TRENDS IN PASSENGER DEMAND AND AIRLINE SUPPLY OF TOP 25 LONG-HAUL U.S. DOMETIC MARKETS

by

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Abstract

The thesis examines the effect of deregulation on passenger demand and airline supply of the top 25 long-haul U.S. domestic markets by measuring the annual and overall percentage changes in passenger traffic, airfare, nonstop flight frequency, total nonstop seat capacity, and average aircraft size over the time period between 1987 and 1995, and quantifying the relationships between these parameters. The correlations between these parameters are obtained by developing non-linear regression models.

Within this time period, aggregate passenger demand of the total 25 markets increased by 3.5% annually and 30% overall. Inflation adjusted airfares of the majority of the top 25 markets decreased very slightly, only 0.03% annually and 2.32% overall. However, airfares tended to increase for the markets associated with hub airports because the dominant airline at that hub station has greater power to increase fare levels. Nonstop frequency increased at about the same rate as passenger demand across the nine-year period, given that there were approximately 1,000 more flights per week in 1995 than in 1987 in these markets. The total nonstop seat capacity of the total 25 markets increased by 90,000 seats per week since 1987, which represents 1.85% annually and 14.42% overall. Average aircraft size for the top 25 market decreased by 0.88% annually and 7% overall.

From the results of the correlation analysis, passenger demand of the top 25 markets is price-elastic, especially of the vacation city-pair markets. On the contrary, passenger demand of the hub-related and business markets is rather insensitive to changes in airfare since both demand and fare increased over time. Interestingly, nonstop frequency has a strong impact on how airlines allocate seat capacity and aircraft size, not passenger demand. Because flight frequency increased at a faster rate than did total nonstop seat capacity in the nine-year period, the shift towards the usage of smaller aircraft is evident, which is consistent with the results of the percentage change analysis.

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Thesis Overview

In the past 18 years of airline history, the strategy in airline operation has changed dramatically. Business strategy alternatives mostly pertain to the airline deregulation in 1978. The Airline Deregulation Act, passed by Congress, gave freedom to airlines to serve any domestic route and set fares without government approval. It also allowed new airlines to form and made it less difficult for existing airlines to expand operations into new markets and abandon existing ones. It is obvious that deregulation has led to increased competition in the airline business. Greater competition means lower airfares, more services, and a wider variety of service offerings. More competition also forces airlines to become more efficient both financially and operationally.

From the basic economic theory of supply and demand, the price of a good is inversely proportional to the quantity demanded of the good: as the price of a good falls, the quantity demanded of the good rises, and vice versa. For example, the price of a good is the fare prices that airlines charge their customers and the quantity demanded of a good is the number of passengers who purchase a ticket from an airline. Therefore, greater competition (lower fares, more service, and a wider variety of service offerings), the growth of global business, and better ergonomics in air transport are the key factors which have stimulated the demand for air travel since deregulation. The current-year demand in air transportation is much higher than the demand in 1978. One interesting issue which is worth further study is how and to what extent airline supply, in terms of airfare, average seat capacity and service frequency, has been changed since deregulation in response to a higher demand in air transportation and an increase in competition between airlines.

1.2 Thesis Objective

The objective of the thesis is to relate the trends in the average fare charged and average seat capacity for nonstop services in the top 25 long-haul U.S. domestic markets to changing airline business strategy and increasing demand in air transportation after the Airline Deregulation in 1978. A long-haul domestic market is a domestic city-pair market with a distance between origin and destination over 750 miles. According to *Aviation Daily* (March 7, 1996), the top 25 domestic long-haul markets are the markets listed in Table 1.1.

The airline's business strategy strictly refers to the flight frequency or, in other words, the number of departures per day which airlines offer in their regular schedule. The demand in air transportation refers to passengers who travel from one city to another for any purpose (i.e., business or leisure).

According to the objective of the thesis, three important questions will be answered:

1. What are the trends in the average fare charged by airlines of these top 25 long-haul U.S. domestic markets.
2. How changes in the average airfare charged by airlines may be correlated to increases in air travel demand for the time periods after the deregulation.
3. How and to what extent the average seat capacity has changed in correspondence to the increase of air travel demands and the changing patterns of route networks after the deregulation.
4. How changes in average seat capacity may be correlated to changes in demand, flight frequency, and fare for the time periods after the deregulation.

The result of this thesis will include a summary of the trends in airline demand and supply (including average fare, service frequency, and seat capacity), and the correlation between the changes in these components of airline supply with respect to the changes in demand since deregulation in 1978.

Rank	City-Pair Markets		Distance
1	Los Angeles	New York	2,467
2	New York	San Francisco	2,574
3	Miami	New York	1,097
4	New York	Orlando	947
5	New York	San Juan	1,603
6	Atlanta	New York	756
7	Los Angeles	Honolulu	2,555
8	Fort Lauderdale	New York	1,068
9	Chicago	Los Angeles	1,751
10	Los Angeles	Seattle	957
11	Chicago	San Francisco	1,851
12	Dallas/Fort Worth	New York	1,389
13	Las Vegas	New York	2,235
14	Chicago	Phoenix	1,446
15	Boston	Chicago	854
16	New York	West Palm Beach	1,030
17	Chicago	Orlando	995
18	New York	Tampa	1,009
19	San Francisco	Honolulu	2,401
20	Anchorage	Seattle	1,443
21	Los Angeles	Washington	2,300
22	Chicago	Denver	904
23	Chicago	Dallas/Fort Worth	805
24	Boston	San Francisco	2,694
25	San Francisco	Washington	2,428

Table 1.1: *Top 25 City-Pair Markets Over 750 Miles, 3rd Quarter 1995*

1.3 Thesis Structure

This thesis is arranged into five additional chapters. Chapter 2 presents a literature review which includes aspects of airline industry under deregulation, the trend and/or forecast in the average system seat capacity of aircraft by U.S. commercial airlines, flight frequency for nonstop services, and airfares. Chapter 2 also provides an overview of studies that involve the use of econometric modeling in estimating relationships of various parameters related to air transportation. The literature review helps the readers understand how the airline business has changed in general since the deregulation. Specific investigation and analysis of trends in demand and supply of the U.S. air transportation system after deregulation will be presented in later chapters.

Chapter 3 addresses the methodology used in the analysis. Since the analysis focuses only on the nonstop services of the top 25 city-pair markets in terms of passengers enplaned in 1995, the rationale for using the airport-pair approach in the analysis will be explained. Chapter 3 also specifies and explains the assumptions, mathematical methods, models, and tools used to collect data and analyze the collected data, such as calculation methods and econometric models. In addition, examples are presented to provide a better understanding of these mathematical methods, models, and tools.

Chapter 4 concentrates on the annual and overall percentage changes in demand, airfare, nonstop frequencies, total seat capacity, and average aircraft size in each of the 25 markets over the 9 years of deregulation (1987 – 1995). Note that the year 1987 is the earliest year in which the data are available. The year 1995 represents the most current year that has a complete data set.

Chapter 5 studies the relationships between passenger demand and air transport supply including airfare, nonstop frequencies, total seat capacity, and average aircraft size. First, the relationship between passenger demand and CPI adjusted airfare will be studied in the same markets and for the same time period as the analysis in Chapter 4. The demand-fare relationships will be calculated by two different approaches. The first approach calculates the elasticity of demand with respect to average fare using the direct method. The second approach uses econometric model (regression) to estimate this relationship. Both calculation methods are described in Chapter 3. The results obtained from both approaches will be compared and discussed. Second, the econometric models (regression) will be developed in order to study total seat capacity and average aircraft size relationships in the post-deregulation era. The models will help explain possible correlations between the total seat capacity and average aircraft size with respect to inherent variables including passenger demand, nonstop flight frequencies, and airfares.

The written structure of Chapters 4 and 5 are similar. Each chapter contains an introduction, results of the analyses, and a brief conclusion. The introduction section provides the readers with an overall picture of the motivations for and contents of the chapter. The result section presents formal definitions (if necessary), the results of the analysis, and result discussions. The last section presents conclusions that can be drawn from the preceding analysis.

Finally, Chapter 6 provides the conclusion and summary of the analyses performed in Chapters 4 and 5. This chapter is divided into three main sections. The first section of this chapter summarizes the results of the annual and overall percentage change analysis. The second section summarizes the results of the correlations between the analyzed parameters. The last section provides directions for further research studies.

Chapter 2: Literature Review

2.1 Introduction

In this chapter, several studies and journals that have investigated and forecasted airline demand and supply in the long haul non-stop services since deregulation will be discussed. The remainder of this chapter is divided into three sections. Because it is important to how the airline industry has changed in general since deregulation before emphasizing the changes in airline demand and supply, the second section of this chapter briefly reviews general aspects of airline industry under deregulation. The third section gives the overviews of trends and forecasts in demand, fares, and average seat capacity of the U.S. air transportation system. The fourth section reviews the literature on the relationship between the market variables such as airfares, seat capacity, service frequencies and the growth of demand. This section also includes the results of mathematical models that have been developed by different researchers in an attempt to explain changes in the U.S. airline market supply with respect to the growing demand.

2.2 Airline Industry under Deregulation

In the early existence of air transportation in the United States, the airline industry was comprehensively regulated by the Civil Aeronautics Board (CAB) because of concerns over safety and the financial health of the airline industry. The CAB was given the exclusive authority to control the number of airlines that could provide air transportation to the public. It also decided on which city-pair markets these airlines would be allowed to enter or exit, and regulated fares charged by airlines. Although air travel demand and airline revenue grew at a high rate from 1938 to 1977, several airlines were near bankruptcy and service was not reliable because airlines operated under high fixed costs. Additionally, downturns in the U.S. economy, especially the economic recession in the beginning of the 1970s, led the airline industry to big losses. By the mid-1970s, it was obvious that airline regulation was not very successful.

The move toward deregulating the airlines actually began in the late 1970s. It was initially promoted by President Gerald Ford and then realized under Jimmy Carter with the agreement of Alfred E. Kahn - Chairman of the CAB. In 1978, Congress finally decided to end the CAB regulation by enacting the Airline Deregulation Act.[1] This Act gave freedom to airlines to serve any desirable domestic route and set fares without government approval. It also allowed new airlines to form and made it less difficult for existing airlines to expand operations into new markets and abandon the old ones. It is obvious that deregulation has led to increased competition in the airline business. Most economists expected that greater competition in the airline industry would eventually lead to lower fares, more services, and a wider variety of route offerings.

From 1978 through 1983, there was a dramatic increase in the number of new airlines, the number of certificated airlines increasing from 44 to 114.[2] These new airlines operated as low-cost airlines, which did not offer frilly services, and concentrated their routings mostly on short haul, high-density markets. Surprisingly, the new airlines were able to compete effectively with the former airlines despite the fact that the market shares of these airlines remained relatively small. However, the market share of new airlines continued to increase slowly while the major airlines' shares declined over the next couple of years. By 1985, the share of domestic traffic handled by the majors fell from around 90 percent prior to deregulation to 72 percent.[3] In terms of profitability, the overall airline industry did not perform well financially in the early years of deregulation because airlines were inexperienced in this new marketing environment and, more importantly, economic recession in the early 1980s decreased the demand for air transport.

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[1] Andrew R. Goetz and Paul S. Dempsey, "Airline Deregulation Ten Years After –Something Foul in the Air," *Journal of Air Law and Commerce* (Vol. 54), 927.

[2] GAO, "The Airline Industry under Deregulation," *Fares and Service at Major Airports* (1990), 23.

[3] GAO, 30.

Later, numbers of new marketing strategies were developed by the major airlines in order to gain back their market share from the new entrants. Four major developments are listed as following:

1. <u>Hub-and-Spoke System</u>

The main objective of the "Hub-and-Spoke" system is to accommodate larger volumes of traffic from an increased number of city-pair markets. Airlines created hub facilities in their air service networks to combine passengers from many origins into a hub and then fly the passengers out to their destinations. This configuration of an airline's route system allows airlines to capture more demand by effectively offering numerous daily nonstop flights in many airport-pair markets, and better use their airplanes by operating simultaneous departures and arrivals several times a day. Hub-and-Spoke systems also make things easier for many travelers to secure flights departing and arriving at times that best match their desired departure and arrival times. In addition, the airline with hub facilities can gain recognition and preference from travelers living in the city, preventing travelers from using another airline services.

2. <u>Frequent Flyer Program</u>

The purpose of a frequent flyer program is to influence customer choice of airline and discourage potential competitors from challenging a major airline at its dominated airport. This type of program was introduced in 1982 by American Airlines. It provided travelers with a reward for continuing to make use of one specific airline's services. Normally, the rule of this program is that the more flights or mileage a traveler flies with the airline, the more he/she will be awarded. Therefore, the travelers, who earn some credit but still need to fly more to get the reward, will likely stay with one airline for the future trips. Some of the major airlines also impose expiration for the use of the reward in order to force a traveler to fly more often. This frequent flyer program has been very successful in the deregulated years. In 1990, for example, frequent flyers were defined as individuals taking more than 12 airlines trips and 40 percent of airline revenues.[4]

3. Computerized Reservation System

The purpose of constructing the computerized reservation systems (CRS) is similar to the other development discussed above, making things more difficult for new entrant airlines to compete successfully with major airlines in the same market. The airlines that own CRS gain an advantage over their competitors by listing their flights before other airlines' flights on the computer screen display. This way the major airlines were able to achieve positions of market dominance, while leaving almost no chance for the new entrant airlines. Because this strategy is extreme in anti-competitiveness, CAB decided to prohibit it in 1984. The recent CRS no longer biases the screen displays to the CRS-owning airlines. However, it still has had anti-competitive impacts on the new airlines because of two reasons: (1) the CRS-owning airline maintains a supportive business relationship with its network of travel agent subscribers and (2) the other airlines have to pay extra costs (booking fee) to the CRS-owning airline for each seat booked by a travel agent. [5] [6]

4. Yield Management

The purpose of yield management (YM) is twofold: (1) to improve revenue earnings of the airline itself, and (2) to adjust fares in response to potential competition from new entrant airlines. Airlines attempt to maximize their revenues by mixing different types of passengers on each flight departure including those willing to pay full, discount, and deep discount fares. Yield Management helps airlines forecast demand and calculate the number of seats to be assigned for each fare type so that enough seats are available for the late-booking passengers (or full-fare passengers). Yield management also involves

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[4] Humphreys, 42.
[5] GAO, 23.
[6] Williams, 29.

changing prices over time of day, day of month, or season of the year. Therefore, it frustrates competitors that attempt to attract travelers by reducing the fare to lower ones than offered by a major airline. With the implementation of the basic YM system, airlines' revenue increases by approximately two to five percent.[7]

All of these marketing strategic developments have provided major airlines with a great competitive advantage over their smaller competitors. Apparently, these developments are very successful. In recent years, there has been a major decline in the number of U.S. airlines due to the bankruptcies of the new entrants and mergers between major and minor airlines. The reduced competition may change the aspect of the airline industry to oligopoly in the future. However, deregulation continues to provide significant benefits to the public: lower airfares and more services. In addition, economists at Brookings Institute estimated that the airline deregulation generates approximately $10 billion annually in savings to the public.[8]

2.3 Passenger Demand and Airline Supply of the U.S Air Transportation System after Deregulation

Since 1978, deregulation has created many positive effects for the U.S. airline market in both demand and supply sides. The current year demand in air transportation has escalated substantially from the demand in the early years after deregulation. Indeed, the growth of global business and the technological advancement of transportation systems are the significant factors that increase the need for faster and more convenient transportation - airplane. Airline deregulation also played an important role in the expansion of air transportation systems. The strong competition in the airline business under deregulation forces airlines to be attractive not only in services but also in prices. The strategy such as discounted fare and frequent flyer programs made air travel more affordable for many moderate incomes. Air Transport Association reported that the

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[7] Peter Belobaba and John L. Wilson, "Cleaning up on Yields," *Airline Business* (April 1997), 48.

[8] GAO, 31.

revenue passenger miles by U.S. carriers rose by 109 percent within the ten years after the airline deregulation.[9] According to Boeing researchers, the air travel demand in the recent years is twice as many as the demand in the late years of the airline regulation era. The forecast also projected annual worldwide traffic growth averaging 4.9 percent over the next 20 years.[10]

When examining changes in airline supply, it is important to note that there are many dimensions of airline supply. In this thesis, the airline supply includes airfares, seat capacity, and service frequency. In terms of airfare, the average fare paid by consumers has declined since deregulation, both compared to consumer prices in general and the fares that an airline would likely have charged if regulation still continued. The average fare fell 6 percent between 1978 and 1984. Today, the average fare is one-third less than it was at the time of deregulation. According to the database of the Air Transportation Association and the Department of Transportation, the average price charged per passenger mile by U.S. airlines decreased by 35 percent after adjustment for inflation.[7]

The Federal Aviation Administration reported that the average system seating capacity of aircraft used by U.S. air carriers increased by almost 20 seats (from 147.2 to 167.1 seats) between 1978 and 1983, the early years of the deregulated airline industry. Between 1983 and 1992, the average seat capacity of the U.S. fleet remained almost unchanged, up only 1.2 seats (from 167.1 to 168.3 seats). Surprisingly, the average seat capacity decreased by 2.1 and 3.3 seats in 1993 and 1994, respectively.[11] These two years show the largest declines observed over the past 20 years since deregulation. The explanation behind the decrease in average seat capacity is the fact that the short haul traffic with carriers utilizing relatively smaller aircraft rapidly increased. This trend continued through 1997. The Federal Aviation Administration also mentioned the impact of new

[9] Paul Sheehan, "What Went Right," *The Atlantic Monthly* (August 1993), 86.

[10] B. A. Smith, P. Sparaco, and M. Mecham, "Business Deals Evolve As Market Grows," *Aviation Week & Space Technology* (March 17, 1997), 59.

[11] "Aircraft Performance," *Article for Course 16.74 Air Transportation Economic*. Massachusetts Institute of Technology (Fall, 1996), 8.

legislation that requires stage-2 aircraft to be abandoned from the U.S. fleet by the year 2000. This legislation should result in the retirement of large numbers of the smaller stage-2 fleet. Therefore, the aircraft being replaced should result in an increase in the average seat capacity of the air carrier for the period 1997 through 2006.[9]

The Air Transport Association indicated that the proportion of the narrow body aircraft was approximately 78 percent of the U.S fleet in 1994 (the wide-body aircraft composed the remaining 22 percent of the U.S. fleet). However, the narrow body aircraft are expected to account for 82 percent in 2006, which will decrease the number of wide-body aircraft to 18 percent of the U.S. fleet. Bob Wolfe, president of the Large Commercial Engines unit at Pratt & Whitney, supported that "the very large wide-body market is shrinking". During the next 20 years, it is predicted that North America will remain the largest market for new aircraft, with requirements for 3,300 narrow body aircraft, which are twice as many as wide body models.[12]

The other supply in air transportation system refers to service frequency. The service frequencies provided by U.S. airlines have increased substantially since deregulation. The domestic airline industry is now more than twice as large as it was in the regulation era, while the population growth is measured to be only 15 percent. There are currently more than 40 hub-and-spoke operations in 32 cities in the United States. This means that at least 30 U.S metropolitan areas have significantly greater non-stop services than they did in the early years after deregulation. In addition, a substantial increase in service frequencies has taken place in many markets, for example, the number of daily non-stop flights from Boston to Dallas is only one in 1978, increasing to 10 flights in 1993. [7]

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[12] Bruce A. Smith, "Engine makers Develop New Service Strategies," Aviation Week & Space Technology (March 17, 1997), 60.

2.4 *Survey of Previous Studies*

A survey of previous studies on the subject of trends in airline demand and supply since deregulation revealed that there are a number of previous studies that have focused on the analysis of price elasticity of air travel demand. The literature regarding price elasticity of air travel demand is extensive for a wide variety of U.S. domestic markets including nonstop city-pair, and hub-and-spoke markets. Because this thesis focuses on nonstop city-pair markets, the elasticity of air transport supply with respect to air travel demand of hub-and-spoke markets will not be included.

In 1976, Jung and Fujii studied the price of elasticity of demand for air travel using "quasi-experimental" procedure. It involved the computation of arc elasticity of demand (e_p) from passenger loads along an individual route before and after a fare change. The equation for arc elasticity of demand is formulated as:

$$e_p = [(\Delta Q/Q) - \Sigma (\Delta Q_c/Q_c)/n] / (\Delta P/P) \qquad (2.1)$$

Where;

$\Delta Q/Q$	=	Relative change in the number of local passengers along a route where prices changed.
$\Delta Qc/Qc$	=	Relative change in the number of local passengers along comparable route where prices did not changed.
$(\Delta P/P)$	=	Relative price change
n	=	Number of routes compared

The markets that were analyzed in Jung's and Fujii's study were less than 500 miles in the southeast and south central sections of the U.S. and originated from New Orleans, Atlanta, and Memphis. The median price elasticity of air travel demand were -2.350, -2.704, and -2.905 for New Orleans, Atlanta, and Memphis, respectively.[13]

[13] J.M. Jung and E.T. Fujii, "The Price Elasticity of Demand for Air Travel," *Journal of Transport Economics and Policy* (September 1976), 3-5.

The literature of price elasticity of air travel demand can also be obtained from demand modeling studies since most of the demand models were developed as a function of airfares. It is important to note that most demand models were developed as a function of other air transport supply (besides airfare) and socioeconomic variables. The important air transport supply variables include travel time, flight frequency, and aircraft size. The most often used socioeconomic variables include population of origin and destination cities, and per capita income. Some models also include the competitive influence, such as changes in airfares, flight time, and/or service frequency of another competitive airlines, into the models.

The air-travel demand model developed by Verleger in 1972 estimated market price elasticity at -1.03 for a market under 500 miles and -0.91 for market between 500 and 1,000 miles. The results showed that only the estimate of short haul markets was statistically significant.[14] In 1974, De Vany, one of the first researchers who incorporated some levels of service in modeling the demand for air travel, estimated market price elasticity at -1.02 for a markets range less than 400 miles and -1.07 for a market between 400 and 650 miles.[15] In 1981, Ippolito, Anderson, and Kraus developed the demand model that incorporated flight frequency and load factor as quality-of-service variables affecting air travel demand.[16] They estimated market price elasticity at -0.525 for a 440-mile market and -1 for an 830-mile market.

