by international passenger traffic, behind New York's JFK.[55]

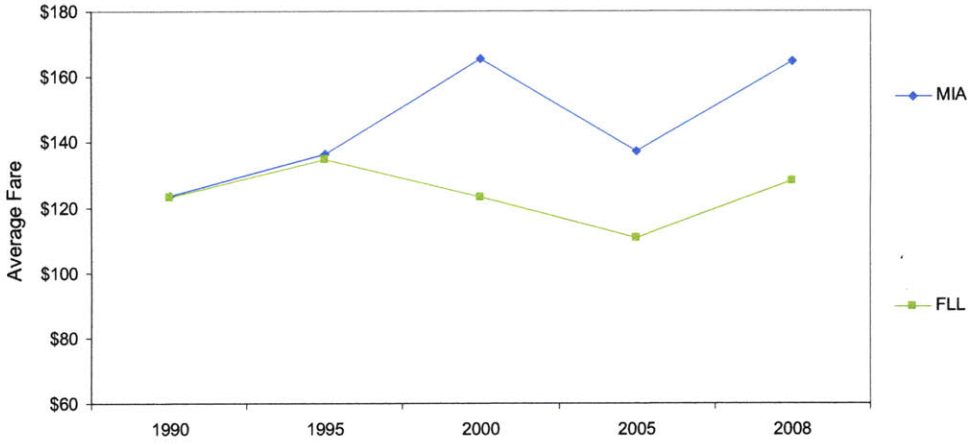

Figure 72: Average Fares at the Airports in the Miami Metropolitan Region

Figure 72 shows that average fare at MIA increased by 21% between 1995 and 2000, while average fare at FLL decreased by 9% during the same period, a fact that can be explained by Southwest starting service at FLL in 1996. Several other Low-cost carriers have followed the entry of Southwest; Spirit in 1999, and JetBlue and AirTran in 2000, reinforcing the low-fare competition at the airport. As a result, the decrease in average fare persisted at FLL between 2000 and 2005. Recently from 2005 to 2008, as seen in the previous four case studies, average fare increased by 20% and 16% respectively at MIA and FLL, driven by the increase in fuel prices.

We compared average fares at the two Miami airports, in a sample of O-D markets: New York, Atlanta, Chicago, Washington, Dallas, Los Angels, Orlando, Boston, Charlotte, and Tampa. We found that in 2008, FLL reported on average 20% lower average fares than MIA. For example, the average one-way airfare to New York was $144 from MIA and $123 from FLL—a 14%-difference, while the airfare to Los Angeles was $241 at MIA and $167 at FLL—a 31%-difference: American Airlines, the main tenant at MIA, uses its domestic flights to MIA more as feeders for longer haul trips rather than point-to-point services, meaning that AA does not need to compete on fares with the LCC serving FLL. Another plausible explanation for the difference in average fares between FLL and MIA is the concentration of LCC at FLL, targeting primarily the leisure price-sensitive passengers.

[55] http://www.centreforaviation.com/news/2010/02/12/miami-airports-rising-international-status/page1, last accessed 03/24/2010.