The comprehensive demand model developed by Ghobrial and Kanafani in 1995 includes various socioeconomic and air transport supply variables.[17] The model was developed for the top 100 U.S. airport pairs. The analysis was limited to passengers flying directly between selected origin and destination cities because the researchers wanted to ensure

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[14] P.K. Verlerger, " Method of the Demand for Transportation," *Bell Journal of Economics Management Science* (1972), Vol. 3 No. 2.

[15] A.S. De Vany, " The Revealed Value of Time in Air Travel," *Review of Economics and Statistics* (February 1974), Vol. 56.

[16] A. Ghobrial and Adib Kanafani, "Quality-of-Service Model of Intercity Air-Travel Demand," *Journal of Transportation Engineering* (March/April 1995), Vol. 121, No. 2, 136.

[17] A. Ghobrial and Adib Kanafani, 137.

that the same aircraft is flown on a given flight itinerary between the origin and destination cities. Their demand model was presented on the following form:

$$Tij = \alpha . P_{ij}^{\beta} . I_{ij}^{\gamma} . FR_{ij}^{\phi} . FP_{ij}^{\mu} . FO_{ij}^{\eta} . SP_{ij}^{\lambda} . SO_{ij}^{\varphi} . TM_{ij}^{\sigma} . \mathit{Exp}(\omega TR_{ij} + \psi HUB_{ij}) . \varepsilon \quad (2.2)$$

Where;

Tij	=	Daily passenger demand who fly directly in market ij
P_{ij}	=	Product of populations of cities i and j
I_{ij}	=	Product of income per capita of cities i and j
FR_{ij}	=	Weighted average airfare by class type in market ij
FP_{ij}	=	Number of daily direct flights between city-pair ij during peak periods
FO_{ij}	=	Number of daily direct flights between city-pair ij during off-peak periods
SP_{ij}	=	Weighted average aircraft size during peak periods between city pair ij
SO_{ij}	=	Weighted average aircraft size during off-peak periods between city-pair ij
TM_{ij}	=	Average travel time in hours between cities i and j
TR_{ij}	=	Dummy variable for tourist markets that is set to one if city i or j is located in Florida, Hawaii, or Las Vegas and zero otherwise
HUB_{ij}	=	Dummy variable that takes on the value of one if airport i or j is a capacity-constrained airport, and zero otherwise
ε	=	Error term of estimation

$\alpha, \beta, \gamma, \phi, \mu, \eta, \lambda, \varphi, \sigma, \omega$, and ψ = Coefficients to be estimated

In this analysis, three model specifications were estimated using different combinations of variables. The first model included all variables in Equation (2.2). The result showed that that the price elasticity of demand is -1.314, but it is statistically insignificant. The second model excluded the travel time variable (TM_{ij}) from the specification of the model. The result showed that that the price elasticity of demand is -1.211, and it is statistically significant.

In terms of flight frequency, Ghobrial and Kanafani estimated that a 10 percent increase in flights during the peak period would result in a 4.4 percent increase in demand for air travel. They also concluded that the correlation between flight frequency and demand was strong. These results are consistent with the conclusion of Ippolito, Anderson, and Kraus. In terms of seat capacity (aircraft size), the results showed that air travel demand is inelastic with respect to market seat capacity. Nevertheless, the demand is more responsive to changes in market seat capacity during the peak periods than during off-peak periods.

2.5 Conclusion

Most of the studies reviewed in this chapter have looked at the elasticity of air transport supply (airfares, travel time, flight frequency, and aircraft size) and socioeconomic variables (population and per capita income) with respect to air travel demand since deregulation. None of these studies have taken a detailed look at correlation with air transport supply. Therefore, this thesis aims to analyze trends in both demand and supply in the long haul U.S. city-pair markets in order to provide some insight into the relationship with air transport supply as well as the relationship between air travel demand and air transport supply. The next chapter of this thesis will present the methodology used in the analyses.

Chapter 3: Analysis Methodology

3.1 Introduction

This chapter is divided into four main sections. It includes the definition of the origin-destination city-pair market in the first section, a list of the collected data and the methodology of the data analysis in the second section, expectation of the analysis results in the third section, and chapter conclusion in the fourth section.

3.2 Origin-Destination City-Pair Market

The purpose of this thesis is to analyze the trends in airline demand and supply of the top 25 long-haul U.S domestic markets. In these 25 city-pair markets, there are 40 airport-pair markets to be analyzed. It is important to understand the definitions of the origin-destination city-pair and airport-pair markets and clarify the difference between these two terms before performing the analysis.

A market is a collection of buyers and sellers whose interaction results in the possibility for exchange.[1] In air transportation, a market is made of all the customers who want to travel from a specific origin area to a destination area, and of all airlines that provide transportation and services from that origin to destination area. To explain the concept of origin-destination city-pair markets, a simplified air transportation network of three different origin/destination cities: A, B, and C, will be considered (see Figure 2.1). The demand for air transportation from origin A to destination B is not affected by any improvement of in services or changes in airfare price from A to C, and vice versa. Therefore, the market for air service from A to B is distinct from the market for air service from A to C. In this three-node network, there are six distinctly different markets for air travel: ABA, BAB, ACA, CAC, BCB, and CBC. Each market represents demand

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[1] Robert S. Pindyck and Daniel L. Rubinfield, *Microeconomics* (New Jersey: Prentice-Hall, 1995), 11.

for roundtrip services from origin to destination and back to origin; for instance, market ABA represents demand for roundtrip services from A to B and back to A. These markets are called "city-pair" markets.[2]

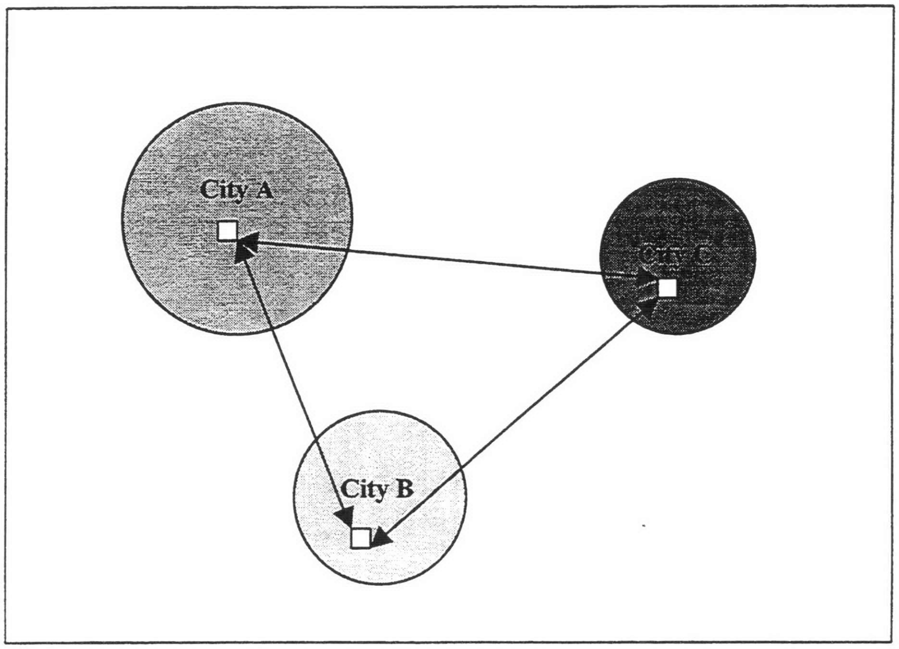

***Figure 2.1**: Origin/Destination City-Pair Markets –A, B, and C*

Most of the U.S. metropolitan cities, such as Chicago, New York, and Washington, D.C., contain more than one major airport in each of the city regions. These airports are equally accessible from the origin or destination regions and provide competitive services for the travelers. Therefore, a city-pair market can contain more than one airport-pair market. For example, the New York - Los Angeles city-pair market contains 3 different airport-pair markets including EWR-LAX, JFK-LAX, and LGA- LAX[3].

[2] Peter Belobaba and Robert W. Simpson, *Notes for Course 16.74 Air Transportation Economics-Chapter2*, Massachusetts Institute of Technology (January 1995), 13-15.

[3] JFK = John F. Kennedy International Airport
LGA = La Gaurdia International Airport
EWR = Newark International Airport
LAX = Los Angeles International Airport

In order to study trends in airline demand and supply of the top 25 long-haul U.S domestic markets, we will look at an origin-destination city-pair market as an aggregation of the airport-pair markets. However, some origin or destination regions may contain several types of airports including major airports, small local airports (operating only propeller aircraft) and heliports. In addition, each airport has its own service boundary (or airport region) and provides transportation services to all travelers in the nearby residents. One airport region can overlap with the other(s) in terms of convenience and services. Some criteria in selecting airport-pair markets will be imposed in order to employ consistent analyses and, eventually, obtain accurate conclusions.

3.3 Methodology

The analysis is divided into four steps. The first step involves collecting all the data which will be used in the analysis. The second step calculates the percentage changes in passenger demand, airfare, nonstop frequency, and total seat capacity, and average aircraft size for the 25 markets from 1987 to 1995. The third step verifies the correlations between passenger demand and airline supply as well as between airline supply variables. The remainder of this section presents the calculation methods, setting, and framework of the analysis.

3.3.1 Analysis Process

Step 1: Data Collection

The process of collecting data includes the selection of airport-pairs and aggregation of yearly passenger demand, airfare, total seat capacity, and nonstop flight frequency, and average aircraft size for each of city-pair markets from 1987 to 1995. The first three sets of data (airport pair, passenger demand, and airfare) are obtained from the O&D Plus database. Data for nonstop flight frequencies, total seat capacity, and average aircraft size are obtained from the Electronic Official Airline Guide (OAG).

1.1 Selection of Airport Pairs

Because most cities that are analyzed in this thesis contain more than one airport per city, the initial step in performing the analysis is to select airport pairs located in each of the top 25 city-pair markets. In order to keep the analysis manageable and consistent, not every airport in one city is included in the analysis. The airport-pair selection allows the researcher to combine data only from major airports while neglecting minor ones such as small local airports and heliports. Among these 25 city-pair markets, there are 20 different cities. These cities can be rearranged in alphabetical order as the following: Anchorage, Atlanta, Boston, Chicago, Dallas-Fort Worth, Denver, Fort Lauderdale, Honolulu, Las Vegas, Los Angeles, Miami, New York, Orlando, Phoenix, San Francisco, San Juan, Seattle, Tampa, Washington D.C., and West Palm Beach. The criteria of the airport-pair selection are:

- The selected airport has to be a major airport located in either an origin or destination city.
- It can be the airport nearby the origin or destination city, if it is considered to be equally accessible from the origin/destination regions and provide competitive services for the travelers,
- It has to have been in operation for every year for which the analysis was performed (1987-1995)
- There must be at least 1 nonstop service between the selected airport pair for each year of the analysis (1987-1995).
- The average coupon passenger mile of each airport-pair (average of outbound and inbound coupon; outbound and inbound from the origin airport to the destination airport via all carriers) should be close to one, which theoretically implies that most passengers travel on nonstop or single-stop flights.

The selected airport pair(s) for each city-pair market is summarized in Table 2:

Rank	City-Pair		Airport-Pair Selection
1	Los Angeles	New York	LAX - EWR, JFK
2	New York	San Francisco	EWR, JFK - SFO
3	Miami	New York	MIA - EWR, JFK, LGA
4	New York	Orlando	EWR, JFK, LGA - MCO
5	New York	San Juan	EWR, JFK, LGA - SJU
6	Atlanta	New York	ATL - EWR, JFK, LGA
7	Los Angeles	Honolulu	LAX - HNL
8	Fort Lauderdale	New York	FLL - EWR, JFK, LGA
9	Chicago	Los Angeles	ORD - LAX, ONT
10	Los Angeles	Seattle	LAX - SEA
11	Chicago	San Francisco	ORD - SFO, OAK
12	Dallas/Fort Worth	New York	DFW - EWR, JFK, LGA
13	Las Vegas	New York	LAS - JFK
14	Chicago	Phoenix	ORD - PHX
15	Boston	Chicago	BOS - ORD
16	New York	West Palm Beach	EWR, JFK, LGA - PBI
17	Chicago	Orlando	ORD - MCO
18	New York	Tampa	EWR, JFK, LGA - TPA
19	San Francisco	Honolulu	SFO - HNL
20	Anchorage	Seattle	ANC - SEA
21	Los Angeles	Washington	LAX - IAD, BWI
22	Chicago	Denver	ORD - DEN
23	Chicago	Dallas/Fort Worth	ORD - DFW
24	Boston	San Francisco	BOS - SFO
25	San Francisco	Washington	SFO - IAD

***Table 3.1**: Airport-Pair Selection of the Top 25 City-Pair Markets*

1.2 Passenger Demand

The demand of one airport pair is the total passengers who travel from the airport origin to the airport destination in all four quarters of the given year. The total demand in each quarter includes all passengers from both outbound and inbound traffic of the given airport pair.

Formula:

$$\text{Quarterly Total Pax} = \text{Outbound Pax} + \text{Inbound Pax}$$

Example:

Origin	Destination	Year/Qtr	Opax	Ipax	Total Pax
LAX	EWR	79/1	11,950	10,200	22,150
LAX	EWR	79/2	17,350	16,840	34,190
LAX	EWR	79/3	16,110	17,300	33,410
LAX	EWR	79/4	12,030	13,090	25,120

***Table 3.2**: Passenger Demand of LAX-EWR Market in Four Quarters of 1979*

The total Demand of LAX-EWR airport pair for 1979 is:

22,150 + 34,190 + 33,410 + 25,120 = 114,870 passengers

1.3 Airfare

Airfare is the price of the airline ticket that a traveler has to pay for the air transportation services from his/her origin to his/her destination. In a deregulated environment, fares increase as time to flight departure approaches because airlines make late-booking passengers pay higher fares than early-booking passengers. Late-booking passengers usually refer to business passengers, while the early-booking passengers are vacationers. Business passengers are willing to pay higher fares because they do not have to use their own budget for the trip and, more importantly, an additional expense for the trip is small compared to the money lost by not making the trip. On the other hand, vacationers are price-sensitive because they use their own money to buy tickets for the trip. Because fares fluctuate over time and differ between passenger types, the annual average fare across airlines is a good representation of multiple fares for the proposed analysis.

Annual average fare is the weighted average of four quarterly fares with respect to the total passenger demand (both outbound and inbound passengers) of each airport-pair market. The weighted average fare is calculated by summing the product of outbound fare and outbound demand with the product of inbound fare and inbound demand, and then dividing the result by the summation of total demand.

To make the analysis meaningful, the weighted average fare should be measured in terms of current dollars. This means analyzing fares in real terms rather than nominal terms. Therefore, annual average fares should be adjusted for the inflation rate of their specific year (see Appendix B). The consumer Price Index (CPI) is the most frequently used tool for this purpose. The CPI is calculated by the U.S. Bureau of Labor Statistics. It records how the cost of a large market basket of goods (in this case, the good is an airplane ticket) purchased by a consumer in some base year changes over time. To be consistent throughout the thesis, the word "airfare" used in later chapters of this thesis refers to the CPI adjusted, annual average fare.

Formulas:

Quarterly Fare	=	[(Outbound Pax * Outbound Fare) + (Outbound Pax * Outbound Fare)] / (Total Pax)
Airfare	=	(CPI of the current year / CPI of the given year) * (Fare of the given year)

Example:

Origin	Destination	Year/Qtr	Opax	Ofare	Ipax	Ifare	Qtr. Fare
LAX	EWR	79/1	11,950	189.39	10,200	190.74	188.39
LAX	EWR	79/2	17,350	174.72	16,840	172.87	173.81
LAX	EWR	79/3	16,110	160.93	17,300	152.50	156.56
LAX	EWR	79/4	12,030	219.07	13,090	218.61	218.83

***Table 3.3**: Weighted Average Fare of LAX-EWR Market in Four Quarters of 1979*

The average fare of the LAX-EWR airport pair in 1979 is:

(188.39 + 173.81 + 156.56 + 218.83) / 4 = 184.40 dollars

Consumer price index of 1995 is 139.10.

Consumer price index of 1979 is 70.50.

The fare of the 1979 LAX-EWR airport pair in terms of 1995 dollars is:

(184.4 * 139.10) / 70.5 = 363.83 dollars

1.4 Nonstop Flight Frequency

Nonstop flight frequency is the total nonstop flights of all airlines between a specific origin and destination. The nonstop flight frequency will be limited to the regular flight schedule. Any nonstop flight that is used in the analysis must meet the following constraints:

- Any accounted nonstop flight has to be in service for more than 15 days in the given month. According to OAG, not every flight offers long-haul nonstop service everyday; operation of the flight can vary from a single day to every day in a month. Therefore, this constraint is made to collect the flights that have been effective for more than 15 days.

- If the departure time and flight number of one airline is changed sometimes during the month while the aircraft type remains unchanged, two flights will be counted as one flight. According to OAG, some flights change the departure time during the month. For example, the departure time of flight 195 of Continental Airlines providing service from New York to Los Angeles in 1995 was changed from 5:30 p.m. to 5:15 p.m., while both flights used the same aircraft (757). In this case, only one flight will be counted. This constraint is made to ensure that the same nonstop flight in different time frames is not double-counted.

1.5 Total Seat Capacity

Seat capacity of one aircraft refers to the total seats of an aircraft used in the accounted nonstop service. The total seat capacity used in the analysis is the total weekly nonstop seats in a particular market. However, the aircraft type of one regular nonstop flight can be altered during the given week due to real time changes in demand in that market. Therefore, if the aircraft type of a nonstop flight is changed during the week, the aircraft type that operates more than four days will be selected. According to OAG, some flights change the aircraft type during the week. For example, Flight 91 of United Airlines, providing service from Boston to Los Angeles in 1988 (departure time is 8:50 am and the arrival time is 11:50 am), switched from using a D10 to a 767 after June 2nd. For this matter, the only aircraft type taken into account is 767 since the 767 was effective for five days of this flight service. This constraint is made to ensure that the accounted aircraft type is the majority of aircraft types used for that nonstop flight.

Step 2: Percentage Change Analysis

In this step, percentage changes of passenger demand, airfare, nonstop flight frequency, total seat capacity, and average aircraft size are calculated on a year-to-year basis and in the overall time period for the individual 25 city-pair markets. The year-to-year change is the percent difference between the value of a parameter in the current year and the previous year. The annual percentage change of each parameter is the average of 15 year-to-year changes. The overall percentage change is the percent difference between the value of a parameter in the first year (1987) and last year (1995) of the analysis. The results will be presented both in table and graphical form in Chapter 4 of this thesis. From these results, the answer to the question: how demand, fare, nonstop frequency, and seat capacity in the top 25 city-pair markets have changed since deregulation, will be provided.

Step 3: Correlation Analysis

3.1 Passenger Demand-Airfare Correlation

The analysis involves estimating the price elasticity with respect to passenger demand in the post-deregulation era for the individual 25 city-pair markets. The detailed analysis will be presented in Chapter 5 (Section 5.2) of this thesis. Two different approaches are applied for accomplishing this objective. The first approach calculates the average price elasticity of demand (E_p) using "midpoint" method. First, the year-to-year price elasticity of demand (E_p') will be calculated. The formula of the midpoint method is

$$E_p' \quad = \quad [(D_2-D_1)/(P_2-P_1)] * [(D_1+D2)/(P1+P2)] \qquad (3.1)$$

Where:

D_1	=	air travel demand of the previous year
D_2	=	air travel demand of the current year
P_1	=	average fare of the previous year
P_2	=	average fare of the current year

Then, the average elasticity of demand (E_p) is the average of 15 year-to-year elasticity of demand.

The second approach uses the econometric model (regression) to explain the demand-fare correlation. The regression model is a method of fitting relationships between demand and fare. The analysis focuses only on non-linear regression forms since the changes in demand are not linear in general. The non-linear relationships fitting to the data can be expressed in the following form:

$$\text{Demand} = k * (\text{Adjusted Fare})^{a} \qquad (3.2)$$

Constant k and exponent a are the estimated parameters that provide the best fit to the data. Constant k represents the intercept of the demand when the fare is equal to zero. Exponent a measures the elasticity of demand with respect to fare. Further details of the regression analysis will be provided in the "Regression Analysis Remarks" section. The results obtained from both approaches will be compared and discussed in Section 3.3.2.

3.2 Airline-Supply Models

The analyses presented in the remaining of Chapter 5 (Sections 5.3 to 5.6) involve the uses of the regression model. The goal is to measure to what extent the total capacity and aircraft size used in the top 25 city-pairs markets have changed with respect to changes in passenger demand and nonstop frequency since deregulation. The dependent variables in all modeling scenarios are the passenger demand, total seat capacity, and average aircraft variables. The independent (explanatory) variables include passenger demand and nonstop frequency. Therefore, the analysis includes:

1. Correlation between average per-day seat capacity and demand
2. Correlation between average per-day seat capacity and nonstop flight frequency
3. Correlation between average per-day seat capacity and demand, and nonstop flight frequency
4. Correlation between average per-day seat capacity and demand, and nonstop flight frequency, and fare

The functions of per-day seat capacity relationships are formulated in the following forms:

1. Total Seat Capacity = k * (Demand) ^{a}
2. Total Seat Capacity = k * (Nonstop Frequency) ^{a}
3. Average Aircraft Size = k * (Demand) ^{a}
4. Average Aircraft Size = k * (Nonstop Frequency) ^{a}

Similar to the analysis of passenger demand-airfare correlation, Constant k represents the intercept of the demand when all independent variables are equal to zero. Exponent (a) measures the elasticity of per-day seat capacity with respect to passenger demand and nonstop flight frequency, respectively.

3.3.2 Regression Analysis Remarks

This section explains the basis of multiple non-linear regression. An example will be given to illustrate the methodology of the regression. As mentioned earlier in the methodology section (*step 3*), the regression model is a method of fitting mathematical relationships to the data. The non-linear relationships fitting to the given data can be expressed in the following form:

$$Y = k * (X_1)^{a} * (X_2)^{b} \quad (3.3)$$

The number of independent variables in an equation does not have to be fixed. In Equation (1), dependent variable Y relates to two independent variables: X_1 and X_2. It is important to note that the regression equation has to be linear in the parameters, but it need not be linear in the variables. Therefore, Equation (1) must be rewritten as the linear form with the logarithmic quantity of variables before the regression is made:

$$\text{Log}(Y) = \text{Log}(k) + a*\text{Log}(X_1) + b*\text{Log}(X_2) \quad (3.4)$$

The three most important regression results are the coefficient estimates (1), the t-statistic value for each independent variable (2), and the adjusted R^2 value (3). For each independent variable in the model, the magnitude of a coefficient estimate is the elasticity of that independent variable with respect to the particular measures of the dependent variable. The sign of a coefficient estimate is also important because it indicates the direction of the independent variables. A positive sign implies that a higher number of the independent variable corresponds to a higher number of the dependent variable, while, a negative sign implies that a higher number of the independent variable corresponds to a lower number of the dependent variable. Elasticity estimates are important because they show the sensitivity of the dependent variable to the same proportional changes in each of the independent variables. Therefore, the elasticity estimates avoid the problems of comparing the effects of variables measured in different units.

The t-statistic and the adjusted R^2 values measure how well a model's independent variables fit the data. The t-statistic value of a variable (i.e., X_1, X_2, and X_3) is a coefficient estimate of the independent variable divided by its standard error. The t-statistic value represents the statistical significance of the independent variable in the model. A significant variable should have a t-statistic value exceeding 1.96 in absolute value. Since the estimated parameters are normally distributed, a t-statistic with an absolute value that is greater than 1.96 represents a 95 percent probability that the true parameter lies within an interval around the parameter estimate.

The adjusted R^2 value measures the proportion of variance in the dependent variable explained by variance in the independent variables. A model with more statistically significant independent variables will have a higher adjusted R^2 value because a greater proportion of the causes of variance in the dependent variable will be a result of variance in the independent variables. Therefore, a good model or a model with many significant independent variables should have an R^2 value close to one.

Example

Airport Pair: Los Angeles International (LAX) – Newark International (EWR)

$$\text{Demand} \quad = \quad k * (\text{Fare})^{a} * (\text{Coupon})^{b} \qquad (3.5)$$

The equation illustrated above refers to the demand model which includes fare and coupon as the independent variables of the function. The data for the regression is as the follows:

Year	Demand	Fare	Coupon	Log(Demand)	Log(Fare)	Log(Coupon)
1979	114,870	363.83	1.27	5.0602	2.5609	0.1051
1980	130,270	318.43	1.23	5.1148	2.5030	0.0912
1981	366,380	266.63	1.14	5.5639	2.4259	0.0550
1982	496,800	240.61	1.22	5.6962	2.3813	0.0850
1983	474,310	277.89	1.25	5.6761	2.4439	0.0956
1984	1,028,250	255.14	1.16	6.0121	2.4068	0.0631
1985	1,028,120	219.88	1.14	6.0120	2.3422	0.0579

***Table 3.4**: Data and Log(Data) for Regression (Example)*

The regression yields:

Regression Statistics	
Multiple R	0.9106
R Square	0.8292
Adjusted R Square	0.7438
Standard Error	0.1941
Observations	7.0000

Variable	Coefficients	Standard Error	t Stat
Intercept	16.46015	3.53364	4.65812
Fare	-4.41049	1.58288	-2.78638
Coupon	-1.49241	5.83488	-0.25577

***Table 3.5**: Result Summary of Non-Linear Regression (Example)*

Therefore: $Demand \quad = \quad 16.46 * (Fare)^{-4.41} * (Coupon)^{-1.49}$

In conclusion, the elasticity of fare and coupon with respect to demand are equal to -4.41 and -1.49, respectively. It means that for each one- percent increase in fare and in coupon, demand decreases by 4.41% and 1.49%, respectively. The t-statistic test confirms that the fare variable is statistically significant because the t-statistic of the fare variable in absolute value is equal to 2.79 which is greater than 1.96. However, the coupon variable is insignificant to the model since its t-statistic (0.26) in absolute value is smaller than 1.96.

3.4 A Priori Expectations

This section justifies the inclusion of independent variables in the proposed correlation models. It explains why independent variables are important to a model and how they would correlate with the change in the model's dependent variable over the years of the analysis. If an independent variable is valid in the proposed model, one should be able to anticipate the direction (sign) of the independent variable coefficient. A positive coefficient implies that increases in an independent variable will cause increases in the dependent variable. A negative coefficient implies that increases in an independent variable will cause decreases in the dependent variable. In terms of magnitude, it is difficult to quantify *a priori* expectations. However, it is an interpretation of all possible ranges of magnitude of independent variables. The ranges of the magnitude of independent variables are either greater than one, equal to one, or less than one in absolute value. The greater-than-one range means that an independent variable increases (or decreases if it is negative) at a lower rate than a dependent variable does. The equal-to-one range indicates that an independent variable increases (or decreases) linearly with respect to increases (or decreases) in the dependent variable. The less-than-one range means that an independent variable increases (or decreases) at a faster rate than a dependent variable does.

3.4.1 Passenger Demand-Airfare Correlation

In general, demand and price move in opposite directions. As the price of a good rises, the quantity demanded of the good decreases, and vice versa. Thus, the airfare elasticity of passenger demand should be negative. However, it is possible to obtain a positive elasticity estimate from the regression. The best explanation is that some significant parameters, such as service quality of an airline and average population income, may be excluded from this demand-fare correlation function. These parameters not only help stimulate air travel demand but also increase airfares; for example, improvements in airline's service quality may attract more customers to use the services of that airline, while the airline has to increase fares to cover the extra costs paid for the improvements. It is important to note that the main objective of the analysis is to verify the correlation between fare and demand, not to calibrate demand models. Therefore, the demand function of the analysis will not consider other independent variables (except airfare), which may be significant to the demand function.

3.4.2 Total Seat Capacity Models

The second model is the correlation between total seat capacity (dependent variable) and passenger demand (independent variable). Intuitively, one expects increases in passenger demand to increase with the number of total seat capacity because a higher demand will force airlines to use bigger aircraft, resulting in greater seat capacity being flown in the system. The third model is the correlation between total seat capacity (dependent variable) and nonstop flight frequency (independent variable). Because increases in the number of nonstop flights means that more seats are flown in the system, one also expects increases in nonstop flight frequency to increase the total seat capacity. Therefore, the demand and nonstop flight frequency elasticities of total seat capacity should be positive.

For the demand elasticity of total seat capacity, the less-than-one elasticity range implies that average load factor per flight increases over the deregulated years because passenger demand increases at a faster rate than does total seat capacity. The greater-than-one elasticity range implies that bigger aircraft are used over the deregulated years because demand increases at a lower rate than does total seat capacity. If the demand elasticity of total seat capacity is equal to one, increases in passenger demand with respect to increases in total seat capacity are linear.

For the nonstop flight frequency elasticity of total seat capacity, the less-than-one elasticity range implies that smaller aircraft are used in the airline industry, but more nonstop flights are provided for increases in passenger demand during the deregulated years. On the other hand, the greater-than-one elasticity range implies that bigger aircraft are used in the airline industry, but fewer nonstop flights are provided for increases in air travel demand during the deregulated years. If the nonstop flight frequency elasticity of total seat capacity is equal to one, then the flight frequency increases linearly with respect to total seat capacity.

Airfare should not be related to the total seat capacity model. Although there may be economies in scale between seat capacity and an airline's operating cost, the relationship between seat capacity and fares are weak because fares made available by airlines do not depend on airline costs alone. Changes in airfares should relate more directly to the changes in air travel demand and/or the time of booking (differential pricing concept).

3.4.3 Average Aircraft Size Models

The fourth model is the correlation between average aircraft size (dependent variable) and passenger demand (independent variable). Intuitively, one expects increases in passenger demand to increase with the aircraft size because it is unlikely to use a smaller aircraft for a higher demand unless more flight frequency is offered. The demand elasticity of total seat capacity should be positive. The fifth model is the correlation between average aircraft size (dependent variable) and nonstop frequency (independent variable). Because increases in the number of nonstop flights means that fewer passengers are boarded per flight, one expects increases in nonstop flight frequency to decrease the average aircraft size. Therefore, the nonstop flight frequency elasticity of average aircraft size should be negative.

For the demand elasticity of average, the less-than-one elasticity range implies not only that smaller aircraft are used, but also that the average load factor per flight increases over the deregulated years because passenger demand increases at a faster rate than does average aircraft size. The greater-than-one elasticity range implies that bigger aircraft are used and the average load factor per flight is likely constant over the deregulated years because demand increases at a lower rate than does total seat capacity. If the demand elasticity of total seat capacity is equal to one, increases in passenger demand with respect to increases in total seat capacity are linear.

The range of the nonstop flight frequency elasticity of total seat capacity is expected to be between zero and one because the nonstop flight frequency changed in a wider range of value than did the aircraft size over the deregulated years.

3.5 Conclusion

This chapter described the methodology used in the thesis. The purpose is to provide a better understanding of the analysis processes including data collection and model development, and the relevant computational tools. The analyses will focus only on the top 25 U.S. city-pair markets in terms of passengers transported in both directions in 1995. For each city-pair market, the trends in airline demand and supply selection are analyzed for the years 1987 to 1995.

Chapter 4: Annual and Overall Percentage Changes in Passenger Demand and Airline Supply

4.1 Introduction

This chapter examines the annual and overall percentage changes of passenger demand and airline supply including CPI adjusted airfare, nonstop flight frequency, total seat capacity, and average aircraft size for the top 25 longhaul U.S. domestic markets between 1987 and 1995. The analysis is divided into two main sections. The first section represents the annual and overall percentage changes of aggregate passenger demand and airline supply of all 25 markets. In the second section, the analysis and discussion are broken down into an individual city-pair market level. The results are presented and summarized in a numerical form. However, a graphical form can be helpful and is also presented if the numerical results alone do not cover any extraordinary change of the analyzed parameters in each market. In addition, the data used in each analysis will be provided at the end of each section.

4.2 Trends in Aggregate Passenger Demand and Airline Supply from 1987 to 1995

4.2.1 Review of Parameter Definition

Aggregate passenger demand is calculated by combining the yearly passenger demand of all top 25 city-pair markets together. Airfare used in the analysis is the CPI adjusted airfare. The average airfare presented in Section 4.2.2 is the weighted average of the average annual airfare with respect to the passenger demand in each city-pair market. Note that the average annual airfare of each city-pair market is the weighted average of the airfare with respect to the passenger demand in each airport-pair market. The nonstop flight frequency and capacity used in this analysis are weekly measurements and obtained from an electronic version of Official Airline Guide (OAG). Aggregate nonstop flight frequency and seat capacity are calculated by the same method as the calculation of the aggregate passenger demand. Average aircraft size is calculated by dividing the weekly seat capacity by the weekly nonstop flight frequency.

The annual percentage change of a parameter is the percent difference of the parameter between given and previous years. The average annual percentage change is the average of eight annual percentage changes, from 1988 to 1995. The overall percentage change of the parameter is the percent difference between the first and the last year of the analysis, 1987 and 1995, respectively.

4.2.2 Results of Aggregate Analysis – Total 25 Markets

Year	Passenger Demand	CPI Adjusted Airfare	Nonstop Flight Frequency	Total Capacity	Average Aircraft Size
1987	-	-	-	-	-
1988	9.59%	1.45%	9.13%	7.15%	0.59%
1989	-2.65%	14.87%	-2.86%	-5.90%	-2.89%
1990	12.20%	-5.62%	12.59%	12.08%	2.69%
1991	-6.47%	0.38%	-3.78%	-3.29%	-2.47%
1992	3.43%	-4.25%	1.36%	-2.96%	-3.08%
1993	0.90%	3.96%	5.28%	5.27%	1.81%
1994	9.59%	-11.49%	1.47%	1.47%	-0.93%
1995	1.46%	0.41%	5.05%	1.00%	-2.71%
Average Annual	**3.51%**	**-0.03%**	**3.53%**	**1.85%**	**-0.88%**
Overall Changes	**29.93%**	**-2.32%**	**30.63%**	**14.42%**	**-6.97%**

***Table 4.1**: Annual Growth Rate and Overall Percentage Change of Aggregate Passenger Demand and Airline Supply from 1987 to 1995*

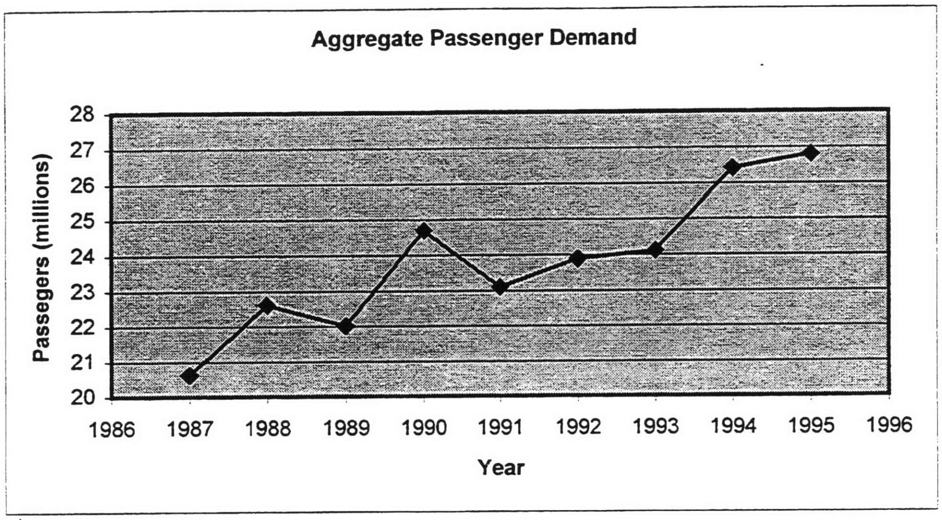

***Figure 4.1**: Graph of Trends in Aggregate Passenger Demand from 1987 to 1995*

The aggregate passenger demand increased at an average annual rate of 3.51% and by 29.93% from 1987 to 1995 (from 20.6 million passengers in 1987 to 26.8 million passengers in 1995). Figure 4.1 shows that the aggregate passenger demand was not very stable in the first five years of the analysis. First, the demand in 1988 increased by approximately two million passengers which is equivalent to a 9.6% increase from its previous year, and slightly decreased towards 1989. Then, it increased significantly by 12.2% in 1990 and decreased again by 6.47% in 1991. After 1991, the passenger demand of all 25 markets continued to increase steadily. Note that the significant increases in passenger demand took place in 1994.

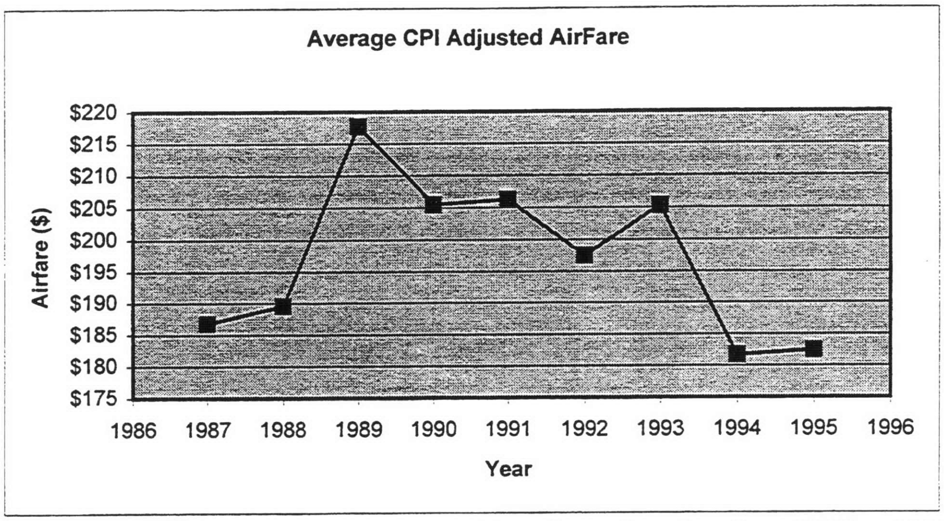

***Figure 4.2**: Graph of Trends in Average CPI Adjusted Airfare from 1987 to 1995*

According to Figure 4.2, the average CPI adjusted airfare of all 25 markets decreased at an average annual rate of 0.03%. The overall percentage changes of airfare decreased by 2.32% (from $186.79 in 1987 to $182.47 in 1995). The changes in airfare were relatively small over nine years of the analysis. Although the average annual change rate and the overall percent changes of airfare indicates that airfare is decreasing under deregulation, average airfare increased remarkably from 1988 to 1989, increasing from $189.49 to $217.67. The $217.67 airfare in 1989 was the most expensive fare over the nine-year period. This increase can be explained by the economic concept of demand curve; prices of goods decrease as demand increases and vice versa. Because airfare in 1989 increased by 14.87% from 1988, the passenger demand in 1989 decreased by 2.65% from 1988. Then, airfare changed alternatively up and down between 1989 and 1993. However, it changed by only a few dollars. In 1994, airfare dropped significantly from $205.30 to $181.71 which is equivalent to an 11.49% decrease from the previous year. Finally, airfare remained almost the same between 1994 and 1995.

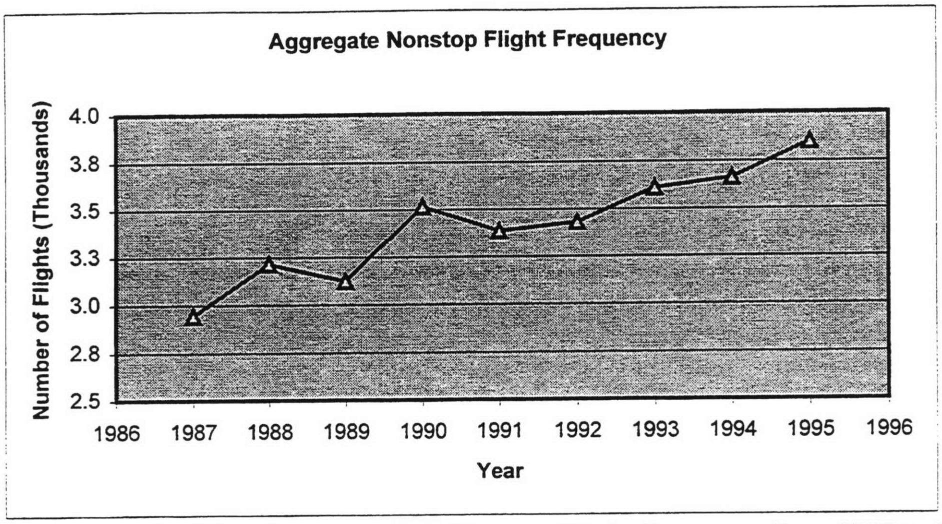

***Figure 4.3**: Graph of Trends in Aggregate Nonstop Flight Frequency from 1987 to 1995*

The aggregate nonstop flight frequency per week of all 25 markets increased at an average annual rate of 3.53% and by 30.63% from 1987 to 1995. According to these results, the aggregate flight frequency per week increased at almost the same proportion to the increases of the aggregate passenger demand over the nine-year period. Also, the trends of the aggregate nonstop flight frequency and of the aggregate passenger demand of all 25 markets are very similar in terms of increasing in 1988, decreasing in 1989, increasing again by significant amount in 1990, and continuing to increase since. This phenomenon is logical because the more the passenger demand is, the more airline supply in terms of number of seats is made available by airlines (either from increasing flight frequency or increasing size of aircraft, or both). Conversely, increases in nonstop frequency also lead to increases in passenger demand because the availability of more flights reduces total travel time and stimulates passenger demand.

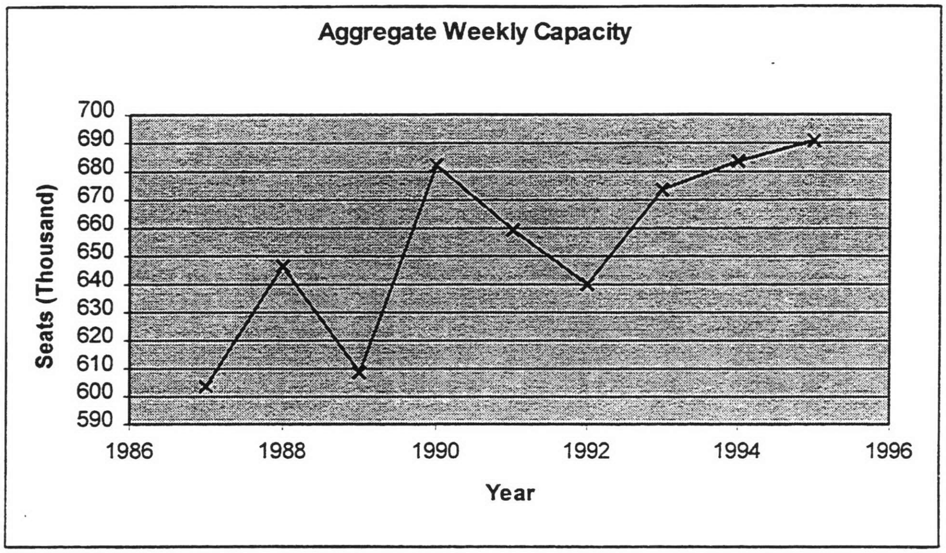

Figure 4.4: *Graph of Trends in Aggregate Weekly Seat Capacity from 1987 to 1995*

The aggregate weekly seat capacity of all 25 markets increased at an average annual rate of 1.85% and by 14.42% from 1987 to 1995 (from 0.60 million in 1987 to 0.69 million passengers in 1995). Although the average annual growth rate and overall percent changes of aggregate capacity are much smaller than both the aggregate passenger demands and nonstop flight frequencies, the trends are the same. This, in turns, means that airlines provided more flight frequency than larger aircraft size in response to a higher passenger demand.