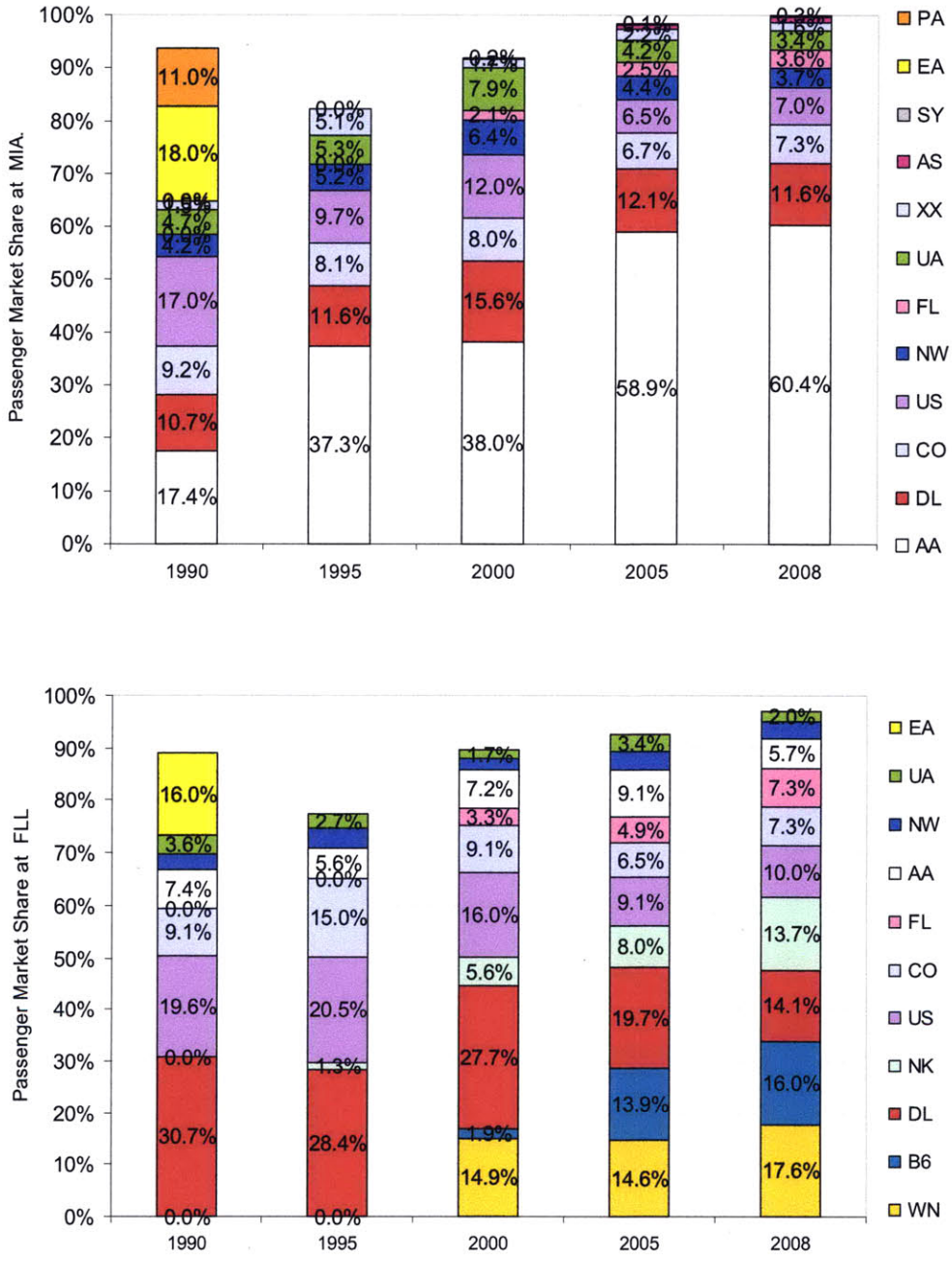

Figure 73: Passenger Market Share per Carrier at MIA and FLL

Figure 73 shows that American Airlines gained significant domestic O-D passenger market share at MIA between 1990 and 2008, hurting primarily US Airways, Continental, and Delta Airlines, and beneficiating from the void left by defunct carriers— Eastern Airlines and Pan American Airways. American Airlines, which controlled 60.4% of the domestic passenger volume at MIA in 2008, has successfully established an "international" hub at the airport. Indeed, American Airlines has built an extensive international network at MIA with a strong focus toward Latin America— 88.4% of the international traffic mix at MIA[55].

In 2008, only AirTran offered a low-fare product at MIA, serving 3.8% of the total domestic O-D passengers at the airport. The low LCC's presence at MIA is due to the recurrent congestion and saturation at the airport, as well as to the low-fare competition at the nearby FLL, and the international gateway status gained by MIA over the past decade.

Figure 73 also highlights the growth of LCC at FLL over the studied period. Southwest entered the airport in 1996, undercutting its NLC competitors' fares and stimulating significantly the price-sensitive leisure demand. Several other Low Cost carriers have followed the entry of Southwest; Spirit entered the airport in 1999, whereas JetBlue and AirTran started their services to FLL in 2000. In 2008, Southwest gained a domestic passenger market share of 17.6% at FLL, hurting primarily Delta Airlines, US Airways, and Continental Airlines. JetBlue grew rapidly to serve 16% of the total domestic O-D passengers at the airport in 2008, while Spirit and AirTran controlled respectively 13.7% and 7.3% of passenger volume at FLL. Low Cost carriers' expansion at FLL caused Delta to lose passenger market share— from 30.7% in 1990 to 14.1% in 2008. Southwest, JetBlue, Spirit and AirTran make up more than 56.9% of the market share at FLL in 2008, and the airport, which recorded an 18% decrease in average fare between 1995 and 2005, had the 15th-least expensive average airfare among the 200 largest US airports in 2008. As a consequence, the widespread of low fares at FLL boosted the airport's popularity among passengers departing from (arriving at) the Miami metropolitan area, diverting domestic traffic from the historically dominant MIA airport.