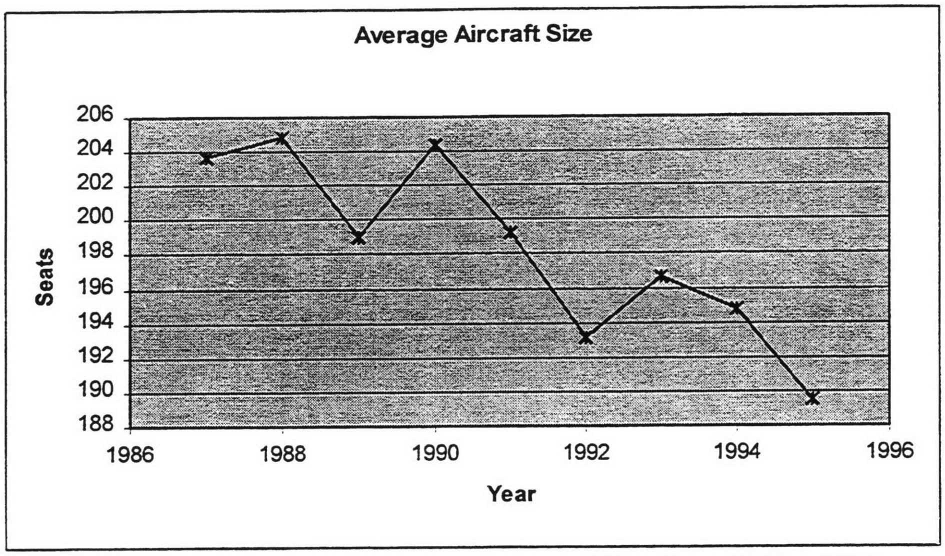

Figure 4.5: Graph of Trends in Average Aircraft Size from 1987 to 1995

The average aircraft size decreased at an average annual rate of 0.88%. The overall percent changes show that the average aircraft size in 1995 is smaller than the average aircraft size in 1987 by approximately 7%. Figure 4.6 shows that the average aircraft size declined substantially between 1990 and 1992, and 1993 to 1995. It means that the flight frequency increased faster than the seat capacity provided by airlines. The biggest average aircraft size belongs to 1988, while the smallest belongs to 1995. These results confirmed the fact that airlines have allocated small aircraft with a high flight frequency rather than large aircraft with a low flight frequency in response to a higher demand over the nine-year period.

From the aggregate analysis, both annual and overall percentage changes show that passenger demand, nonstop flight frequency, and total seat capacity of the top 25 markets increased over nine years of the analysis. On the other hand, airfare and average aircraft size decreased within the same time period. Accordingly, three important facts can be interpreted about the characteristics of the modern deregulated airline industry. First, airfares continue to decrease under deregulation. Second, the airline marketing strategy under a highly competitive environment due to deregulation is to provide smaller aircraft and more flight frequencies rather than larger aircraft and fewer flight frequencies. This way, airlines can improve their service quality in terms of flight-time variety as well as earn more revenue because more demand is captured in various time frames. Finally, because of lower airfares, more service, and some other relevant factors such as the impact from an upturn of the U.S. economy in the past nine years, demand of air transportation increased substantially.

Year	Passenger Demand	CPI Adjusted AirFare	Nonstop Flight Frequency	Total Capacity	Average Aircraft Size
1987	20,630,180	$186.79	2,945	603,544	204
1988	22,609,360	$189.49	3,214	646,702	205
1989	22,009,150	$217.67	3,122	608,557	199
1990	24,695,010	$205.45	3,515	682,070	204
1991	23,097,560	$206.23	3,382	659,610	199
1992	23,889,910	$197.48	3,428	640,060	193
1993	24,105,470	$205.30	3,609	673,761	197
1994	26,418,370	$181.71	3,662	683,686	195
1995	26,803,950	$182.47	3,847	690,554	189

***Table 4.2**: Aggregate Passenger Demand and Airline Supply from 1987 to 1995*

4.3 Trends in Passenger Demand and Airline Supply of 25 Individual Markets from 1987 to 1995

In Section 4.2, the trends in passenger demand and airline supply were examined as an aggregation of the top 25 city-pair markets. Because the trends are not the same for every city-pair market that was analyzed, the aggregate analysis does not really tell us much about the changes in passenger demand and airline supply in different markets. By looking at each of 25 city-pair markets separately, five different types of trends in passenger demand and airline supply are recognized. The first type consists of the markets in which passenger demand, nonstop flight frequency, and seat capacity increased, while average aircraft size decreased. The second type consists of the markets in which passenger demand and average aircraft size decreased, while nonstop flight frequency and seat capacity increased. The third type consists of the markets in which only passenger demand increased. The fourth type consists of the markets in which all parameters increased. The fifth type consists of the markets which do not fit in any of the above categories. Note that these trend types are categorized regardless as to how airfare changed. The results include the annual and overall percentage changes of the analyzed parameters.

Type 1: Markets with increasing demand, frequency, and seat capacity and decreasing average aircraft size

Rank	Market-Pair		Annual Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
1	Los Angeles	New York	2.43%	-1.24%	6.65%	2.74%	-3.32%
2	New York	San Francisco	3.95%	-0.37%	6.51%	4.15%	-2.24%
3	Miami	New York	2.86%	-1.60%	13.69%	10.89%	-2.67%
4	New York	Orlando	4.15%	-0.57%	7.51%	3.52%	-2.50%
6	Atlanta	New York	3.22%	1.32%	4.47%	2.83%	-1.46%
9	Chicago	Los Angeles	2.94%	1.43%	6.15%	2.98%	-2.68%
15	Boston	Chicago	2.79%	3.99%	8.47%	3.13%	-4.34%
16	New York	West Palm Beach	2.62%	2.05%	2.38%	2.20%	-0.63%
17	Chicago	Orlando	6.00%	-1.02%	8.21%	5.63%	-1.53%
18	New York	Tampa	2.85%	-0.89%	3.81%	2.89%	-0.66%
21	Los Angeles	Washington	7.93%	-0.10%	6.34%	5.45%	-0.56%
23	Chicago	Dallas-Fort Worth	4.93%	3.73%	5.34%	3.58%	-0.66%
24	Boston	San Francisco	4.86%	0.48%	16.61%	13.56%	-2.96%

***Table 4.3**: Annual Percentage Changes of Passenger Demand and Airline Supply of Type 1 Markets from 1987 to 1995*

Rank	Market-Pair		Overall Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
1	Los Angeles	New York	*22.69%*	*-6.88%*	*61.63%*	*22.20%*	*-24.39%*
2	New York	San Francisco	*45.23%*	*-4.67%*	*63.46%*	*35.28%*	*-17.24%*
3	Miami	New York	*27.52%*	*-17.86%*	*110.08%*	*62.38%*	*-22.70%*
4	New York	Orlando	*36.94%*	*-11.05%*	*57.14%*	*22.23%*	*-22.22%*
6	Atlanta	New York	*42.34%*	*-11.06%*	*30.58%*	*14.57%*	*-12.26%*
9	Chicago	Los Angeles	*1.17%*	*21.72%*	*49.27%*	*19.70%*	*-19.81%*
15	Boston	Chicago	*23.66%*	*28.31%*	*78.45%*	*23.56%*	*-30.76%*
16	New York	West Palm Beach	*21.96%*	*7.49%*	*-1.10%*	*-6.47%*	*-5.43%*
17	Chicago	Orlando	*61.74%*	*-0.59%*	*69.05%*	*42.60%*	*-15.64%*
18	New York	Tampa	*16.35%*	*-15.10%*	*14.44%*	*7.91%*	*-5.71%*
21	Los Angeles	Washington	*76.17%*	*-2.08%*	*52.73%*	*44.19%*	*-5.59%*
23	Chicago	Dallas-Fort Worth	*46.65%*	*13.93%*	*38.13%*	*27.55%*	*-7.66%*
24	Boston	San Francisco	*38.37%*	*4.96%*	*157.14%*	*97.20%*	*-23.31%*

***Table 4.4**: Overall Percentage Changes of Passenger Demand and Airline Supply of Type 1 Markets from 1987 to 1995*

There are 13 out of 25 city-pair markets that belong to this type. The range of the annual percentage growth of passenger demand from 1987 to 1995 is between 2.43% and of 7.93%. The overall percentage growth shows that passenger demand of these 13 city-pair markets increased significantly over the past nine years, ranging from 1.17% to 76.17%. The same is true for the number of nonstop flights and seat capacity. Notice that the nonstop flight frequency and seat capacity for Miami-New York and Boston-San Francisco markets in 1995 increased more than twice as much as in 1987 (the overall percentage growth of 110% and 157%, respectively), while increases in passenger demand of these two markets are relatively moderate. This implies that the competitiveness of these two markets is stronger than the other markets because airlines attempt to provide more flights in order to attract passengers. On the other hand, the average aircraft size decreased, ranging from 0.56% to 4.34% and 5.43% to 30.76% for annual and overall percentage change, respectively.

According to Tables 4.3 and 4.4, airfares of seven of these Type 1 city-pair markets decreased in the past nine years. The percent changes in airfares are relatively small compared to the percent changes of the other parameters, especially the changes of passenger demand. For those decreasing-fare markets, the range of the annual percentage decreases is between 0.1% and 1.6%, while the range of the overall percentage decreases is between 0.59% and 17.86%. For those increasing-fare markets, the range of the annual percentage increases is between 0.48% and 3.99%, while the range of the overall percentage increases are between 4.96% and 28.31%. This evidence indicates that airfares do not always decrease when passenger demand increases as explained by an economic theory of demand curve. The increasing-fare markets involve Atlanta, Chicago, and Dallas-Fort Worth. The major airports for these cities are operated as hub stations for Delta, United and American, and American, respectively. Under hub-and-spoke systems, the dominant airline has greater power to increase fare levels in the local hub markets. This is one explanation for the fare increases over time in these markets.

For the city-pair markets in which their origin/destination is New York, two interesting characteristics are observed. First, there was a passenger shifting from either EWR or LGA or both airports to JFK (see Tables 4.13 and 4.14). For example, passenger demand of the LAX-EWR airport-pair market decreased by 3.21% annually and 12.34% between 1987 and 1995, while passenger demand of the LAX-JFK increased by 7.49% annually and 51.57% between 1987 and 1995. Second, if passenger shifting between airports did not take place, JFK has the highest growth rate of passenger demand. These phenomena can be an impact of expansions and/or improvements of service quality at JFK. Nonetheless, these are not true for New York-Orlando and New York-Tampa city-pair markets. For the New York-Orlando market, passenger demand of all three major airports in New York (EWR, JFK, and LGA) increased and the growth rate of passenger demand of LGA is the highest. For the New York-Tampa market, the annual and overall percentage changes of passenger demand shows that passenger demand of JFK decreased, while increasing in EWR and LGA (see Tables 4.13 and 4.14). Additionally, the nonstop flight frequency and seat capacity provided for the JFK-TPA market in 1995 decreased by half from 1987. Based only on these results, one can conclude that both passenger demand and airline supply had shifted away from JFK, but whether to EWR or LGA is unclear.

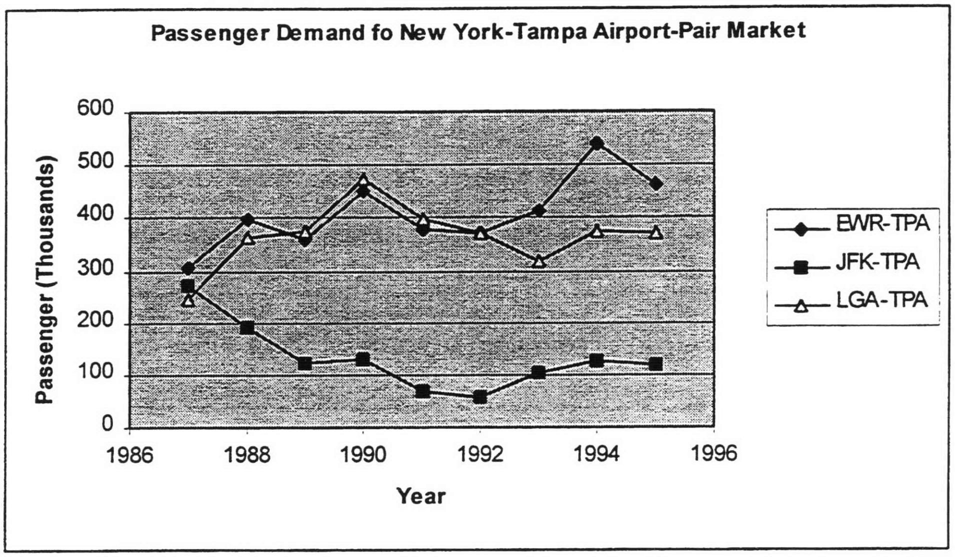

Figure 4.6: Graph of Trends in Passenger Demand of New York-Tampa Airport-Pair Markets from 1987 to 1995

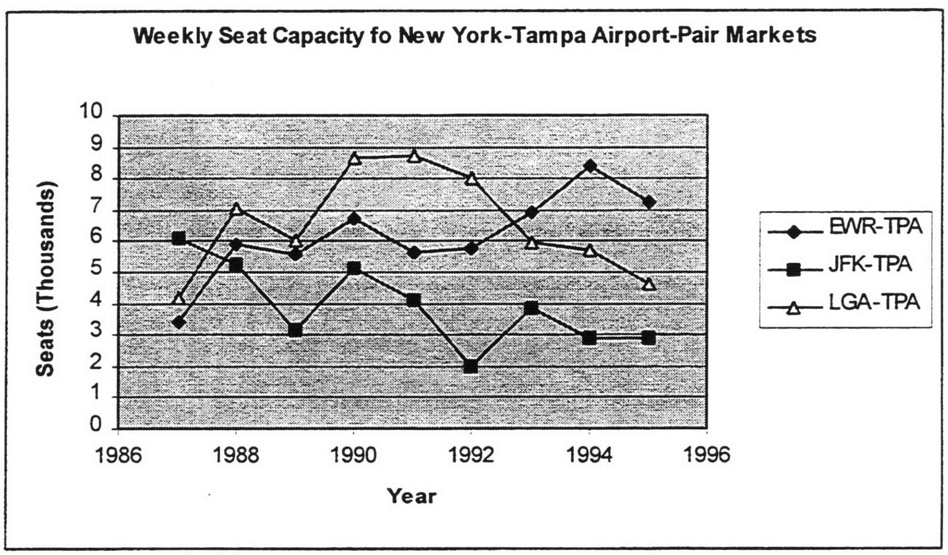

Figure 4.7: Graph of Trends in Seat Capacity of New York-Tampa Airport-Pair Markets from 1987 to 1995

Figures 4.7 and 4.8 show that passenger demand and seat capacity of JFK and LGA started to decrease, while increasing in EWR since 1990. Therefore, it can be concluded that passenger demand and airline supply of the New York-Tampa market shifted from JFK and LGA to the EWR airport.

<u>Type 2</u>: Markets with increasing frequency and seat capacity, and decreasing demand and average aircraft size

Rank	Market-Pair		Annual Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
5	New York	San Juan	*-0.24%*	*-1.31%*	*1.64%*	*1.11%*	*-0.49%*
12	Dallas-Fort Worth	New York	*-1.45%*	*6.91%*	*7.56%*	*3.74%*	*-3.24%*

***Table 4.5**: Annual Percentage Changes of Passenger Demand and Airline Supply of Type 2 Markets from 1987 to 1995*

Rank	Market-Pair		Overall Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
5	New York	San Juan	*3.32%*	*-11.82%*	*10.57%*	*4.98%*	*-5.06%*
12	Dallas-Fort Worth	New York	*0.77%*	*34.09%*	*73.89%*	*31.84%*	*-24.18%*

***Table 4.6**: Overall Percentage Changes of Passenger Demand and Airline Supply of Type 2 Markets from 1987 to 1995*

There are only two markets in this market category. Although the annual percentage changes of passenger demand are negative for both markets, the overall percentage changes indicate that passenger demand in 1996 is larger than in 1987. However, the results (both annual and overall percentage changes) are very small, meaning that passenger demand of these two markets is stable over the past nine years.

The trends in airfares are different between these two markets. According to Tables 4.5 and 4.6, airfare for the New York-San Juan market decreased by 1.31% annually and 11.82% between 1987 and 1995. These decreases in airfare stays in the same range as the type 1 markets. In contrast, airfare of the Dallas–New York market increased significantly over the past nine years because the airport (DFW) in Dallas is a hub station.

The effects of hub-and-spoke operation are shown even more clearly through the trends in nonstop flight frequency, seat capacity and average aircraft size. Based on the overall percentage growth presented in Table 4.6, nonstop flight frequency and seat capacity of the Dallas-New York market increased by as much as 73.89% and 31.84% since 1987, respectively. At the same time, the average aircraft size decreased by 24.18%. Nonstop flight frequency and seat capacity of the New York-San Juan market did not change much over the past nine years since passenger demand of this market is stable. Nonetheless, the result shows that airlines used smaller aircraft for non-hub markets as well as hub markets.

Type 3: Markets with increasing demand only

Rank	Market-Pair		Annual Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
7	Los Angeles	Honolulu	*6.18%*	*-3.08%*	*-0.64%*	*-1.68%*	*-1.03%*
10	Los Angeles	Seattle	*2.85%*	*-3.80%*	*-0.54%*	*-0.46%*	*0.13%*
19	San Francisco	Honolulu	*3.65%*	*-2.12%*	*-4.32%*	*-4.49%*	*-0.15%*

***Table 4.7**: Annual Percentage Changes of Passenger Demand and Airline Supply of Type 3 Markets from 1987 to 1995*

Rank	Market-Pair		Overall Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
7	Los Angeles	Honolulu	*58.11%*	*-14.15%*	*-6.72%*	*-14.55%*	*-8.39%*
10	Los Angeles	Seattle	*30.87%*	*-43.49%*	*-12.64%*	*-12.52%*	*0.13%*
19	San Francisco	Honolulu	*45.83%*	*-13.01%*	*-32.56%*	*-33.65%*	*-1.62%*

***Table 4.8**: Overall Percentage Changes of Passenger Demand and Airline Supply of Type 3 Markets from 1987 to 1995*

In these trends, passenger demand is the only parameter that increased over the past nine years. The range of the annual percentage growth of passenger demand from 1987 to 1995 is between 2.85% and 6.18%, while the range of the overall percentage growth is between 30.87% and 58.11%. The increases in passenger demand of these three markets are close to an upper bound of the increases in passenger demand of the type 1 markets.

Airfares of these markets decreased significantly over the past nine years, much higher than the decreasing rate of the type 1 and 2 markets. Surprisingly, although the increases in passenger demand of these markets are relatively high over the past nine years, both the nonstop flight frequency and seat capacity declined. In addition, the average aircraft size was hardly changed, ranging from only –1.03% to 0.13% annually and a -8.39% to

0.13% difference between 1987 and 1995. Therefore, it can be concluded that airlines increased load factor of flights that served these markets.

Type 4: Markets with increasing demand, frequency, seat capacity, and average aircraft size

Rank	Market-Pair		Annual Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
11	Chicago	San Francisco	*3.51%*	*2.20%*	*2.12%*	*2.98%*	*1.39%*
13	Las Vegas	New York	*31.12%*	*-4.27%*	*0.00%*	*2.98%*	*2.98%*
14	Chicago	Phoenix	*7.56%*	*-0.47%*	*0.83%*	*0.56%*	*0.30%*
20	Anchorage	Seattle	*12.17%*	*-4.28%*	*3.96%*	*4.84%*	*1.01%*
25	San Francisco	Washington	*21.28%*	*1.58%*	*3.13%*	*4.04%*	*0.93%*

***Table 4.9**: Annual Percentage Changes of Passenger Demand and Airline Supply of Type 4 Markets from 1987 to 1995*

Rank	Market-Pair		Overall Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
11	Chicago	San Francisco	*22.23%*	*20.52%*	*12.93%*	*24.42%*	*10.18%*
13	Las Vegas	New York	*298.21%*	*-21.78%*	*0.00%*	*2.70%*	*2.70%*
14	Chicago	Phoenix	*40.53%*	*13.04%*	*0.00%*	*-1.22%*	*-1.22%*
20	Anchorage	Seattle	*180.28%*	*-40.16%*	*29.93%*	*40.51%*	*8.14%*
25	San Francisco	Washington	*229.10%*	*20.09%*	*25.00%*	*30.89%*	*4.71%*

***Table 4.10**: Overall Percentage Changes of Passenger Demand and Airline Supply of Type 4 Markets from 1987 to 1995*

Passenger demand of these markets increased substantially since 1987, highest among the five trend types. The range of the annual percentage growth of passenger demand from 1987 to 1995 is between 3.51% and of 31.52%. The overall percentage growth shows a significant difference of passenger demand between 1987 and 1995, especially in Las Vegas-New York, Anchorage-Seattle, and San Francisco-Washington, D.C. markets. Because passenger demand of these markets grew significantly over time, increasing seat capacity solely by providing more flights, might not be enough. Aircraft size must also increase. In fact, increases of the flight frequency and average aircraft size of these markets were proportionally small compared to the huge increases of passenger demand. Therefore, average load factor should increase as well.

According to Table 4.9, airfares of these markets did not change much over the past nine years. However, the differences of airfares between 1987 and 1995 are quite large. Notice that airfare of Chicago-San Francisco, Chicago-Phoenix, and San Francisco-Washington, D.C. markets increased over the past nine years because Chicago and Washington, D.C. are hub stations (explanation was already given in Type 1 section).

There are two strange characteristics that are noteworthy. First, although Chicago is a large hub station for United and American, the trends in nonstop flight frequency and seat capacity of Chicago-Phoenix market contradict our *a priori* expectation. Theoretically, flight frequency and seat capacity should increase for a hub market. In reality, these parameters of the Chicago-Phoenix market hardly changed over the past nine years. Second, although passenger demand of Las Vegas-New York changed dramatically, demand in 1995 was triple the demand of 1987; not only the nonstop flight frequency remained the same, but also the seat capacity and average aircraft size increased by only a few percentage points throughout nine years. This led us to believe that the average load factor of the flights of these two markets increased over the nine-year period.

Type 5: Special case

Rank	Market-Pair		Annual Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
8	Fort Lauderdale	New York	*-1.23%*	*-1.23%*	*1.42%*	*-0.89%*	-2.31%
22	Chicago	Denver	*2.41%*	*6.88%*	*-3.12%*	*-1.57%*	*1.49%*

***Table 4.11**: Annual Percentage Changes of Passenger Demand and Airline Supply of Type 5 Markets from 1987 to 1995*

Rank	Market-Pair		Overall Percentage Changes (%)				
			Demand	Fare	Frequency	Seat Cap.	A/C Size
8	Fort Lauderdale	New York	*-11.13%*	*-16.61%*	*-8.76%*	*-25.37%*	-18.20%
22	Chicago	Denver	*48.26%*	*2.98%*	*-22.99%*	*-14.81%*	*10.62%*

***Table 4.12**: Overall Percentage Changes of Passenger Demand and Airline Supply of Type 5 Markets from 1987 to 1995*

The characteristics of these two markets are unique. For the Fort Lauderdale-New York market, all parameters decreased over nine years. This is logical in that a decline in passengers engenders fewer services. Therefore, one would expect the rank of this market to go down in the near future. For the Chicago-Denver market, the trends in airline supply are different than every other market that is analyzed. In this market, airlines used bigger aircraft and less nonstop flight frequency. Also, because of decreasing seat capacity, load factor of flights in this market should increase.

Rank	Market-Pair		Airport-Pair		Annual Percentage Change (%)				
					Demand	Fare	Frequency	Seat Cap.	A/C Size
1	Los Angeles	New York	LAX	EWR	-3.21%	1.38%	9.15%	2.66%	-5.50%
			LAX	JFK	7.49%	-3.21%	6.40%	3.28%	-2.29%
				Total	2.43%	-1.24%	6.65%	2.74%	-3.32%
2	New York	San Francisco	EWR	SFO	-0.12%	2.22%	9.71%	5.25%	-4.00%
			JFK	SFO	8.56%	-2.17%	5.49%	3.95%	-1.34%
				Total	3.95%	-0.37%	6.51%	4.15%	-2.24%
3	Miami	New York	MIA	EWR	2.18%	-0.73%	15.59%	8.19%	-3.97%
			MIA	JFK	11.00%	-3.26%	16.29%	16.54%	1.72%
			MIA	LGA	-1.76%	0.05%	13.73%	9.37%	-5.16%
				Total	2.86%	-1.60%	13.69%	10.89%	-2.67%
4	New York	Orlando	EWR	MCO	4.32%	-0.45%	11.65%	5.90%	0.10%
			JFK	MCO	2.26%	-0.83%	12.97%	7.97%	-3.40%
			LGA	MCO	9.01%	-0.22%	9.03%	6.23%	-2.86%
				Total	4.15%	-0.57%	7.51%	3.52%	-2.50%
5	New York	San Juan	EWR	SJU	2.87%	-0.89%	9.60%	8.29%	-0.19%
			JFK	SJU	-1.10%	-1.49%	-0.80%	-0.39%	0.54%
				Total	-0.24%	-1.31%	1.64%	1.11%	-0.49%
6	Atlanta	New York	ATL	EWR	6.94%	1.65%	9.14%	6.61%	-2.75%
			ATL	JFK	15.59%	0.16%	23.84%	29.92%	2.83%
			ATL	LGA	-0.51%	2.44%	0.53%	-1.89%	-0.37%
				Total	3.22%	1.32%	4.47%	2.83%	-1.46%
7	Los Angeles	Honolulu	**LAX**	**HNL**	***6.18%***	***-3.08%***	***-0.64%***	***-1.68%***	***-1.03%***
8	Fort Lauderadale	New York	FLL	EWR	0.17%	-0.78%	3.65%	2.54%	-1.49%
			FLL	JFK	-1.17%	-1.97%	15.08%	8.39%	-1.77%
			FLL	LGA	-0.23%	-1.11%	4.05%	0.58%	-1.66%
				Total	-1.23%	-1.23%	1.42%	-0.89%	-2.31%
9	Chicago	Los Angeles	ORD	LAX	2.86%	1.60%	8.12%	3.69%	-3.36%
			ORD	ONT	3.91%	-0.05%	0.87%	1.54%	0.49%
				Total	2.94%	1.43%	6.15%	2.98%	-2.68%
10	Los Angeles	Seattle	**LAX**	**SEA**	***2.85%***	***-3.80%***	***-0.54%***	***-0.46%***	***0.13%***
11	Chicago	San Francisco	ORD	OAK	-0.18%	1.94%	5.42%	4.87%	1.39%
			ORD	SFO	4.46%	2.09%	2.85%	4.04%	-0.77%
				Total	3.51%	2.20%	2.12%	2.98%	1.39%
12	Dallas-Fort Worth	New York	DFW	EWR	-1.50%	8.00%	9.63%	8.19%	-1.50%
			DFW	JFK	-1.31%	4.54%	12.22%	11.45%	0.22%
			DFW	LGA	-0.30%	5.65%	8.79%	3.08%	-4.68%
				Total	-1.45%	6.91%	7.56%	3.74%	-3.24%
13	Las Vegas	New York	**LAS**	**JFK**	***31.12%***	***-4.27%***	***0.00%***	***2.98%***	***2.98%***
14	Chicago	Phoenix	**ORD**	**PHX**	***7.56%***	***-0.47%***	***0.83%***	***0.56%***	***0.30%***
15	Boston	Chicago	**BOS**	**ORD**	***2.79%***	***3.99%***	***8.47%***	***3.13%***	***-4.34%***
16	New York	West Palm Beach	EWR	PBI	4.04%	2.48%	7.45%	5.86%	-0.90%
			JFK	PBI	12.15%	2.71%	-80.00%	-77.63%	-77.63%
			LGA	PBI	5.40%	1.47%	2.60%	1.63%	-0.49%
				Total	2.62%	-2.05%	2.38%	2.20%	-0.63%
17	Chicago	Orlando	**ORD**	**MCO**	***6.00%***	***-1.02%***	***8.21%***	***5.63%***	***-1.53%***
18	New York	Tampa	EWR	TPA	5.75%	0.19%	14.94%	12.68%	-0.62%
			JFK	TPA	-4.32%	-1.53%	2.13%	0.73%	-0.87%
			LGA	TPA	10.00%	-1.63%	6.67%	5.32%	-0.67%
				Total	2.85%	-0.89%	3.81%	2.89%	-0.66%
19	San Francisco	Honolulu	**SFO**	**HNL**	***3.65%***	***-2.12%***	***-4.32%***	***-4.49%***	***-0.15%***
20	Anchorage	Seattle	**ANC**	**SEA**	***12.17%***	***-4.28%***	***3.96%***	***4.84%***	***1.01%***
21	Los Angeles	Washigton	LAX	BWI	6.98%	-1.20%	7.14%	10.36%	3.22%
			LAX	IAD	9.05%	-0.22%	2.44%	2.02%	-0.39%
				Total	7.93%	-0.10%	6.34%	5.45%	-0.56%
22	Chicago	Denver	**ORD**	**DEN**	***2.41%***	***6.88%***	***-3.12%***	***-1.57%***	***1.49%***
23	Chicago	Dallas-Fort Worth	**ORD**	**DFW**	***4.93%***	***3.73%***	***5.34%***	***3.58%***	***-0.66%***
24	Boston	San Francisco	**BOS**	**SFO**	***4.86%***	***0.48%***	***16.61%***	***13.56%***	***-2.96%***
25	San Francisco	Washigton	**SFO**	**IAD**	***21.28%***	***1.58%***	***3.13%***	***4.04%***	***0.93%***

Table 4.13: *Annual Percent Growth Rate of Airline Demand and Supply by Airport Pairs from 1987-1995*

Rank	Market-Pair		Airport-Pair		Demand	Fare	Frequency	Seat Cap.	A/C Size
					Overall Percentage Change (%)				
1	Los Angeles	New York	LAX	EWR	-12.34%	10.79%	81.63%	14.39%	-37.02%
			LAX	JFK	51.58%	-17.90%	53.66%	25.54%	-18.30%
				Total	22.69%	-6.88%	61.63%	22.20%	-24.39%
2	New York	San Francisco	EWR	SFO	14.37%	10.19%	100.00%	42.59%	-28.71%
			JFK	SFO	77.13%	-16.43%	50.00%	32.55%	-11.64%
				Total	45.23%	-4.67%	63.46%	35.28%	-17.24%
3	Miami	New York	MIA	EWR	33.60%	-12.35%	153.57%	59.23%	-37.20%
			MIA	JFK	111.87%	-27.23%	117.39%	134.41%	7.83%
			MIA	LGA	-25.73%	-4.20%	81.82%	11.99%	-38.40%
				Total	27.52%	-17.86%	110.08%	62.38%	-22.70%
4	New York	Orlando	EWR	MCO	47.50%	-12.99%	82.14%	52.44%	-16.31%
			JFK	MCO	5.13%	-11.41%	31.43%	-10.26%	-31.72%
			LGA	MCO	43.10%	-8.30%	45.24%	12.74%	-22.37%
				Total	36.94%	-11.05%	57.14%	22.23%	-22.22%
5	New York	San Juan	EWR	SJU	24.81%	-10.27%	75.00%	58.88%	-9.21%
			JFK	SJU	-4.24%	-12.59%	-12.09%	-8.99%	3.52%
				Total	3.32%	-11.82%	10.57%	4.98%	-5.06%
6	Atlanta	New York	ATL	EWR	117.04%	-22.48%	75.26%	35.72%	-22.56%
			ATL	JFK	96.32%	-6.14%	90.48%	134.99%	23.37%
			ATL	LGA	-21.35%	17.37%	-14.52%	-21.23%	-7.86%
				Total	42.34%	-11.06%	30.58%	14.57%	-12.26%
7	Los Angeles	Honolulu	LAX	HNL	58.11%	-14.15%	-6.72%	-14.55%	-8.39%
8	Fort Lauderadale	New York	FLL	EWR	2.91%	-16.14%	21.28%	-1.25%	-18.58%
			FLL	JFK	-17.84%	-19.25%	-3.57%	-23.38%	-20.54%
			FLL	LGA	-19.03%	-15.28%	-33.87%	-43.97%	-15.27%
				Total	-11.13%	-16.61%	-8.76%	-25.37%	-18.20%
9	Chicago	Los Angeles	ORD	LAX	-0.88%	24.83%	61.96%	22.11%	-24.61%
			ORD	ONT	15.71%	.3.13%	0.00%	3.17%	3.17%
				Total	1.17%	21.72%	49.27%	19.70%	-19.81%
10	Los Angeles	Seattle	LAX	SEA	30.87%	-43.49%	-12.64%	-12.52%	0.13%
11	Chicago	San Francisco	ORD	OAK	26.78%	20.80%	23.21%	36.24%	10.57%
			ORD	SFO	-0.24%	18.92%	-20.00%	-29.61%	-12.02%
				Total	22.23%	20.52%	12.93%	24.42%	10.18%
12	Dallas-Fort Worth	New York	DFW	EWR	24.06%	20.82%	85.71%	58.02%	-14.91%
			DFW	JFK	-34.27%	28.98%	0.00%	-1.58%	-1.58%
			DFW	LGA	-8.56%	43.01%	85.06%	24.38%	-32.79%
				Total	-0.77%	34.09%	73.89%	31.84%	-24.18%
13	Las Vegas	New York	LAS	JFK	298.21%	-21.78%	0.00%	2.70%	2.70%
14	Chicago	Phoenix	ORD	PHX	40.53%	13.04%	0.00%	-1.22%	-1.22%
15	Boston	Chicago	BOS	ORD	23.66%	28.31%	78.45%	23.56%	-30.76%
16	New York	West Palm Beach	EWR	PBI	57.21%	9.12%	40.00%	24.39%	-11.15%
			JFK	PBI	-58.12%	21.32%	-100.00%	-100.00%	-100.00%
			LGA	PBI	17.58%	5.05%	-2.38%	-6.52%	-4.24%
				Total	21.96%	7.49%	-1.10%	-6.47%	-5.43%
17	Chicago	Orlando	ORD	MCO	61.74%	-0.59%	69.05%	42.60%	-15.64%
18	New York	Tampa	EWR	TPA	51.39%	-12.30%	133.33%	111.91%	-9.18%
			JFK	TPA	-55.61%	-17.85%	-48.78%	-52.32%	-6.90%
			LGA	TPA	51.99%	-19.83%	17.86%	11.11%	-5.73%
				Total	-16.35%	-15.10%	-14.44%	-7.91%	-5.74%
19	San Francisco	Honolulu	SFO	HNL	45.83%	-13.01%	-32.56%	-33.65%	-1.62%
20	Anchorage	Seattle	ANC	SEA	180.28%	-40.16%	29.93%	40.51%	8.14%
21	Los Angeles	Washigton	LAX	BWI	65.26%	-4.81%	50.00%	56.18%	4.12%
			LAX	IAD	82.19%	-1.95%	14.55%	8.71%	-5.10%
				Total	76.17%	-2.08%	52.73%	44.19%	-5.59%
22	Chicago	Denver	ORD	DEN	48.26%	2.98%	-22.99%	-14.81%	10.62%
23	Chicago	Dallas-Fort Worth	ORD	DFW	46.65%	13.93%	38.13%	27.55%	-7.66%
24	Boston	San Francisco	BOS	SFO	38.37%	4.96%	157.14%	97.20%	-23.31%
25	San Francisco	Washigton	SFO	IAD	229.10%	20.09%	25.00%	30.89%	4.71%

Table 4.14: *Overall Percent Growth Rate of Airline Demand and Supply by Airport Pairs from 1987-1995*

4.4 Conclusion

This chapter has presented the trends of passenger demand and airline supply of the top 25 U.S. longhaul domestic markets across the nine year period of deregulation based on the average annual and overall percentage changes. The analysis was divided into two sections, aggregate base and individual market base. The aggregate analysis combined 25 markets, incorporating the parameters of the individual markets. The results showed that passenger demand increased approximately 6.2 million passengers between 1987 and 1995, approximately 3.5% annually and 30% overall. On an air supply side, the results can be summarized as follows:

1. Changes in airfares were very small. The average airfare was the highest in 1989 and continued to decrease by only a few dollars since.
2. Nonstop flight frequency increased in about the same rate as passenger demand across the nine-year period. The number of flights in 1995 is greater than the number of flights in 1987 by approximately 1000 flights.
3. Total weekly seat capacity of the total 25 markets increased by 90,000 seats per week since 1987, which is accounted for 1.85% annually and 14.42% overall. Total weekly seat capacity grew at a slower rate than the aggregate passenger demand of all 25 markets
4. The average aircraft size decreased by approximately 15 seats per departures since 1987.

The individual-market analysis provided more insight into the changes of passenger demand and airline supply of these top 25 markets. The majority of the top 25 markets has the same trends as the results of the aggregate analysis: increasing demand, nonstop flight frequency, and seat capacity, but decreasing average aircraft size. There are also some markets in which the nonstop flight frequency, seat capacity, and average aircraft decreased or increased by a very small proportion compared to increases in passenger demand. In this case, it can be concluded that load factor of flight, on average, should be increased. In addition, hub-and-spoke systems affect airline supply in many ways. First, increases in nonstop flight frequency and seat capacity across the nine-year period were higher than non-hub markets in general. Second, the average aircraft size of hub markets decreased at a faster rate than non-hub markets. Finally, airfares of local hub markets tended to increase, suggesting that there might exist a greater potential for monopolistic pricing by the dominant hub carrier in such markets.

Chapter 5:
Correlation of Passenger Demand and Airline Supply

5.1 Introduction

In the previous chapter, although the same conclusion of trends in passenger demand and airline supply in recent years could not be made for every analyzed market, the results showed that passenger demand, seat capacity, and nonstop flight frequency increased, while airfare and average aircraft size decreased in the nine year period for aggregate measurements and most of the top 25 city-pair markets. In this chapter, we look further into correlations between different pairs of the parameters in an attempt to understand how and to what extent the changes in one parameter may affect the other parameters in the deregulation era. This includes the studies of correlations between passenger demand and demand-relevant airline supply and between airline supply measures themselves. The analyses focus solely on a non-linear (exponential) form because response to price is typically non-linear.

Since the analysis of this thesis has concentrated on five parameters including passenger demand, airfare, seat capacity, nonstop frequency, and average aircraft size, there are ten possible correlations to be explored.[1] However, it is not necessary to analyze all of them because some are redundant and some are meaningless. The potentially meaningful correlations that will be analyzed in this chapter include airfare-passenger demand, seat capacity-passenger demand, seat capacity-nonstop frequency, average aircraft size-passenger demand, and average aircraft size-nonstop frequency correlations. These correlations will be presented and discussed in five separate sections, respectively. Each

[1] The 10 possible correlation models include demand-fare, demand-capacity, demand-frequency, demand-A/C size, fare-capacity, fare-frequency, fare-A/C size, capacity-frequency, capacity-A/C size, and frequency-A/C size.

section contains two subsections, dealing with aggregate and individual city-pair models. The data associated with the analysis are given in Appendix A.

5.2 Passenger Demand-Airfare Correlation

According to economic theory, passenger demand increases as the price of an air ticket falls. The analysis in the previous chapter showed that airfares of the top 25 markets continue to decrease under deregulation (except some markets that involve hub operations). In this section, the elasticities of passenger demand with respect to airfare are estimated for the top 25 markets. Accurate estimates of the price elasticity of demand are difficult to obtain because the changes in passenger demand depend not only upon the changes in airfare, but also upon other factors such as population, employment, per capita income, frequency of scheduling, and service quality. The problem is that these data are normally unavailable, very hard to measure, or, most importantly, subject to errors in the estimation. For example, although, in general, one would expect that the demand for air travel is greater in a highly populated city than in a sparsely populated city, it is not always the case. Consider three different cities: Boston, Lisbon, and Sydney. Boston has about four times as much passenger traffic as Lisbon and twice that of Sydney, but all have about the same overall population.[2]

Therefore, two different approaches will be used to calculate the price elasticity of demand for the top 25 markets. The first approach is the midpoint method (see Chapter 3, Section 3.2) which is the average of arc elasticity of demand of an individual market before and after a fare change over the nine-year period. The second approach is the non-linear regression method which finds the best fitting curve for the given data of passenger demand and airfares. Both methods will not yield the same result because of the differences in characteristics of the calculations described above. Therefore, the results will be summarized in the range between, and the average of, the price elasticity of demand obtained from these two methods. Additionally, R^2 and t-statistic values of the

[2] Source: Notes for 1.231J/16.781 Planning and Design of Airport Systems, MIT, Spring 1998.

second approach calculation will be reported in order to verify how well the model fits the data.

5.2.1 *Aggregate Model*

1. Midpoint Method

Year	Demand	AirFare	Ep
1987	20,630,180	186.79	-
1988	22,609,360	189.49	6.38
1989	22,009,150	217.67	-0.19
1990	24,695,010	205.45	-1.99
1991	23,097,560	206.23	-17.53
1992	23,889,910	197.48	-0.78
1993	24,105,470	205.30	0.23
1994	26,418,370	181.71	-0.75
1995	26,803,950	182.47	3.51
		Average	**-1.39**

***Table 5.1**: Price Elasticity of Aggregate Passenger Demand by Midpoint Method*

2. Non-Linear Regression Method (NLR)

	Intercept			Demand Variable		
R-Square	Coefficient	T-Stat	Significant?	Exponent	T-Stat	Significant?
0.125	5,316,732	22.982	Sig	**-0.350**	-2.724	Sig

***Table 5.2**: Aggregate Price Elasticity with Respect to Passenger Demand by NLR Regression Method*

The results can be interpreted that for each one percent decrease in airfare, passenger demand of the top 25 markets increased by 1.39% and 0.35% for Midpoint and NLR methods, respectively. The value for the fare elasticity obtained from the Midpoint method is much smaller than from the NLR method. By looking at passenger demand and airfares over nine years from Table 5.1, one can observe that the decreases in airfares were very small compared to the increases in passenger demand over the nine-year period. Therefore, the demand should be elastic. However, the price elasticity of demand obtained from the NLR method (-0.35) is much greater than negative one, indicating that passenger demand of the top 25 market is inelastic. Indeed, it contradicts both the priori economic intuition and the result obtained from the Midpoint method. Because the fare variable is significant in the model according to the t-statistic values, the only evidence that helps to argue that the result obtained from the NLR method does not make sense conceptually, is the R^2 value. The best fitting model should have R^2 close to one. In the NLR model, the R^2 value is extremely small (0.12), meaning that the fitting level of the model is very poor. On the other hand, the price elasticity of demand obtained from Midpoint method is lower than negative one. This number is acceptable in terms of the priori expectation.

5.2.2 Individual Market Models

The previous sub-section presented the price elasticity of passenger demand of all 25 markets combined. It is important to note that it may contain errors because the trends of passenger demand and airfares are not the same for all markets. This sub-section examines the price elasticity of demand for the 25 markets in isolation. Therefore, the results should be more accurate and provide more insight about the correlation between airfares and passenger demand of these 25 markets.

Rank	Market-Pair		Ep Low Value	Ep High Value	Ep Average
1	Los Angeles	New York	-1.34	*-2.56*	**-1.34**
2	New York	San Francisco	-1.20	*-2.85*	**-1.20**
3	Miami	New York	*-1.28*	-1.91	**-1.60**
4	New York	Orlando	-1.82	*-4.62*	**-3.22**
5	New York	San Juan	-1.90	*-2.01*	**-1.90**
6	Atlanta	New York	-1.48	*-1.69*	**-1.59**
7	Los Angeles	Honolulu	*-1.21*	-2.03	**-1.62**
8	Fort Lauderdale	New York	*-1.48*	-2.10	**-2.10**
9	Chicago	Los Angeles	-1.13	*-1.23*	**-1.23**
10	Los Angeles	Seattle	*-0.80*	-1.01	**-0.91**
11	Chicago	San Francisco	-0.93	*-1.24*	**-0.93**
12	Dallas-Fort Worth	New York	*-1.09*	-1.16	**-1.16**
13	Las Vegas	New York	*-1.66*	-3.36	**-2.51**
14	Chicago	Phoenix	*-0.97*	-1.04	**-1.04**
15	Boston	Chicago	*-0.38*	-0.61	**-0.61**
16	New York	West Palm Beach	*-1.02*	-1.76	**-1.76**
17	Chicago	Orlando	*-1.23*	-1.75	**-1.75**
18	New York	Tampa	-1.44	*-2.42*	**-1.93**
19	San Francisco	Honolulu	*-1.72*	-1.77	**-1.75**
20	Anchorage	Seattle	*-1.64*	-1.77	**-1.71**
21	Los Angeles	Washington	-1.18	*-2.29*	**-1.18**
22	Chicago	Denver	*-0.71*	-0.88	**-0.88**
23	Chicago	Dallas-Fort Worth	*-0.001*	-0.54	**-0.54**
24	Boston	San Francisco	-1.02	*-1.61*	**-1.02**
25	San Francisco	Washington	-1.32	*-1.78*	**-1.55**
				Average	**-1.48**

***Table 5.3**: Price Elasticity Estimations of Passenger Demand of the 25 Individual Markets*

Note that the values in an *italic* form are the results of the NLR method and only the significant ones are considered (see Table 5.4). The fare elasticities of passenger demand of these 25 markets varies from –0.54 to –3.22. The most fare-inelastic market is the Chicago-Dallas market, while the most fare-elastic market is the New York-Orlando market. According to Table 5.1, 20 of these city-pair markets have fare elasticity lower than -1, meaning that the passenger demand is elastic. Among these 20 markets, the price elasticities of three markets including the New York-San Francisco, New York-Orlando, and Las Vegas- New York markets, are extremely high. The reason for such an extreme fare elasticity is because passenger demand of these markets grew substantially, while airfares corresponding to these markets did not change much over nine years (see Tables 4.3 and 4.9). By contrast, there are five markets in which their fare elasticities are greater than negative one, meaning that the passenger demand is inelastic. These markets include the Los Angeles-Seattle, Chicago-Phoenix, Boston-Chicago, Chicago-Denver, and Chicago-Dallas markets. Notice that the origins/destinations of these markets involve hub operations and business markets. As discussed in Chapter 4, airfares in hub-related markets increased because the dominant airline at that hub station is more likely to have monopoly power to increase fare levels. On the other hand, business travelers are insensitive to changes in airfare because they do not use their own money to pay for airline tickets. Therefore, it is logical for the price elasticity for passenger demand of these markets to be inelastic. In addition, the average fare elasticity of these 25 markets is –1.48, very close to the result of the Midpoint method of the aggregate model.