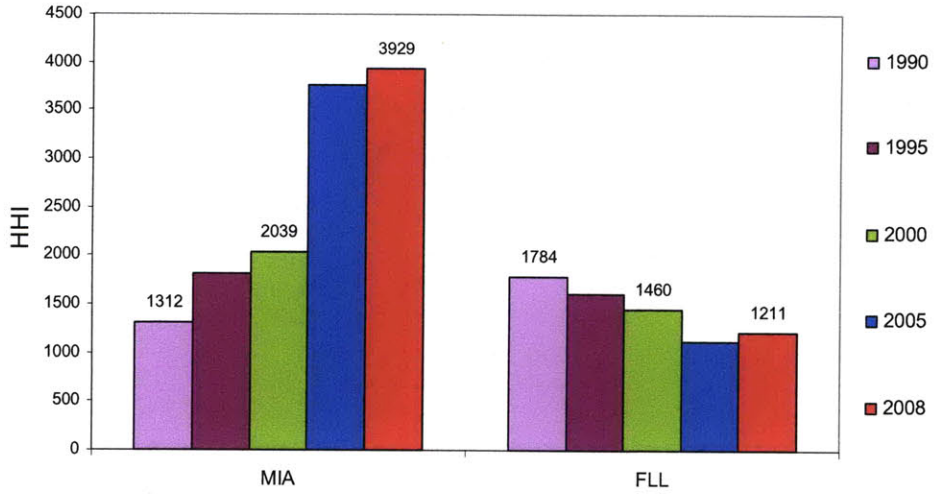

Figure 74: Airport Concentration Level as Measured by the HHI at MIA and FLL

In Figure 74, we can observe that the level of market concentration, as measured by the HHI, jumped from 1,312 to 3,929 at MIA between 1990 and 2008. Hence, MIA went from a moderately concentrated marketplace to a concentrated marketplace, a fact that can be directly attributed to American Airlines' rapid growth at the airport. In addition, MIA has been shifting focus toward international traffic and handled more international cargo than any other airport in the United States in 2008[56]. In contrast, the HHI at FLL recorded a dramatic decrease from 1,784 in 1990 to 1,211 in 2008. This drop in HHI is primarily due to the rapid growth of LCC that followed the development of the cruise industry at Fort Lauderdale. Hence, FLL is considered as a moderately concentrated marketplace, less concentrated in 2008 compared to 1990.

Figure 75 shows that the numbers of destinations with reported O-D traffic decreased between 1990 and 2008 at the two primary Miami area's airports. As we have seen in all four previous case studies, the decline of the total number of destinations at the airport level is due to network reduction despite more over-lapping services between the competing carriers.

[56] http://www.miami-airport.com/pdfdoc/facts_at_a_glance.pdf, last accessed 03/25/2010.

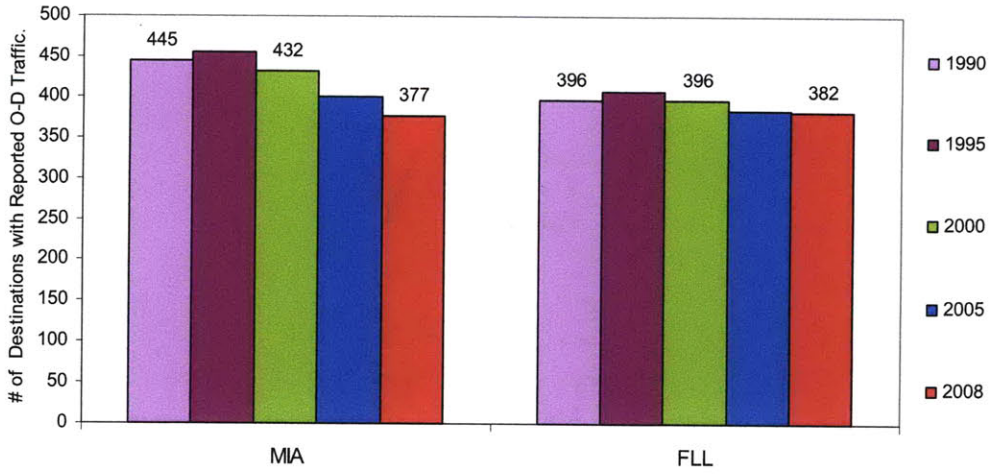

Figure 75: Number of destinations with reported O-D Traffic at MIA and FLL

5.5.1 Summary

Similar to Boston, New York and Washington DC metropolitan regions, the Miami area's total domestic O-D passenger traffic increased dramatically between 1990 and 2005, but slightly decreased by 2008. MIA, the historically dominant airport in the region, saw its domestic passenger volume decrease steadily from 1990 to 2008: The airport has been shifting focus toward international traffic, becoming a major international hub to Latin America and Europe. In the meantime, FLL domestic O-D passenger traffic increased significantly as a result of LCC stimulation and the development of the cruise industry at Fort Lauderdale.

Only AirTran offers a low-fare product at MIA, serving 3.8% of the total domestic O-D passengers at the airport in 2008. In contract, Southwest, JetBlue, Spirit and AirTran have gained significant domestic passenger traffic shares over their Network Legacy peers at FLL. In 2008, FLL had on average 20% lower average fares compared to MIA in a sample of ten popular O-D markets. Thus, the generalization of discount tickets at FLL boosted the airport's popularity among price-sensitive leisure travelers originating or terminating their trips in the Miami metropolitan area. Consequently, FLL surpassed, in 2000, MIA in term of domestic O-D passenger traffic and by 2008, FLL domestic passenger traffic had grown to 67% of the Miami area total traffic, while it only accounted for 41% in 1990.

5.6 Summary

The five case studies performed in this chapter show that Boston, New York, Washington DC and Miami metropolitan regions' total domestic O-D passenger traffic increased dramatically between 1990 and 2005, but slightly decreased by 2008. In contrast, San Francisco area's total domestic O-D passenger traffic increased between 1990 and 2000, but decreased by 10% after the dot-com bubble burst and during the 2001-2005 airline industry crisis. In Boston, New York and San Francisco multi-airport systems, secondary airports' domestic passenger traffic share of the total traffic in the MAS has grown significantly since 1990. For instance, in the Boston metropolitan region, PVD and MHT combined domestic passenger traffic grew to 33% of the Boston area total traffic by 2005, while the PVD and MHT combined domestic passenger traffic only accounted for 16% in 1990. In Washington DC and Miami multi-airport systems, a primary airport— BWI and FLL, respectively— became the largest airport in the metropolitan region after several Low Cost carriers started their services to the airport, surpassing the historically dominant primary airport— DCA and MIA, respectively. In all five case studies, the number of destinations with reported O-D traffic at each airport decreased between 1990 and 2008, revealing shrinking network coverage by Legacy carriers.

Southwest Airlines' business model played a key role in the emergence of MHT, PVD OAK and SJC airports as successful secondary airports. Southwest stimulated the traffic at these airports by offering low fares, attracting passengers that would have otherwise not traveled. In all five case studies, we found that Southwest and JetBlue have gained significant domestic passenger market shares from their Network Legacy peers. But, while JetBlue focused on primary airports inside each catchment area, Southwest built its network using uncongested and less expensive secondary airports, targeting price-sensitive customers. Secondary airports continue to report lower average fares than primary airports, a result of their lower business/leisure mix, low-fare competition intensity, and propensity of price-sensitive passengers to seek out lower fares at the secondary airports, as well as shorter haul flights.

Chapter 6
Summary of Findings and Future Research

The main objective of this thesis was to analyze the evolution of domestic traffic and fares at the Top 200 airports in the United States between 1990 and 2008. The impetus behind this research was also to shed light on the differences in trends between the largest and smaller airports within the sample studied airports, and to measure the impact of low-cost carriers on traffic, fares and competition. In this chapter, we present a summary of the findings, discuss some of the conclusions of this analysis, and suggest directions for future research.