Similar to the NLR result of aggregated model, Table 5.4 shows that the extrapolations contain low R^2 value and the fare variable is statistically insignificant for most of the 25 markets. This implies that changes in passenger demand do not depend solely upon changes in airfares. Some other factors should also be considered as part of the model. However, the objective of the analysis concentrated strictly on the sensitivity of passenger demand with respect to the changes in airfares. A positive feature of the NLR results of the individual market model is that the estimations confirm our *a priori* expectation.

Rank	Market-Pair		Adjusted R-Square	Fitting Level	Intercept (k)	T-Stat Test	Signif. Level	Coeff T-Stat	Signif. Level
1	Los Angeles	New York	-0.01	Poor	9.37E+06	10.75	Sig	-0.97	Not Sig
2	New York	San Francisco	-0.07	Poor	2.17E+07	4.39	Sig	-0.71	Not Sig
3	Miami	New York	0.77	Good	2.17E+07	22.71	Sig	-5.27	Sig
4	New York	Orlando	0.61	Good	4.28E+08	13.20	Sig	-3.67	Sig
5	New York	San Juan	0.03	Poor	4.33E+06	14.78	Sig	-1.10	Not Sig
6	Atlanta	New York	0.71	Good	6.35E+07	21.32	Sig	-4.58	Sig
7	Los Angeles	Honolulu	0.62	Good	8.69E+09	9.68	Sig	-3.78	Sig
8	Fort Lauderdale	New York	-0.07	Poor	4.24E+06	11.79	Sig	-0.69	Not Sig
9	Chicago	Los Angeles	-0.02	Poor	2.46E+06	17.02	Sig	-0.91	Not Sig
10	Los Angeles	Seattle	0.77	Good	1.86E+07	27.69	Sig	-5.23	Sig
11	Chicago	San Francisco	-0.14	Poor	8.38E+05	11.54	Sig	-0.07	Not Sig
12	Dallas-Fort Worth	New York	-0.03	Poor	1.47E+06	25.86	Sig	-0.87	Not Sig
13	Las Vegas	New York	0.77	Good	1.47E+14	8.31	Sig	-5.22	Sig
14	Chicago	Phoenix	-0.07	Poor	1.66E+06	9.55	Sig	-0.71	Not Sig
15	Boston	Chicago	0.25	Poor	1.91E+05	19.05	Sig	1.90	Not Sig
16	New York	West Palm Beach	-0.02	Poor	9.51E+06	7.28	Sig	-0.90	Not Sig
17	Chicago	Orlando	-0.02	Poor	4.92E+04	4.20	Sig	0.90	Not Sig
18	New York	Tampa	0.56	Poor	2.26E+07	17.55	Sig	-3.34	Sig
19	San Francisco	Honolulu	0.41	Poor	8.09E+09	6.34	Sig	-2.57	Sig
20	Anchorage	Seattle	0.94	Good	3.28E+09	25.80	Sig	-10.83	Sig
21	Los Angeles	Washington	-0.14	Poor	5.26E+05	2.34	Sig	0.05	Not Sig
22	Chicago	Denver	0.01	Poor	3.22E+06	9.32	Sig	-1.04	Not Sig
23	Chicago	Dallas-Fort Worth	0.03	Poor	8.98E+06	6.74	Sig	-1.13	Not Sig
24	Boston	San Francisco	-0.12	Poor	1.74E+05	3.90	Sig	0.38	Not Sig
25	San Francisco	Washington	0.49	Poor	7.27E-05	-1.24	Not Sig	2.92	Sig

Table 5.4: Additional Results of the Non-Linear Regression Method of the 25 Individual Markets

5.3 Total Nonstop Seat Capacity-Passenger Demand Correlation

Because passenger demand has grown greatly over time, this section estimates the sensitivity of the total nonstop seat capacity to the same proportional changes in passenger demand. In general, the higher the passenger demand, the higher the seat capacity would be provided in the market. The elasticity of the total seat capacity with respect to demand should be positive. Note that the range of the elasticity is important for interpretations of the correlation between these two parameters. If the calculated elasticity ranges between zero and one, it means that passenger demand grew at a faster rate than the total seat capacity did over time. One, therefore, can expect the number of passengers per flight (load factor) to be higher. In contrast, if the calculated elasticity is greater than one, it means that passenger demand grew at a slower rate than the total seat capacity did over time. In this case, airlines have to increase either the size of aircraft, flight frequency, or the combination of both parameters.

5.3.1 Aggregate Model

Adjusted R-Square	Intercept			Demand Variable		
	Coefficient	T-Stat	Significant?	Exponent	T-Stat	Significant?
0.32	0.30	-1.53	Not Sig	**0.82**	14.35	Sig

***Table 5.5**: Aggregate Total Nonstop Seat Capacity Elasticity with Respect to Passenger Demand*

The results can be interpreted that for each one percent change in aggregate passenger demand of the top 25 markets, the total seat capacity changes by 0.82 percent. Because the elasticity estimate of the seat capacity with respect to passenger demand is positive and less than one, it implies that passenger demand grew at a faster rate than seat capacity did over the nine year period. Conceptually, a load factor of flights on average should be higher. It is also important to note that the elasticity of 0.82 is close to one. In other words, the correlation between the total seat capacity and passenger demand is close to linear. Therefore, increases in load factor may not be as substantial. Although this estimate confirms our *a priori* expectation and is significant statistically, the adjusted R^2 statistic is low, suggesting that the demand variable in the aggregate model poorly explained the variance in the total nonstop seat capacity of the top 25 markets.

5.3.2 Individual Market Models

Rank	Market-Pair		Adjested R^2	Fitting Level	Intercept (k)			Passenger Demand (a)		
					Coeff.	T-Stat	Signif?	Expont.	T-Stat	Signif?
1	Los Angeles	New York	0.49	Poor	2.07E+00	0.21	Not Sig	**0.70**	2.96	Sig
2	New York	San Francisco	0.68	Good	1.99E-01	-0.58	Not Sig	**0.84**	4.26	Sig
3	Miami	New York	0.23	Poor	2.94E-02	-0.45	Not Sig	**0.99**	1.83	Not Sig
4	New York	Orlando	0.38	Poor	8.01E-01	-0.05	Not Sig	**0.74**	2.43	Sig
5	New York	San Juan	0.18	Poor	1.66E+01	0.62	Not Sig	**0.53**	1.66	Not Sig
6	Atlanta	New York	0.29	Poor	2.18E+01	0.84	Not Sig	**0.53**	2.06	Sig
7	Los Angeles	Honolulu	-0.01	Poor	5.57E+05	4.92	Sig	**-0.19**	-0.98	Not Sig
8	Fort Lauderdale	New York	0.55	Poor	1.02E-05	-1.76	Not Sig	**1.50**	3.30	Sig
9	Chicago	Los Angeles	0.06	Poor	1.17E+09	2.47	Sig	**-0.73**	-1.21	Not Sig
10	Los Angeles	Seattle	-0.09	Poor	2.57E+05	3.19	Sig	**-0.17**	-0.59	Not Sig
11	Chicago	San Francisco	0.59	Poor	1.11E-01	-0.62	Not Sig	**0.93**	3.55	Sig
12	Dallas-Fort Worth	New York	-0.12	Poor	4.54E+02	0.55	Not Sig	**0.32**	0.39	Not Sig
13	Las Vegas	New York	-0.12	Poor	7.99E+02	2.60	Sig	**0.10**	0.49	Not Sig
14	Chicago	Phoenix	-0.14	Poor	1.39E+04	3.43	Sig	**0.003**	0.01	Not Sig
15	Boston	Chicago	0.34	Poor	4.73E-01	-0.16	Not Sig	**0.81**	2.26	Sig
16	New York	West Palm Beach	0.17	Poor	3.55E-01	-0.16	Not Sig	**0.75**	1.63	Not Sig
17	Chicago	Orlando	0.33	Poor	7.18E-01	-0.08	Not Sig	**0.72**	2.21	Sig
18	New York	Tampa	0.20	Poor	1.58E+00	0.08	Not Sig	**0.68**	1.71	Not Sig
19	San Francisco	Honolulu	-0.12	Poor	1.24E+05	2.54	Sig	**-0.12**	-0.35	Not Sig
20	Anchorage	Seattle	0.79	Good	1.17E+02	4.95	Sig	**0.43**	5.66	Sig
21	Los Angeles	Washington	0.78	Good	2.79E+00	0.63	Not Sig	**0.64**	5.35	Sig
22	Chicago	Denver	-0.09	Poor	9.13E+04	6.01	Sig	**-0.09**	-0.60	Not Sig
23	Chicago	Dallas-Fort Worth	0.45	Poor	1.39E+02	2.62	Sig	**0.39**	2.75	Sig
24	Boston	San Francisco	0.41	Poor	1.38E-10	-1.87	Not Sig	**2.37**	2.58	Sig
25	San Francisco	Washington	0.14	Poor	5.49E+02	3.48	Sig	**0.21**	1.52	Not Sig

***Table 5.6**: Elasticity Estimations of Total Nonstop Seat Capacity with Respect to Passenger Demand*

The total nonstop seat capacity elasticities with respect to passenger demand of these 25 markets vary from –0.73 to 2.37. The elasticity range is large because it includes negative values, which contradict our priori expectation. There are five markets with a negative elasticity, including the Los Angeles-Honolulu, Chicago-Los Angeles, Los Angeles-Seattle, San Francisco-Honolulu, and Chicago-Denver markets. Two observations are made regarding these unexpected results. First, none of the negative estimates are statistically significant and therefore they are not useful. Second, the results are negative because the trends of the total seat capacity and passenger demand of these five markets go in opposite directions, increasing passenger demand, but decreasing total seat capacity over the nine year period (See Tables 4.7 and 4.11).

Two markets including Fort Lauderdale-New York and Boston-San Francisco have the estimates that are greater than one and statistically significant. According to the results, for each one percent change in passenger demand, the total seat capacity changed by 1.50% and 2.37%, respectively. The estimates are high compared to the other markets. Therefore, changes in seat capacity of these two markets are more sensitive to changes in passenger demand than the other 23 markets. This leads us to believe that airlines provide larger aircraft, and/or more flight frequency in these two markets for competitive reasons.

The remaining 18 markets have the total seat capacity with respect to passenger demand between zero and one. Within this range, the result estimates vary greatly from near zero to almost one. Interestingly, the exponent of passenger demand variable of Chicago-San Francisco is almost equal to one, suggesting that the relationship between the total nonstop seat capacity and passenger demand for this market are very close to linear. This result is consistent with the results obtained from Chapter 4 since these two parameters of this market grew at almost the identical rate based on the annual and overall percentage changes over nine years (see Tables 4.9 and 4.10). Note that the result estimate for the Miami-New York market is also very close to one, but it is insignificant due to the t-statistic value. Additionally, there is no sign of a difference between the total seat capacity elasticity of non-hub and hub-related markets since the ranges of the estimates between these two markets are nearly the same.

Three markets including the New York-San Francisco, Anchorage-Seattle, and Los Angeles-Washington, D.C markets, have acceptable R^2 and significant t-statistic values, meaning the seat capacity of these markets are demand-sensitive. However, the total seat capacity is not as demand-sensitive for most of the 25 analyzed markets based on low R^2 and insignificant t-statistic. Therefore, it is reasonable to conclude that the changes in passenger demand do not have much effect on the changes in total seat capacity.

5.4 Total Nonstop Seat Capacity-Nonstop Frequency Correlation

In the previous section, although the correlation between passenger demand and total seat capacity is somewhat weak, both aggregate and individual market analyses confirm that the demand grew slightly faster than total seat capacity over the nine year period, generating a likely increase in load factor in the top 25 markets. This section attempts to verify the trends of aircraft size by examining the correlation between nonstop frequency and total seat capacity. In general, the higher the flight frequency, the higher the seat capacity would be provided in the market. One expects the elasticity of the total seat capacity with respect to nonstop frequency to be positive. The analysis in Chapter 4 showed decreases in the average aircraft size over the nine-year period. For this matter, the calculated elasticity of total seat capacity with respect to nonstop frequency should be between zero and one. The greater-than-one value of elasticity estimates would mean that the average aircraft size is larger because the increases in total seat capacity are faster than the increases in nonstop frequency.

5.4.1 Aggregate Model

Adjusted R-Square	Intercept			Nonstop Frequency Variable		
	Coefficient	T-Stat	Significant?	Exponent	T-Stat	Significant?
0.80	307.06	57.09	Sig	**0.90**	43.07	Sig

Table 5.7: *Aggregate Total Nonstop Seat Capacity Elasticity with Respect to Nonstop Frequency*

The results can be interpreted that for each one percent change in aggregate nonstop frequency of the top 25 markets, the total seat capacity changes by 0.9 percent. As expected, the elasticity estimate of the seat capacity with respect to passenger demand is positive and less than one. This implies that nonstop frequency grew at a faster rate than seat capacity did over the nine-year period, and that airlines moved towards smaller aircraft. The correlation between total seat capacity and nonstop frequency is close to linear, slightly larger than the value of total seat capacity elasticity with respect to passenger demand. Based on the t-statistic value, nonstop frequency is statistically significant. The adjusted R^2 value of 0.80 indicates that the nonstop frequency parameter explains much of the variance in total seat capacity. Compared to the results of the total seat capacity-passenger demand correlation model, the adjusted R^2 value of this model is much higher, suggesting that the nonstop frequency variable does a better job of explaining the variance of the total seat capacity over the nine year period.

5.4.2 Individual Market Model

Rank	Market-Pair		Adjusted R^2	Fitting Level	Intercept (k) Coeff.	Intercept (k) T-Stat	Intercept (k) Signif?	Nonstop Frequency (a) Expont.	Nonstop Frequency (a) T-Stat	Nonstop Frequency (a) Signif?
1	Los Angeles	New York	0.74	Good	6.44E+03	20.30	Sig	**0.39**	4.89	Sig
2	New York	San Francisco	0.92	Good	1.51E+03	23.06	Sig	**0.62**	9.53	Sig
3	Miami	New York	0.68	Good	1.15E+03	8.17	Sig	**0.67**	4.23	Sig
4	New York	Orlando	0.80	Good	1.27E+03	12.57	Sig	**0.61**	5.76	Sig
5	New York	San Juan	0.63	Good	3.28E+02	4.89	Sig	**0.94**	3.84	Sig
6	Atlanta	New York	0.91	Good	3.61E+02	11.09	Sig	**0.87**	8.91	Sig
7	Los Angeles	Honolulu	0.84	Good	1.83E+02	6.26	Sig	**1.10**	6.48	Sig
8	Fort Lauderdale	New York	0.77	Good	1.92E+02	5.75	Sig	**0.97**	5.23	Sig
9	Chicago	Los Angeles	0.90	Good	1.53E+03	19.14	Sig	**0.62**	8.67	Sig
10	Los Angeles	Seattle	0.90	Good	1.85E+02	9.17	Sig	**0.95**	8.69	Sig
11	Chicago	San Francisco	0.60	Poor	2.01E+02	3.76	Sig	**1.00**	3.59	Sig
12	Dallas-Fort Worth	New York	0.59	Poor	4.68E+03	14.90	Sig	**0.38**	3.54	Sig
13	Las Vegas	New York	-	-	-	-	-	-	-	-
14	Chicago	Phoenix	0.34	Poor	1.37E+03	6.98	Sig	**0.52**	2.27	Sig
15	Boston	Chicago	0.85	Good	3.00E+03	25.38	Sig	**0.44**	6.77	Sig
16	New York	West Palm Beach	0.95	Good	1.16E+02	12.18	Sig	**1.05**	12.37	Sig
17	Chicago	Orlando	0.84	Good	3.21E+02	11.37	Sig	**0.83**	6.60	Sig
18	New York	Tampa	0.95	Good	2.70E+02	17.17	Sig	**0.87**	12.62	Sig
19	San Francisco	Honolulu	0.96	Good	4.47E+02	21.56	Sig	**0.91**	14.15	Sig
20	Anchorage	Seattle	0.99	Good	1.40E+02	23.97	Sig	**1.01**	25.56	Sig
21	Los Angeles	Washington	0.91	Good	3.89E+02	14.08	Sig	**0.86**	8.82	Sig
22	Chicago	Denver	0.44	Poor	6.70E+02	4.66	Sig	**0.75**	2.70	Sig
23	Chicago	Dallas-Fort Worth	0.79	Good	1.46E+03	14.23	Sig	**0.56**	5.53	Sig
24	Boston	San Francisco	0.95	Good	5.28E+02	31.72	Sig	**0.74**	12.13	Sig
25	San Francisco	Washington	0.89	Good	4.05E+01	5.51	Sig	**1.56**	7.98	Sig

***Table 5.8**: Elasticity Estimations of Total Nonstop Seat Capacity with Respect to Nonstop Frequency*

The total seat capacity elasticities with respect to nonstop frequency of these 25 markets vary from 0.38 to 1.56. The result estimates of the individual-market analysis agree with our *a priori* expectation and are consistent with the results obtained from the aggregate model (except a few markets that have elasticity greater than one). These result estimates confirm the fact that average aircraft size tends to become smaller over time because nonstop frequency increased at a faster rate than total seat capacity did. Note that the elasticity estimate of the Las Vegas-New York market cannot be obtained because nonstop frequency remains the same throughout nine years of the analysis (see Appendix A).

Most of the markets have elasticity estimates around the high end of zero-to-one range, indicating close to linear relationships. The Chicago-San Francisco and Anchorage-Seattle markets are the only two markets among these 25 markets that show a very close to linear relationship. In the previous section, the relationship between total seat capacity and passenger demand of the Chicago-San Francisco market is also very close to linear (elasticity estimate is 0.93). Because passenger demand, total seat capacity, and nonstop frequency increased in the same proportion, average aircraft size should remain unchanged. In fact, the average aircraft size associated with this market increased slightly based on the annual percentage changes of 1.39 percent (see Table 4.9). This contradiction in the results between the two analyses probably comes from errors of averaging eight different changes over nine years. On the other hand, the correlation between total seat capacity and passenger demand of the Anchorage-Seattle market is 0.43, much lower than Chicago-San Francisco. This implies that passenger demand of Anchorage-Seattle market grew much faster than the market's total seat capacity did, while the nonstop frequency and total seat capacity increased at about the same rate. Therefore, the trends in airline supply of this market are either higher load factor and stable average aircraft size, or stable load factor and slightly larger average aircraft size. It happens that the second scenario agrees with the results obtained from the analysis of Chapter 4 -- slight increases in average aircraft size (see Table 4.9).

The markets with the low-end elasticity (lower than 0.5) estimates include Los Angeles-New York, Dallas-New York, and Boston-Chicago markets. The reason why these three markets generate such low elasticity estimates is quite simple: the nonstop frequency growth rates are much larger than total nonstop seat capacity growth rates compared to the other markets. Notice that nonstop frequency of these three markets increased at the annual rate of 6.65%, 7.56%, and 8.47%, while their total seat capacity only increased at the annual rate of 2.74%, 3.74%, and 3.13%, respectively (see Tables 4.3 and 4.5).

The markets with a relative high elasticity estimate (greater than one) include the Los Angeles-Honolulu, New York-West Palm Beach, and San Francisco-Washington, D.C. markets. The elasticity estimates of these three markets are 1.10, 1.05, and 1.56, respectively. This indicates that average aircraft size provided for these city pairs tends to increase with nonstop frequency. The estimates of the first two markets disagree with the results of the analysis in Chapter 4. The annual and overall percentage changes of average aircraft size displayed decreasing trends in average aircraft size (see Tables 4.3, 4.4, 4.7, and 4.8). This is probably because the elasticity estimates are still very close to one, reflecting a linear relationship between the changes of total seat capacity and nonstop frequency. It is difficult to make any absolute conclusion regarding a direction of the trends in average aircraft size because the total seat capacity and nonstop frequency variables apparently change in the same proportion and direction. In this case, the annual and overall percentage changes of average aircraft size seem to be better sources of information. Nonetheless, the elasticity estimate of the San Francisco-Washington, D.C. market is consistent with the annual and overall percentage changes presented in Chapter 4. Therefore, it can be confirmed that average aircraft size of this market has increased over the nine-year period.

Unlike the correlation between total seat capacity and passenger demand, a link between these two parameters is very strong because the t-statistic values of the independent variable are significant for all 25 markets. Adjusted R^2 values of around 0.9 do indicate that nonstop frequency is an important factor in explaining the variance of total seat capacity of the top 25 markets. In others words, the total seat capacity is highly frequency sensitive, as one would expect.