6.1 Summary of Findings

The US airline industry has always been characterized by a cyclic profitability pattern. Since industry deregulation in 1978, the ten-to-eleven-year cycle of profitability has amplified, and has led to a growth in volatility. Since 2000, the US airline industry has gone through a severe crisis caused by the 9/11 terrorist attacks, soaring jet fuel prices, the global recession and, most importantly, the unrelenting and rapid expansion of the Low Cost carriers.

In Chapter 1, we introduced the objectives of this Thesis with a set of key questions that we ultimately wanted to address. After presenting the research and analysis in Chapters 4 and 5, we can now respond to these questions in order to summarize our findings:

- *How did the domestic O-D passenger traffic and revenue evolve over the past two decades?*

Looking at the evolution of traffic at the Top 200 commercial airports in the United States, we showed that the domestic O-D passenger volumes increased by more than 52% between 1990 and 2005, but dropped by 2% from 2005 to 2008 because of the global economic downturn. In contrast, revenues declined by 8% between 2000 and 2005, and then rebounded by 14% between 2005 and 2008. More importantly, average fares at the Top 200 airports decreased by 13% during the period 2000-2005 due to LCC competition. Thus, lower average fares contributed to higher passenger volumes but lower revenues in 2005. Soaring jet fuel prices in 2008 led to average fare's increase by 16% between 2005 and 2008.

- *Are there notable trends in the distribution of traffic among the Top 200 airports?*

The US domestic O-D air traffic is heavily concentrated at the largest commercial airports. The nation's Top 30 airports handled 58.5% of the total domestic O-D passenger traffic in 2008, while 74.9% of the traffic was handled by the 50 busiest airports. The Top 200 airports studied in this research accounted for 97.1% of the total domestic O-D traffic in 2008, up from 94.7% in 1990. The concentration of traffic at the busiest airports is an increasing trend; the Top 50 airports' cumulative passenger traffic share increased from 71.9% to 74.9% of the total domestic O-D traffic between 1990 and 2008, while the Top 100 airports' share grew from 87.9% to 91% during the same period. In 1990, the Top 200-airport total sample handled 94.7% of the total O-D passenger traffic, but the same share of traffic was handled by the Top 140 airports in 2008.

- *What are the trends in air fares and what do the distributions of fare changes over different time spans look like?*

Average fares at the Top 200 airports decreased by 3% from 1990 to 1995, then increased by 14% during the "golden 90s". During the industry's crisis that started in 2001 and ended in 2005, average fares decreased by 13%, but they rebounded by 16% between 2005 and 2008. We also analyzed the distribution of changes in average fares. Our analysis led to the conclusion that 83.5% of the Top 200 airports saw higher average fares in 2008 compared to 1990. However, the biggest decreases in average fares occurred from 2000 to 2005; 77% of airports had recorded a decrease in average fare as a result of the airlines' efforts to stimulate demand after the 2001-2002 decline in passenger volumes. The decrease in average fare was also caused by the fierce competition by LCC which, by offering more attractive fares to more markets, obliged the NLC to match their lower fares. In contrast, 95.5% of the airports had overall increases in average fares between 2005 and 2008, driven by the peak in crude oil prices.

- *What are the differences in trends between the largest and smaller airports?*

Between 1990 and 2008, domestic O-D passenger traffic increased the most in absolute and percentage terms— 52%— at the Top 50 airports. In parallel, the revenues generated at the busiest airports rose by 68%. The second airport tier (51-100), which represented between 16 and 17% of the total passenger traffic in the total sample, faced an increase in passenger volumes by 47% and in associated revenues by 73%. At the same time, the third airport tier (101-150) increased its traffic by 28% and its revenues by 52%. The fourth airport tier (151-200) experienced an increase in passenger traffic by 41%, while the associated revenues grew outstandingly by 93%, a fact that can be attributed to the significant increase in average fares at the smallest airports. Indeed, average fare increased the most— 35%— at the smallest 50 airports, followed by airports in the third tier, which have recorded a 20% increase. Average fare rose only by 12% at the 50 busiest airports. This can be explained by the fact that the competition is fiercer at the busiest airports where Low Cost carriers are more present, since their point-to-point networks do not allow for consolidation of traffic, and hence require high levels of demand.

- *How did the number of destinations with reported O-D traffic evolve at each airport?*

The average number of domestic destinations per airport with reported O-D traffic, which is a proxy of the airlines' network coverage, has been decreasing since 1995, dropping by more than 9% from 1995 to 2008. This trend has been more pronounced for the biggest airports— a 15% drop— while the smallest 50 airports have increased their number of destinations by 7%. The busiest airports have consistently maintained a higher average number of destinations than the smaller airports: This can be explained by the fact that the busiest airports are generally hub airports with an established hub network, enabling airlines to serve greater number of markets flying the same number of aircrafts through traffic consolidation.

- *What percentage of the domestic O-D passenger traffic has been gained by the low-cost carriers over the years?*

We demonstrated that LCC's share of the total domestic O-D traffic is still growing but leveling off, reaching 34% in 2008. The average number of LCC per airport increased from 0.47 in 1990 to 2.84 in 2005, but has recently dropped in 2008. It was interesting to observe that LCC were not only spared, but even boosted during the industry down-cycle that started in 2001. In addition, LCC's presence is greatest at the biggest airports, where they compete not only against NLC but also against each other. Our analysis found that LCC entry focused initially on the largest airports, then grew rapidly in second and third airport tiers. As a result, in 2008, 95 of the Top 200 airports had an LCC aggregated market share greater than 20%, up from 27 in 1990. In particular, individual carriers, such as Southwest, JetBlue and AirTran, have significantly expanded their presence in the Top 200-airport list, and reinforced their competitive position in their markets by increasing their market shares. For instance, Southwest, which has increased its number of airports with a leading passenger market share position from 15 airports in 1990 to 48 airports in 2008, surpassed all other airlines in terms of market share leadership in 2008.

- *How are the average fare and passenger traffic at an airport affected by the "effective entrance" of a low-cost carrier or by a "substantial increase" in LCC aggregated market share?*

Our analysis showed that LCC effective entrance or substantial growth at a particular airport had a significant impact, lowering average fares. We also demonstrated that LCC effective entrance or substantial growth at an airport significantly stimulates passenger volumes at the affected airport. But, this LCC market stimulation effect has been leveling off in recent years, as the gap in average fares between LCC and NLC narrowed.

- *How did the number of competitors and airport concentration level evolve at each airport?*

The analysis of the competition at the airport level showed that the average number of effective competitors increased to 4.62 competitors per airport in 2008, up from 4.01 back in 1995. Still, the airport market concentration levels, as measured by the average weighted Herfindahl-Hirschman Index, increased by 8% between 1990 and 2008. Similarly, the weighted average Concentration Ratio 1-firm (CR1) increased from 36.8% in 1990 to 40.2% in 2008, while the weighted average CR2 rose from 55.2% in 1990 to 57.5% in 2008. These observations led us to the conclusion that the Top 200-airport sample is more concentrated in 2008 compared to 1990.

- *What are the differences between hub and non-hub airports?*

The segmentation of the total sample into hub and non-hub airports showed that the 18 hub airports concentrated 28.9% of the total domestic O-D traffic at the Top 200 airports in 1990, while generating 32.1% of the total revenues. Average fares for local traffic at hub airports are higher than prices on routes where both origin and destination are non-hub airports. However, this gap has narrowed since 2000 to reach a minimum point of $10 in 2008. Average fare increased by 18% at hub airports between 1995 and 2000, but dropped by 20% between 2000 and 2005. The evolution of passenger traffic at the hub and non-hub airports has followed the same trends as passenger traffic in the total sample, that is, a 49% and 54% increase in passenger traffic respectively for hub and non-hub airports between 1990 and 2005, followed by a 2% decrease between 2005 and 2008. Finally, the average number of destinations with reported O-D traffic decreased by 17% and 11% respectively at hub and non-hub airports between 1990 and 2008.

- *Which airports are growing? Which airports are shrinking?*

We found that New York John F. Kennedy/JFK, Denver International/DEN and major leisure destination airports (Las Vegas McCarran International/LAS, Orlando International/MCO and Fort Lauderdale/FLL) have seen the greatest traffic growth during the studied period. In contrast, Honolulu/HNL, Miami International/MIA and small Florida airports, such as Sarasota/SRQ, Melbourne/MLB and Daytona Beach/DAB, have lost the most traffic between 1990 and 2008. We also found evidence of traffic redistributions between airports located in the same catchment area. For instance, Los Angeles/LAX lost 3.4 million passengers between 2000 and 2008, while the nearby Long Beach/LGB, John Wayne International/SNA and Hollywood-Burbank/BUR airports gained, respectively, 2 million, 1 million and 0.5 million passengers.