5.5 Average Aircraft Size-Passenger Demand Correlation

Thus far, one could see that the correlation between total seat capacity and nonstop frequency is significant and the latter grew at a faster rate than the first parameter based on the elasticity estimates, which lead us to believe that smaller aircraft are more commonly used in recent years. The objective of this section is to confirm whether or not this finding of decreasing trends in aircraft size is true. If it were true, one would expect poor correlation between average aircraft size and passenger demand because the average aircraft size is likely to increase as passenger demand increases. If it were not the case, the opposite results would be expected. However, the result expectation leans towards the first scenario because of two reasons:

1. The analysis of percentage changes over the nine year period reported that average aircraft size has decreased for a majority of the 25 analyzed markets (see Chapter 4).
2. The correlation of total seat capacity and passenger demand is poor based on the regression results and, therefore, the correlation between demand and aircraft size should not be strong also, given that the average aircraft size is the ratio of total seat capacity to nonstop frequency.

Regardless of the model's significance, the calculated elasticity of average aircraft size with respect to nonstop frequency should be positive because the higher the passenger demand, the greater the average aircraft size should be.

5.5.1 Aggregate Model

	Intercept			Demand Variable		
R-Square	Coefficient	T-Stat	Significant?	Exponent	T-Stat	Significant?
0.15	141.63	13.36	Sig	**0.02**	0.84	Not Sig

***Table 5.9**: Aggregate Average Aircraft Size Elasticity with Respect to Passenger Demand*

The results can be interpreted that for each one percent change in aggregate passenger demand of the top 25 markets, average aircraft size changes by 0.02 percent. This implies that average aircraft size hardly changed as passenger demand grew. However, this elasticity estimate is not statistically significant due to the t-statistic test. The adjusted R^2 value of 0.15 indicates that passenger demand variable does not explain much of the variance in average aircraft size. The results agree with our *a priori* expectation in terms of direction and significance of the model. The results of this model are also similar to the results obtained from the total seat capacity-passenger demand correlation model in the sense that the changes in passenger demand do not have much effect on the changes in average aircraft size.

5.5.2 Individual Market Models

Rank	Market-Pair		Adjested R^2	Fitting Level	Intercept (k)			Passenger Demand (a)		
					Coeff.	T-Stat	Signif?	Expont.	T-Stat	Signif?
1	Los Angeles	New York	0.71	Good	4.98E+09	5.96	Sig	**-1.15**	-4.49	Sig
2	New York	San Francisco	0.44	Poor	1.51E+05	4.97	Sig	**-0.45**	-2.68	Sig
3	Miami	New York	-0.14	Poor	8.01E+01	0.69	Not Sig	**0.06**	0.13	Not Sig
4	New York	Orlando	0.25	Poor	1.10E+05	3.37	Sig	**-0.46**	-1.90	Not Sig
5	New York	San Juan	0.08	Poor	6.98E+00	0.71	Not Sig	**0.25**	1.30	Not Sig
6	Atlanta	New York	0.04	Poor	8.37E+02	4.93	Sig	**-0.11**	-1.15	Not Sig
7	Los Angeles	Honolulu	0.41	Poor	2.29E+03	9.68	Sig	**-0.15**	-2.55	Sig
8	Fort Lauderdale	New York	0.08	Poor	7.10E-01	-0.08	Not Sig	**0.38**	1.29	Not Sig
9	Chicago	Los Angeles	-0.03	Poor	1.31E+00	0.05	Not Sig	**0.36**	0.86	Not Sig
10	Los Angeles	Seattle	0.42	Poor	1.29E+03	8.50	Sig	**-0.16**	-2.59	Sig
11	Chicago	San Francisco	0.14	Poor	2.06E+00	0.24	Not Sig	**0.34**	1.51	Not Sig
12	Dallas-Fort Worth	New York	-0.14	Poor	8.29E+02	0.41	Not Sig	**-0.11**	-0.09	Not Sig
13	Las Vegas	New York	-0.12	Poor	5.70E+01	1.58	Not Sig	**0.10**	0.49	Not Sig
14	Chicago	Phoenix	0.36	Poor	1.78E+04	4.86	Sig	**-0.36**	-2.34	Sig
15	Boston	Chicago	0.84	Good	5.58E+10	8.28	Sig	**-1.46**	-6.52	Sig
16	New York	West Palm Beach	-0.13	Poor	2.20E+02	3.30	Sig	**-0.03**	-0.24	Not Sig
17	Chicago	Orlando	-0.02	Poor	1.23E+03	3.24	Sig	**-0.15**	-0.92	Not Sig
18	New York	Tampa	-0.14	Poor	1.04E+02	2.85	Sig	**0.02**	0.20	Not Sig
19	San Francisco	Honolulu	-0.05	Poor	6.09E+02	6.86	Sig	**-0.05**	-0.76	Not Sig
20	Anchorage	Seattle	-0.004	Poor	1.21E+02	21.69	Sig	**0.02**	0.98	Not Sig
21	Los Angeles	Washington	0.01	Poor	6.72E+02	5.83	Sig	**-0.09**	-1.04	Not Sig
22	Chicago	Denver	0.20	Poor	2.29E+01	2.60	Sig	**0.16**	1.74	Not Sig
23	Chicago	Dallas-Fort Worth	0.14	Poor	3.12E+03	4.08	Sig	**-0.23**	-1.53	Not Sig
24	Boston	San Francisco	0.55	Poor	2.71E+08	4.53	Sig	**-1.05**	-3.26	Sig
25	San Francisco	Washington	-0.06	Poor	1.38E+02	5.28	Sig	**0.05**	0.75	Not Sig

***Table 5.10**: Elasticity Estimations of Average Aircraft Size with Respect to Passenger Demand*

The average aircraft size elasticities with respect to passenger demand of these 25 markets vary from -1.46 to 0.38. The range of the estimates is considered to be narrow. Most of the result estimates of the individual-market analysis disagree with our *a priori* expectation because of negative estimates. Negative elasticity means that for a one percent increase in passenger demand of any particular market, average aircraft size of that market decreases by some percentage. Note that all of the statistically significant estimates are negative, while all of the positive estimates are insignificant. The explanation for a negative estimate is that average aircraft size of a particular market decreased, while passenger demand increased in the past nine years. This suggests that nonstop frequency increased in this time period.

Two markets, including Los Angeles-New York and Boston-Chicago, show good fitting regression (adjusted R^2 values are close to one) and significant elasticity. The results corresponding to these two markets can be interpreted that for each one percent increase in passenger demand, average aircraft size of that market decreased by 1.15 and 1.46 percent. These negative estimates are consistent in the sense that decreasing trends in average aircraft size of these two markets were observed from the percentage change analysis (see Table 4.3 and 4.4). However, they are meaningless in terms of conceptual intuition.

Similar to the correlation between total seat capacity and passenger demand, a link between these two parameters is weak due to insignificant t-statistic values of the independent variable and low adjusted R^2 values of the model. At this point, it is safe to conclude that changes in passenger demand do not create a strong impact in the way that airlines assign seat capacity and aircraft size.

5.6 Average Aircraft Size-Nonstop Frequency Correlation

The last potentially meaningful correlation is the correlation between average aircraft size and nonstop frequency. From the above correlation choices of analysis, decreasing trends of aircraft size used in the top 25 markets are revealed. Interestingly, the variable which heavily influences such trends is not passenger demand but, instead, flight frequency. Therefore, this section examines to what extent changes in nonstop frequency affect changes in average aircraft size. In general, the higher the flight frequency, the smaller the average aircraft size should be because the number of passengers boarding on each flight tend to be fewer as more flights are offered during a day. The result estimates are expected to be negative because these two parameters move in the opposite direction. In terms of magnitudes, range between zero and one is expected because not only is it theoretically easier for airlines to adjust the flight frequency over a wide range of value than it is to alter drastically the aircraft size, but also the aggregate percentage change analysis confirms that aggregate annual percentage changes of flight frequency (3.53% annually and 30.63% overall) are larger than the aggregate annual percentage changes of average aircraft size (-0.88% annually and –6.97% overall) of the total 25 markets (see Table 4.1).

5.6.1 Aggregate Model

Adjusted R-Square	Intercept			Nonstop Frequency Variable		
	Coefficient	T-Stat	Significant?	Exponent	T-Stat	Significant?
0.80	307.06	57.09	Sig	**-0.10**	-4.65	Sig

***Table 5.11**: Aggregate Average Aircraft Size Elasticity with Respect to Nonstop Frequency*

According to the results shown in Table 5.11, for each one percent increase in aggregate nonstop frequency of the top 25 markets, the average aircraft size of the top 25 markets decreases by 0.1 percent. As expected, the elasticity estimate of this model is negative in terms of direction and between zero and negative one in terms of magnitude. This implies that nonstop frequency grew, while average aircraft size decreased over the nine-year period. Based on the t-statistic value, the estimate is statistically significant. The adjusted R^2 value of 0.80 indicates that the nonstop frequency parameter explains much of the variance in average aircraft size. Compared to the results of the average aircraft size-passenger demand correlation model, the adjusted R^2 value of this model is much higher, suggesting that the nonstop frequency variable does a better job of explaining the variance of the average aircraft size over the nine year period.

5.6.2 *Individual Market Models*

Rank	Market-Pair		Adjested R^2	Fitting Level	Intercept (K)			Nonstop Frequency (a)		
					Coeff	T-Stat	Signif?	Expont	T-Stat	Signif?
1	Los Angeles	New York	0.87	Good	6443.38	20.30	Sig	**-0.61**	-7.50	Sig
2	New York	San Francisco	0.80	Good	1511.82	23.06	Sig	**-0.38**	-5.77	Sig
3	Miami	New York	0.30	Poor	1148.86	8.17	Sig	**-0.33**	-2.11	Sig
4	New York	Orlando	0.61	Good	1265.99	12.57	Sig	**-0.39**	-3.66	Sig
5	New York	San Juan	-0.13	Poor	327.98	4.89	Sig	**-0.06**	-0.24	Not Sig
6	Atlanta	New York	0.10	Poor	360.62	11.09	Sig	**-0.13**	-1.38	Not Sig
7	Los Angeles	Honolulu	-0.09	Poor	183.27	6.26	Sig	**0.10**	0.58	Not Sig
8	Fort Lauderadale	New York	-0.14	Poor	192.42	5.75	Sig	**-0.03**	-0.15	Not Sig
9	Chicago	Los Angeles	0.78	Good	1530.89	19.14	Sig	**-0.38**	-5.37	Sig
10	Los Angeles	Seattle	-0.11	Poor	184.66	9.17	Sig	**-0.05**	-0.42	Not Sig
11	Chicago	San Francisco	-0.14	Poor	200.94	3.76	Sig	**0.003**	0.01	Not Sig
12	Dallas-Fort Worth	New York	0.80	Good	4679.74	14.90	Sig	**-0.62**	-5.75	Sig
13	Las Vegas	New York	-	-	-	-	-	-	-	-
14	Chicago	Phoenix	0.29	Poor	1373.05	6.98	Sig	**-0.48**	-2.08	Sig
15	Boston	Chicago	0.90	Good	3001.09	25.38	Sig	**-0.56**	-8.72	Sig
16	New York	West Palm Beach	-0.08	Poor	116.32	12.18	Sig	**0.05**	0.62	Not Sig
17	Chicago	Orlando	0.09	Poor	320.87	11.37	Sig	**-0.17**	-1.33	Not Sig
18	New York	Tampa	0.25	Poor	270.17	17.17	Sig	**-0.13**	-1.92	Not Sig
19	San Francisco	Honolulu	0.12	Poor	447.48	21.56	Sig	**-0.09**	-1.43	Not Sig
20	Anchorage	Seattle	-0.12	Poor	139.61	23.97	Sig	**0.01**	0.35	Not Sig
21	Los Angeles	Washigton	0.12	Poor	389.30	14.08	Sig	**-0.14**	-1.45	Not Sig
22	Chicago	Denver	-0.02	Poor	669.85	4.66	Sig	**-0.25**	-0.91	Not Sig
23	Chicago	Dallas-Fort Worth	0.70	Good	1463.96	14.23	Sig	**-0.44**	-4.39	Sig
24	Boston	San Francisco	0.68	Good	527.82	31.72	Sig	**-0.26**	-4.21	Sig
25	San Francisco	Washigton	0.48	Poor	40.49	5.51	Sig	**0.56**	2.87	Sig

Table 5.12: *Elasticity Estimations of Average Aircraft Size with Respect to Nonstop Frequency*

The average aircraft size elasticities with respect to nonstop frequency of these 25 markets vary from -0.62 to 0.56. The range of these estimates is 1.18 (|-0.62|+0.56), considered to be narrow. The result estimates of the individual-market analysis agree with our *a priori* expectation in terms of both direction and magnitude. However, only 11 markets have elasticity estimates with a significant t-statistic value. The Dallas-New York market is the one that has the highest negative elasticity among these 11 markets. It is logical because this city-pair market involves hub operations (at Dallas/Fort Worth). In general, flight frequency increase substantially when airline(s) build(s) their hub at a particular airport, and as a consequence, aircraft size decreases because fewer passengers are carried in each flight. Notice that other hub-related markets with a statistically significant elasticity estimate, including the Chicago-Los Angeles, Chicago-Phoenix, Boston-Chicago, and Chicago-Dallas markets, also hold high negative elasticity estimates (close to –0.62 rather than to zero). In addition, the elasticity estimate of the Las Vegas-New York market cannot be obtained because nonstop frequency was constant throughout nine years of the analysis (see Appendix A).

Five markets have positive elasticities which contradict the expectation. These markets include Los Angeles-Honolulu, Chicago-San Francisco, New York-West Palm Beach, Anchorage-Seattle, and San Francisco-Washington, D.C. Among these five markets, only the elasticity of the San Francisco-Washington, D.C. market is statistically significant. The estimate is positive because average aircraft size increased by 0.93 percent annually and 4.71 percent overall of the nine-year period (see Tables 4.9 and 4.10). Because Table 5.10 showed that the elasticity of aircraft size with respect to passenger demand of the San Francisco-Washington, D.C. market is not significant, the conclusion is now more apparent that changes in aircraft size used in this market are sensitive to changes in flight frequency.

There are 11 markets in which neither passenger demand nor flight frequency is a good independent variable in explaining the variance of average aircraft size of these markets based on the insignificant t-statistic value of the estimates. These markets are listed as following:

Rank	Market-Pair	
5	New York	San Juan
6	Atlanta	New York
8	Fort Lauderdale	New York
11	Chicago	San Francisco
16	New York	West Palm Beach
17	Chicago	Orlando
18	New York	Tampa
19	San Francisco	Honolulu
20	Anchorage	Seattle
21	Los Angeles	Washigton
22	Chicago	Denver

***Table 5.13**: List of Markets with No Correlation to Demand and Frequency*

One observes that these markets involve New York, Chicago, and Los Angeles. The major airport of these three cities, including JFK, ORD, and LAX are ranked among the top 10 most congested airports in the world. Therefore, the other potential independent variables, which may have a strong correlation with the average aircraft size variable of these markets, include congestion level of airports of these city-pair markets.[3]

The other 14 markets are divided into three cases: (1) only demand sensitive, (2) only frequency sensitive, and (3) both demand and frequency sensitive. Only two of these 14 markets, including Los Angeles-Honolulu and Los Angeles-Seattle are demand sensitive only. Notice that these two markets involve Los Angeles International Airport (LAX), a highly congested airport. It is possible that frequency variable is not a significant factor for the changes in aircraft size because airlines are already forced by airport authority to limit the number of flights offered each day, or a particular departing time window is reserved for more beneficial markets. Therefore, changes in aircraft size strongly relate to changes in passenger demand instead.

Seven of the 14 markets are only frequency sensitive. These markets are listed as following:

[3] Congested airports may force an airline to use bigger aircraft in order to carry more passengers per flight, while airlines are allowed to offer high flight frequency in uncongested airports

Rank	Market-Pair	
3	Miami	New York
4	New York	Orlando
9	Chicago	Los Angeles
12	Dallas-Fort Worth	New York
13	Las Vegas	New York
23	Chicago	Dallas-Fort Worth
25	San Francisco	Washington

Table 5.14: *List of Frequency-Sensitive Markets*

Possible reasons why changes in aircraft size of these markets correlated only with changes in frequency are because competitiveness between airlines in these markets is extremely intense. Therefore, each airline attempts to gain market share by increasing flight frequency in order to attract more passengers. Finally, the remaining five markets are both demand and frequency sensitive. These markets are listed as following:

Rank	Market-Pair	
1	Los Angeles	New York
2	New York	San Francisco
14	Chicago	Phoenix
15	Boston	Chicago
24	Boston	San Francisco

Table 5.15: *List of Demand-and-Frequency-Sensitive Markets*

In terms of the model's fitting quality, only seven markets hold high R^2 values (see Table 5.12). Most of the 25 markets hold low adjusted R^2 values. This indicates that that nonstop frequency does not explain much of the variance in average aircraft size for most of the top 25 markets.

5.7 Conclusion

This chapter has presented the correlation between passenger demand and airline supply, and the correlation among airline supply variables of the top 25 U.S. long-haul domestic markets. The analysis focused on five meaningful correlations, which included the correlation between:

1. passenger demand and airfare
2. total seat capacity and passenger demand
3. total seat capacity and nonstop frequency
4. average aircraft size and passenger demand, and
5. average aircraft size and nonstop frequency

The time period of analysis is between 1987 and 1995. Similar to Chapter 4, each correlation was divided into two sections, aggregate and individual markets. The primary objective was to estimate elasticity of the dependent variable with respect to the corresponding independent variable and decide whether or not the correlation between these two variables is significant based on the t-statistic and R^2 values.

Passenger Demand-Airfare Correlation: Two different methods are used for estimating the price elasticity with respect to passenger demand of these 25 markets. The first one is the Midpoint direct calculation method. The second one is the Non-Linear Regression (NLR) method. The elasticity estimates obtained from both methods differ in magnitude at the aggregate level, but are acceptably consistent with each other at the individual market level. Based on the individual-market analysis, the airfare elasticity with respect to passenger demand of 25 markets ranges from –0.54 to –3.22, with the average value of –1.48. In the aggregate analysis, the results obtained from the Midpoint method is –1.39, which is very close to the average estimate of 25 individual markets. On the other hand, the results obtained from the NLR method is -0.35, which is near the low end of the range of the individual-market analysis. For both aggregate and individual markets, the R^2 value of the regression model showed a poor fitting. The differences in the results and poorly fitting quality of given data make it difficult to conclude the accurate airfare elasticity for these top 25 markets. A possible reason behind these poor quality results may involve the fact that changes in passenger demand do not depend upon changes in airfares only. The other inherent variables may include flight frequency, service quality, per capita income, and population.

Total Nonstop Seat Capacity-Passenger Demand: The total seat capacity elasticity with respect to passenger demand of the 25 markets ranges from 0.39 to 2.37. Most of these 25 markets have positive elasticity, which agrees with our a priori expectation. Note that only five markets have the counterintuitive results (negative elasticity) because the total seat capacity of these markets apparently decreased as passenger demand increased, while both variables should be increasing simultaneously. The elasticity estimates of 12 markets are statistically significant. The elasticity estimate obtained from the aggregate analysis is equal to 0.82 and statistically significant. However, the fitting quality of this model is poor.

Total Nonstop Seat Capacity-Nonstop Frequency: The total seat capacity elasticity with respect to nonstop frequency of the 25 markets ranges from 0.38 to 1.56. The elasticity estimates of all 25 markets are statistically significant and agree with our a priori expectation. The elasticity estimate obtained from the aggregate analysis is equal to 0.9 and also statistically significant. The fitting quality of this model is extremely good.

Average Aircraft Size-Passenger Demand: The average aircraft size elasticity with respect to passenger demand of the 25 markets ranges from -1.46 to -0.15. Most of the estimates are counterintuitive since they are negatives (the positive elasticity is expected because the greater the passenger demand, the higher the aircraft size should be). The elasticity estimates of 12 markets are not statistically significant and the R^2 values suggest that the fitting quality of this model is poor. The elasticity estimate obtained from the aggregate analysis is equal to 0.02 and not statistically significant. The R^2 value of the aggregate analysis is equal to 0.15, indicating the same result as the individual market analysis.

Average Aircraft Size--Nonstop Frequency: The average aircraft size elasticity with respect to nonstop frequency of 25 markets ranges from -0.62 to 0.56. The elasticity estimates of 12 markets are statistically significant, while the estimates of the other 13 markets are not. The elasticity estimate obtained from the aggregate analysis is equal to –0.1 and also statistically significant. The fitting quality of this model is good overall.

According to the results obtained from all correlation models, one could see that the relationships between the airline supply variables (including total seat capacity and average aircraft size) and passenger demand are somewhat weak. Therefore, changes in demand are not significant to the changes in airlines' seat inventory. In contrast, links between total seat capacity and nonstop frequency, and between average aircraft size and nonstop frequency are very strong. Both models suggest that airlines prefer to use small aircraft rather than large aircraft for these top 25 markets. The changes in average aircraft size of the nonstop flights of these 25 markets mostly depend on how the nonstop frequency changes.

Chapter 6: Conclusions

6.1 Introduction

Airline deregulation has brought several positive impacts to both users and providers in the U.S. air transport industry. Since 1978, the number of air travelers has increased significantly. One reason for such an increase is the fact that competition between airlines increased substantially in the deregulation era. For airlines to survive as well as to be profitable, they have to compete heavily in fares and services (i.e., flight frequency, network configurations and quality). Therefore, airfares are lower and more flights in many origin/destination markets are available.

This thesis has attempted to measure the changes in passenger demand and airline supplies including airfare, flight frequency, total seat capacity, and average aircraft size, as well as determine the correlations between these parameters. The thesis has concentrated on the top 25 longhaul U.S. domestic markets over the time period between 1987 and 1995. The changes in passenger demand and airline supplies were presented in the annual and overall (difference between the first and last years of the selected time period) percentage differences. The correlations between these parameters were obtained by developing non-linear regression models. It is important to note that the choice between a linear and a non-linear form properly revolves around the question of which underlying behavior one really wants to model. The first section of this chapter summarizes the results of the percentage change analysis. The second section summarizes the results of the correlations between the analyzed parameters. Finally, the third section provides directions for further research studies.