- *What is the importance of multi-airport systems in the U.S. commercial airport system, and what are the differences in trends between primarily and secondary airports?*

We found that multi-airport systems account for 47% of the total domestic O-D passenger traffic in the Top 200-airport sample, and hence are an important component of the commercial airport system. MAS are a characteristic of the metropolitan regions with the greatest volume of originating and terminating traffic. Our analysis showed that secondary airports served 19.8% of the total domestic O-D passenger traffic in the 15 studied multi-airport systems in 2008, compared to 16.9% in 1990. Similarly, secondary airports collected 16.3% of the total revenues generated in MAS in 2008, compared to 13% in 1990, a fact that can be attributed to the lower average fares at secondary airports. This result can be explained by the shorter average haul at secondary airports compared to primary airports, as well as by the difference in business/ leisure passenger mix. However, the gap in average fares between primary and secondary airports narrowed from 1995 to 2005. In particular, average fares decreased the most at primary airports between 2000 and 2005—a 19% decline. Finally, the HHI level increased for both primary and secondary airports between 1990 and 2008, a fact that highlights the increase of market concentration and the decrease in the level of competition at these 39 airports.

- *What trends are shaping multi-airport systems?*

The exceptional growth in demand for air traffic combined to capacity constraints on existing major airports led to the emergence of secondary airports in the nation's largest metropolitan areas. The development of these secondary airports, serving the same catchment areas as one or more primary airports, led to the emergence of Multi-Airport Systems (MAS). MAS play a critical role in accommodating the increase in demand. The development of such MAS increased the competition among airports themselves. In fact, airports are now competing with other primary and secondary airports belonging to the same multi-airport system. The case studies performed in Chapter 5 show that, in general, secondary airports' domestic passenger traffic share of the total traffic in the MAS has grown significantly between 1990 and 2008. For instance, in the Boston metropolitan region, PVD and MHT combined domestic passenger traffic had grown to 33% of the Boston area total traffic by 2005, while the PVD and MHT combined domestic passenger traffic only accounted for 16% in 1990. Southwest Airlines' business model played a key role in the emergence of these airports as successful secondary airports; Southwest stimulated the traffic at these airports by offering appealing low fares, attracting passengers that would have otherwise never considered travelling. In particular, our analysis shows that LCC,

such as Southwest and JetBlue, have gained significant domestic passenger market shares over their Network Legacy peers. But, while JetBlue focused on primary airports inside each catchment area, Southwest built its network using uncongested and less expensive secondary airports, targeting price-sensitive customers. In general, LCC tend to prefer secondary airports because these airports are less congested and have lower facility charges, whereas NLC prefer primary airports, which concentrate international traffic, handle a significant level of connecting passengers, and serve a disproportionate share of total passenger enplanements in the metropolitan region. Therefore, secondary airports continue to report lower average fares than primary airports, a result of business/leisure mix, low-fare competition intensity, and propensity of price-sensitive passengers to seek out lower fares at the secondary airports.

6.2 Conclusions and Future Research

Domestic O-D passenger traffic at the Top 200 commercial airports in the United States increased by more than 52% between 1990 and 2005 but dropped by 2% from 2005 to 2008 because of the global economic downturn. In contrast, domestic revenues declined by 8% between 2000 and 2005 and then rebounded by 14% between 2005 and 2008. More importantly, average fares at the Top 200 airports decreased by 13% in 2000-2005, corresponding to the severe crisis that affected the US airline industry. Thus, lower average fares contributed to higher passenger volumes but lower revenues in 2005. Finally between 2005 and 2008, average fare increased by 16%, a fact that can be attributed to soaring jet fuel prices. (In 2008, the price of a barrel of crude oil fluctuated between $145.29 and $33.87 in just 118 days of trading.[57])

The studied period has been characterized by the unrelenting and rapid growth of the Low Cost carriers. LCC's share of the total domestic O-D traffic in the US is still growing, although leveling off, reaching 34% in 2008. LCC focused primarily on the largest airports, then grew rapidly in the second and third airport tiers. As a result, in 2008, 95 of the Top 200 airports had an LCC aggregated market share greater than 20%, up from 27 airports in 1990. We showed that LCC effective entrance or substantial growth at a particular airport had a significant impact, lowering average fares and stimulating passenger volumes. However in recent years, this market stimulation effect has been leveling off, as the gap in average fares between LCC and NLC has narrowed. Low Cost carriers' rapid expansion at most of the large, medium and small hub airports gave incentives to price-sensitive passengers to bypass the small airport serving their communities and drive to the nearest airport served by an LCC. Future research could analyze the impact of LCC on Legacy carriers' networks, investigating the development of parallel and semi-parallel networks.

Between 2005 and 2008, the average number of Low Cost carriers per airport in the total sample dropped as a consequence of the economic downturn, increase in the level of competition, and perhaps saturation of the market. Evidence suggests that LCC have scarcer opportunities for expansion now that they hold a critical share of the domestic market. Besides, the convergence in unit cost between NLC and LCC, and hence the ability of NLC to match LCC's lower fares, brought the fierce competition between carriers to a new level. As a result, LCC need rigorous

[57] ATA, 2008 Economic Report, p. 9.

discipline on fares and innovation if they want to thrive and to keep expanding their domestic networks.

The average number of destinations, per airport, with reported O-D traffic has been decreasing since 1995, driven by a reduction in NLC's network coverage. This trend accentuated in the aftermath of the 9/11 attacks and the global financial crisis, when Network Legacy carriers started pulling out capacity by retiring some of their old aircrafts and grounding others. Small airports, which already offer fewer flight options, are impacted the most by the capacity cuts. As mentioned in Chapter 2, 38 airports lost all service from 2007-Q4 to 2008-Q4, which is twice the number of airports that lost service during the same period one year before[47]. Hence, we should ask ourselves if shrinking airline networks can support yesterday's commercial airport map.

Despite Low Cost carriers' deep penetration of the domestic air transportation market and the fierce competition between LCC and NLC on the O-D market level, the airport market concentration levels, as measured by the average weighted Herfindahl-Hirschman Index, increased by 8% between 1990 and 2008. Similarly, the weighted average Concentration Ratio 1-firm increased from 36.8% in 1990 to 40.2% in 2008, while the weighted average Concentration Ratio 2-firm rose from 55.2% in 1990 to 57.5% in 2008. These observations led to the conclusion that the Top 200-airport sample is more concentrated in 2008 compared to 1990.

In terms of directions for future research, several questions surface from our findings. First, our research concentrated on the Top 200 commercial airports in the US, but disregarded the remaining 322 small, non-hub airports. Although these airports do not enplane a large proportion of passengers, they are nevertheless important to their communities, providing access to the global air transportation network. Thus, this research should be extended to include all commercial airports in the National Plan of Integrated Airport Systems (NPIAS). This inclusion should shed light on the diminishing service at many of the US small and non-hub airports. Second, as we saw, New York John F. Kennedy/JFK, Denver International/DEN and major leisure destination airports, such as Las Vegas McCarran International/LAS, Orlando International/MCO and Fort Lauderdale/FLL, are the big winners in terms of traffic growth between 1990 and 2008, whereas Honolulu/HNL, Miami International/MIA and small Florida airports have lost the most traffic during the studied period. But, in order to better understand the fundamental mechanisms that govern the distribution of passenger traffic between competing airports within 50, 100 or 150 miles, as well as the attributes of growing and shrinking markets,

we need to add some economic data (income, employment, GDP, housing, regional business and economic factors and indicators, etc.) and demographic data (population, age, sex, educational attainment, mobility, location and geography, etc.) to each airport market. Third, we mention that the difference in average fares between hub and non-hub airports could be partially explained by the difference in average haul. We can ask ourselves to what extent are average fares correlated to the average haul at a particular airport. This correlation should be further studied by measuring the evolution of average haul at each airport. Finally, one of the main limitations of this analysis comes from the fact that the survey's data do not differentiate between various fare structures, which prohibit, for example, the interesting distinction between leisure and business passengers.

The airline industry is fast-changing, highly cyclical and unstable. Volatility in jet fuel prices, emergence of an epidemic, or a global financial meltdown are some of the causes of this instability. Major mergers and consolidations, such as the Delta Airlines' acquisition of Northwest Airlines in October 2008, dramatically change the nature of the competition at the airport and O-D market level. For these reasons, it would be useful to update this analysis periodically in order to take the pulse of the industry's stakeholders (airlines, airports and passengers) and to monitor the evolution of domestic passenger traffic and fares at the national and regional scales.

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