6.2 *Summary of Percentage Change Analysis*

Among the top 25 U.S. domestic O&D markets, five different types of trends in passenger demand and airline supply are revealed. The first type involves the set of markets with increasing passenger demand, nonstop frequency, and weekly seat capacity, but decreasing average aircraft size. The majority of the top 25 markets (13 markets) belong to this type. Interestingly, nonstop frequency increased at a faster rate than did passenger demand and weekly seat capacity over the nine-year period. The high frequency flight schedule distributes origin/destination passengers among more flights. Therefore, airlines allocate smaller aircraft when they increase their flight frequency. This strategy has two advantages. First, total operating costs associated with small aircraft are typically less expensive than with large aircraft. Second, travelers are attracted to an airline with higher flight frequency because they have more options on flight times that would fit best with their personal schedules.

The second trend type involves the set of decreasing-demand markets with increases in weekly seat capacity and flight frequency, and decreases in average aircraft size. Only two markets belong to this type. Note that passenger demand of these markets decreased very slightly. However, the trends are counterintuitive because it is unlikely for airlines to provide the larger number of seats and flights for less passenger demand. The markets involve hub operations since more flights are flown into and out of the hub-related airport. Therefore, flight frequency and weekly seat capacity increased, while passenger demand remained almost unchanged. For the same reason given in the previous case, increases in flight frequency would decrease aircraft size.

The third type involves the set of markets with increasing demand, while their flight frequency, weekly seat capacity, and average aircraft size decreased over the nine-year period. The results led us to believe that the average load factor of the flights that served these markets is higher because passenger demand grew at a faster rate than both flight frequency and weekly seat capacity.

The fourth type involves the set of markets with passenger demand, nonstop frequency, weekly nonstop seat capacity, and average aircraft size increasing over the nine-year period. For this trend type, the number of passengers increased substantially over the nine-year period. Because of this significant growth of passenger demand, increasing seat capacity solely by providing more flights is not enough. Airlines must allocate a larger aircraft size. In addition, passenger demand grew at a much faster rate than nonstop frequency and weekly seat capacity did. Therefore, higher load factors on the flights serving these markets is expected.

The fifth type is a special case and does not fit in any of the above categories. One of the two markets is the Fort Lauderdale-New York market. Both demand and airline supplies, including flight frequency, weekly seat capacity, and average aircraft size of this market decreased over time. In this case, the market's rank will likely fall in the near future. The other market is the Chicago-Denver market. The special characteristic of this market is that airlines allocated bigger aircraft size and provided less nonstop frequency and weekly seat capacity for larger passenger demand.

In terms of airfares, the results showed that airfares of 15 of the top 25 markets decreased over the nine-year period. However, airfares tended to increase for the markets associated with hub airports. This is because the dominant airline has greater power to increase the fare levels.

Overall, passenger demand and nonstop frequency increased at a very high rate compared to the changes of the other variables. The total weekly seat capacity also increased but at a much slower rate than demand and frequency did over the nine-year period. Note that the trends in total weekly seat capacity of all 25 markets were not very stable in the first six years of the analysis, but were increasing smooth afterwards. The average aircraft size decreased by approximately 15 seats per departure since 1987. Airfares of all 25 markets increased in the first three years of the analysis (1987- 1989) but continued to decrease by a few dollars every year since 1989.

6.3 Summary of Correlation Analysis

The non-linear regression models were developed in order to verify the relationships between passenger demand and airline supply, and between airline supply measures. The first model examines the relationship between passenger demand and airfare. This model was developed to study the responses of travelers when airlines change their ticket price. The results showed that the price level of an airline ticket is significant to how demand changes. The range of calculated elasticity is between –1.0 and –2.0 for most of the top 25 markets. Indeed, there are a few markets whose demand is extremely price-sensitive (elasticity less than –2.0) and price-insensitive (elasticity greater than –1.0 and very close to zero). The markets with extremely price-sensitive demand include vacation destinations such as Orlando and Las Vegas, while the markets with extremely price-insensitive demand include business markets. This is logical because leisure travelers are sensitive to price, while business travelers are not.

The second model examines the relationship between total seat capacity and passenger demand. This model was developed to verify to what extent airlines adjust their total seat capacity when demand increases. It also indicates how the average aircraft size of the top 25 markets changes in the nine-year period. Surprisingly, the results did not show strong correlation between these two variables. The calculated elasticities of most markets are not significant and the model fitting is very poor. Therefore, no solid conclusion can be made from this model.

The third model examines the relationship between total seat capacity and nonstop frequency. Because the correlation between total seat capacity and passenger demand is weak, it was hoped that the correlation between these two parameters would be strong. The results showed that our *a priori* intuition was correct. The calculated elasticities are significant for every of the 25 markets. This model has a much better fit than the second model. The range of calculated elasticity is between zero and one for most of the top 25 markets. This implies that nonstop frequency grew at a faster rate than total seat capacity did over the nine-year period. Therefore, it is reasonable to conclude that average aircraft size decreased over time.

The fourth model examines the relationship between average aircraft size and passenger demand. This model was developed to find how airlines allocate size of aircraft in response to the growth of air travel demand. The results are somewhat similar to the second model. The calculated elasticities of most markets are not significant and the model fitting is also very poor. Therefore, total passenger demand is not a significant variable for the changes in aircraft size.

The last model examines the relationship between average aircraft size and nonstop frequency. The model is well correlated and the calculated elasticities are significant for most of the 25 markets. The results showed that the majority of elasticity estimates stay within the range of 0.0 and –0.5, indicating smaller aircraft are allocated when airlines' flight frequency increases. Therefore, nonstop frequency is a significant variable for the changes in aircraft size.

In general, the following phenomena were acknowledged from these five correlation models:

1. Passenger demand of the top 25 markets is considered to be price-elastic, especially of the vacation city-pair markets. On the contrary, passenger demand of the hub-related markets is not very sensitive to the changes in airfares.
2. Changes in passenger demand do not strongly relate to how airlines allocate seat capacity and aircraft size. However, flight frequency is the main factor that drives the way airlines manage their seat capacity.
3. Airlines have increased the flight frequency significantly in recent years of deregulation. The flight frequency grew even faster than passenger demand did from 1987 to 1995. In response to high frequency schedule, utilization of smaller aircraft increased. Therefore, it is possible that a large aircraft, such as 747, will vanish from the longhaul U.S. domestic markets in the future.

6.4 Directions for Further Studies

This thesis has studied the trends in passenger demand and airline supplies for the long-haul U.S. domestic market only. As one direction of further inquiry, the study could be extended to short-haul, medium-haul, and international markets. The comparison between these types (by distance) of a market could also be a valuable study. Second, although this thesis showed that the average aircraft size of the top 25 longhaul U.S. domestic has declined over time, it did not specify the manufacturing types of aircraft being used by commercial airlines. The thesis could be expanded to include the type of aircraft in order to understand how airlines have composed their fleet in the deregulated years. Third, it is reasonable to state the rapid growth in passenger demand and flight frequency will eventually outstrip existing airports and air traffic control systems. In fact, most of the major U.S. airports have already faced severe congestion problems, especially during the peak period (usually around late afternoon). For that matter, it would be of value to study the sensitivity of congestion in major U.S. airports with respect to the increases in passenger demand and flight frequency. However, measuring a congestion level in quantitative terms could be difficult to achieve since the characteristic of one airport may be entirely different from the others' in terms of design, public policy, weather conditions, and location. Researchers must impose some standard criteria so that congestion levels of different airports are measured under the same quantitative basis. The thesis and suggested thesis extensions could be of value to airlines, aircraft manufacturers, and airport planners in detailing the ways that aircraft be properly designed to match the futures needs of airlines; how to mitigate congestion problems, perhaps by controlling airlines' flight frequency; and proposing that expansions of current airports and/or constructions of new airports be well-planned to accommodate rapid growth of air transport demand and supplies.

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Appendix A: ***Data of Passenger Demand and Airline Supply from 1987 to 1995***

Market Rank # 1: Los Angeles - New York

Year	Passenger Demand			CPI Adjusted Airfare			Weekly Nonstop Freq. (August)			Weekly Seat Capacity (August)			Average Aircraft Size		
	LAX-EWR	LAX-JFK	Total	LAX-EWR	LAX-JFK	W.Average	LAX-EWR	LAX-JFK	Total	LAX-EWR	LAX-JFK	Total	LAX-EWR	LAX-JFK	Total
1987	901,090	1,092,530	1,993,620	$196.02	$271.27	$237.26	49	123	172	15,050	35,155	50,205	307	286	292
1988	837,240	1,175,540	2,012,780	$202.70	$299.72	$259.36	49	142	191	13,560	38,550	52,110	277	271	273
1989	770,930	1,435,690	2,206,620	$252.22	$299.27	$282.83	56	131	187	14,812	35,664	50,476	265	272	270
1990	845,750	1,397,970	2,243,720	$251.72	$299.85	$281.71	84	131	215	19,433	34,715	54,148	231	265	252
1991	892,170	1,399,810	2,291,980	$233.11	$256.62	$247.47	84	131	215	18,821	36,293	55,114	224	277	256
1992	830,980	1,478,240	2,309,220	$205.64	$245.10	$230.90	70	158	228	15,141	37,614	52,755	216	238	231
1993	786,620	1,364,290	2,150,910	$243.18	$276.21	$264.13	70	140	210	15,141	35,967	51,108	216	257	243
1994	822,000	1,459,540	2,281,540	$227.15	$246.21	$239.34	77	143	220	16,758	35,657	52,415	218	249	238
1995	789,890	1,656,010	2,445,900	$217.17	$222.72	$220.93	89	189	278	17,216	44,135	61,351	193	234	221

Market Rank # 2: New York - San Francisco

Year	Passenger Demand			CPI Adjusted Airfare			Weekly Nonstop Freq. (August)			Weekly Seat Capacity (August)			Average Aircraft Size		
	EWR-SFO	JFK-SFO	Total	EWR-SFO	JFK-SFO	W.Average	EWR-SFO	JFK-SFO	Total	EWR-SFO	JFK-SFO	Total	EWR-SFO	JFK-SFO	Total
1987	590,210	571,070	1,161,280	$231.79	$310.89	$270.68	28	76	104	7,413	19,775	27,188	265	260	261
1988	590,720	553,650	1,144,370	$228.10	$341.83	$283.12	34	69	103	8,390	18,200	26,590	247	264	258
1989	571,310	836,560	1,407,870	$287.71	$316.75	$304.97	35	76	111	8,680	19,306	27,986	248	254	252
1990	574,460	830,270	1,404,730	$284.85	$310.49	$300.01	35	83	118	8,764	22,957	31,721	250	277	269
1991	605,910	864,440	1,470,350	$267.55	$270.81	$269.46	35	83	118	8,141	21,571	29,712	233	260	252
1992	609,390	882,360	1,491,750	$244.83	$256.43	$251.69	35	97	132	8,332	22,712	31,044	238	234	235
1993	599,950	837,170	1,437,120	$280.07	$313.03	$299.27	42	105	147	9,686	22,637	32,323	231	216	220
1994	664,280	906,940	1,571,220	$267.25	$285.15	$277.58	56	115	171	12,306	25,959	38,265	220	226	224
1995	675,010	1,011,560	1,686,570	$255.41	$259.80	$258.04	56	114	170	10,570	26,211	36,781	189	230	216

Market Rank # 3: Miami - New York

Year	Passenger Demand				CPI Adjusted Airfare				Weekly Nonstop Freq. (August)				Weekly Seat Capacity (August)			
	MIA-EWR	MIA-JFK	MIA-LGA	Total	MIA-EWR	MIA-JFK	MIA-LGA	W.Average	MIA-EWR	MIA-JFK	MIA-LGA	Total	MIA-EWR	MIA-JFK	MIA-LGA	Total
1987	450,840	440,920	749,910	1,641,670	$139.91	$147.21	$158.36	$150.30	28	46	55	129	7,994	9,647	13,292	30,933
1988	491,330	488,540	830,680	1,810,550	$153.91	$153.05	$161.89	$157.34	49	84	126	259	9,926	17,609	30,751	58,286
1989	428,700	362,220	838,960	1,629,880	$161.80	$161.46	$161.44	$161.54	63	56	104	223	8,405	11,448	18,091	37,944
1990	552,750	333,290	1,042,450	1,928,490	$133.04	$127.31	$135.31	$133.28	63	97	97	257	9,297	18,243	18,442	45,982
1991	500,920	379,290	672,710	1,552,920	$150.97	$146.23	$166.88	$156.71	78	79	91	248	11,596	18,972	14,417	44,985
1992	485,700	398,480	679,080	1,563,260	$155.97	$147.20	$172.60	$160.96	57	80	90	227	8,454	15,947	13,723	38,124
1993	451,880	540,450	641,870	1,634,200	$152.09	$135.75	$178.64	$157.12	70	90	107	267	12,160	18,216	15,984	46,360
1994	602,950	653,880	674,260	1,931,090	$118.11	$113.00	$141.47	$124.53	70	108	105	283	12,502	21,401	15,585	49,488
1995	602,310	934,160	556,990	2,093,460	$122.64	$107.12	$151.71	$123.45	71	100	100	271	12,729	22,614	14,886	50,229

	Average Aircraft Size			
Year	MIA-EWR	MIA-JFK	MIA-LGA	Total
1987	286	210	242	240
1988	203	210	244	225
1989	133	204	174	170
1990	148	188	190	179
1991	149	240	158	181
1992	148	199	152	168
1993	174	202	149	174
1994	179	198	148	175
1995	179	226	149	185

Market Rank # 4: New York - Orlando

	Passenger Demand				CPI Adjusted Airfare				Weekly Nonstop Freq. (August)				Weekly Seat Capacity (August)			
Year	EWR-MCO	JFK-MCO	LGA-MCO	Total	EWR-MCO	JFK-MCO	LGA-MCO	W.Average	EWR-MCO	JFK-MCO	LGA-MCO	Total	EWR-MCO	JFK-MCO	LGA-MCO	Total
1987	637,560	301,160	462,040	1,400,760	$136.45	$135.76	$138.81	$137.08	56	35	42	133	10,339	7,511	7,196	25,046
1988	681,220	304,280	591,290	1,576,790	$135.19	$133.81	$134.83	$134.79	77	56	63	196	11,921	9,261	11,417	32,599
1989	643,290	230,570	658,220	1,532,080	$137.40	$145.47	$141.66	$140.45	98	42	70	210	13,797	6,314	10,808	30,919
1990	795,560	227,450	902,040	1,925,050	$119.56	$116.08	$122.11	$120.34	90	56	89	235	13,514	8,113	14,809	36,436
1991	704,390	254,050	657,250	1,615,690	$142.99	$129.19	$149.90	$143.63	70	63	69	202	13,223	11,060	11,061	35,344
1992	789,900	194,690	714,710	1,699,300	$140.75	$142.43	$146.94	$143.54	119	35	105	259	15,921	6,832	15,105	37,858
1993	968,020	167,180	723,880	1,859,080	$116.67	$129.40	$137.68	$126.00	106	32	112	250	15,089	4,521	15,938	35,548
1994	970,980	313,190	702,830	1,987,000	$108.32	$111.31	$119.74	$112.83	86	66	83	235	16,799	9,394	11,547	37,740
1995	940,380	316,600	661,170	1,918,150	$118.73	$120.28	$127.29	$121.93	102	46	61	209	15,761	6,740	8,113	30,614

	Average Aircraft Size			
Year	EWR-MCO	JFK-MCO	LGA-MCO	Total
1987	185	215	171	188
1988	155	165	181	166
1989	141	150	154	147
1990	150	145	166	155
1991	189	176	160	175
1992	134	195	144	146
1993	142	141	142	142
1994	195	142	139	161
1995	155	147	133	146

Market Rank # 5: New York - San Juan

Year	Passenger Demand			CPI Adjusted Airfare			Weekly Nonstop Freq. (August)			Weekly Seat Capacity (August)			Average Aircraft Size		
	EWR-SJU	JFK-SJU	Total	EWR-SJU	JFK-SJU	W.Average	EWR-SJU	JFK-SJU	Total	EWR-SJU	JFK-SJU	Total	EWR-SJU	JFK-SJU	Total
1987	381,180	1,083,450	1,464,630	$153.54	$152.38	$152.68	32	91	123	6,340	24,472	30,812	198	269	251
1988	391,570	1,121,620	1,513,190	$189.67	$184.01	$185.47	35	98	133	8,162	26,467	34,629	233	270	260
1989	307,680	1,006,600	1,314,280	$196.56	$179.35	$183.38	28	98	126	6,503	23,996	30,499	232	245	242
1990	348,330	1,072,620	1,420,950	$191.74	$180.07	$182.93	32	84	116	7,019	22,008	29,027	219	262	250
1991	289,450	1,032,470	1,321,920	$196.01	$176.32	$180.63	28	105	133	5,999	27,594	33,593	214	263	253
1992	281,550	1,002,320	1,283,870	$188.49	$172.07	$175.67	35	93	128	5,558	23,839	29,397	159	256	230
1993	359,060	930,430	1,289,490	$168.31	$163.24	$164.65	38	79	117	7,338	21,165	28,503	193	268	244
1994	360,190	1,019,610	1,379,800	$156.53	$145.66	$148.50	35	85	120	6,923	23,438	30,361	198	276	253
1995	475,760	1,037,540	1,513,300	$137.76	$133.20	$134.63	56	80	136	10,073	22,272	32,345	180	278	238

Market Rank # 6: Atlanta - New York

Year	Passenger Demand				CPI Adjusted Airfare				Weekly Nonstop Freq. (August)				Weekly Seat Capacity (August)			
	ATL-EWR	ATL-JFK	ATL-LGA	Total	ATL-EWR	ATL-JFK	ATL-LGA	W.Average	ATL-EWR	ATL-JFK	ATL-LGA	Total	ATL-EWR	ATL-JFK	ATL-LGA	Total
1987	486,890	56,540	618,870	1,162,300	$178.57	$154.51	$194.37	$185.81	97	21	124	242	19,087	3,052	21,540	43,679
1988	495,040	100,230	650,660	1,245,930	$246.76	$163.52	$238.62	$235.81	91	21	112	224	16,241	3,171	18,871	38,283
1989	487,190	50,180	641,340	1,178,710	$236.04	$179.92	$235.29	$233.25	104	14	111	229	17,111	2,114	21,177	40,402
1990	529,980	41,300	712,410	1,283,690	$218.84	$163.02	$226.92	$221.53	104	14	126	244	17,982	2,051	23,226	43,259
1991	494,720	61,330	620,260	1,176,310	$227.27	$157.84	$229.48	$224.82	82	14	96	192	11,748	2,051	18,064	31,863
1992	609,140	152,120	528,610	1,289,870	$192.98	$152.26	$233.11	$204.62	86	46	63	195	13,376	7,653	14,385	35,414
1993	879,840	142,770	503,290	1,525,900	$138.22	$147.69	$229.42	$169.19	124	62	63	249	20,058	9,672	13,570	43,300
1994	1,069,190	124,740	545,270	1,739,200	$115.64	$130.58	$188.74	$139.63	124	49	80	253	20,870	8,139	15,059	44,068
1995	1,056,740	111,000	486,730	1,654,470	$138.43	$145.02	$228.13	$165.26	170	40	106	316	25,904	7,172	16,966	50,042

Year	Average Aircraft Size			
	ATL-EWR	ATL-JFK	ATL-LGA	Total
1987	197	145	174	180
1988	178	151	168	171
1989	165	151	191	176
1990	173	147	184	177
1991	143	147	188	166
1992	156	166	228	182
1993	162	156	215	174
1994	168	166	188	174
1995	152	179	160	158

Market Rank # 7: Los Angeles - Honolulu

	LAX-HNL				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	873,580	$174.25	134	42,071	314
1988	1,314,130	$160.00	141	42,057	298
1989	1,089,560	$166.39	142	40,826	288
1990	1,146,810	$156.32	148	45,149	305
1991	1,047,740	$184.23	147	44,469	303
1992	982,150	$178.92	124	37,137	299
1993	1,171,260	$162.77	127	38,342	302
1994	1,307,990	$155.27	132	37,746	286
1995	1,381,210	$149.59	125	35,951	288

Market Rank # 8: Fort Lauderdale - New York

	Passenger Demand				CPI Adjusted Airfare				Weekly Nonstop Freq. (August)				Weekly Seat Capacity (August)			
Year	FLL-EWR	FLL-JFK	FLL-LGA	Total	FLL-EWR	FLL-JFK	FLL-LGA	W.Average	FLL-EWR	FLL-JFK	FLL-LGA	Total	FLL-EWR	FLL-JFK	FLL-LGA	Total
1987	636,370	445,620	752,910	1,834,900	$147.39	$145.54	$154.44	$149.83	47	28	62	137	8,536	6,258	11,738	26,532
1988	651,870	383,360	810,790	1,846,020	$149.65	$146.72	$157.35	$152.42	61	21	56	138	9,956	3,857	9,485	23,298
1989	576,490	282,720	780,660	1,639,870	$157.91	$157.09	$169.63	$163.35	49	21	35	105	7,620	3,619	7,000	18,239
1990	666,020	352,650	991,220	2,009,890	$130.09	$121.91	$133.61	$130.39	50	42	77	169	7,696	6,720	13,944	28,360
1991	568,850	341,120	697,470	1,607,440	$149.67	$142.08	$162.18	$153.49	49	49	49	147	7,807	7,714	8,274	23,795
1992	640,810	271,810	717,330	1,629,950	$141.09	$143.23	$155.05	$147.59	49	35	48	132	7,301	5,355	7,705	20,361
1993	863,070	207,920	707,960	1,778,950	$125.80	$134.18	$149.65	$136.27	63	14	69	146	10,248	2,345	11,151	23,744
1994	771,040	308,700	674,240	1,753,980	$114.67	$118.57	$125.51	$119.52	63	33	55	151	12,824	4,475	8,345	25,644
1995	654,870	366,140	609,640	1,630,650	$123.60	$117.52	$130.84	$124.94	57	27	41	125	8,429	4,795	6,577	19,801

	Average Aircraft Size			
Year	FLL-EWR	FLL-JFK	FLL-LGA	Total
1987	182	224	189	194
1988	163	184	169	169
1989	156	172	200	174
1990	154	160	181	168
1991	159	157	169	162
1992	149	153	161	154
1993	163	168	162	163
1994	204	136	152	170
1995	148	178	160	158

Market Rank # 9: Chicago - Los Angeles

Year	Passenger Demand			CPI Adjusted Airfare			Weekly Nonstop Freq. (August)			Weekly Seat Capacity (August)			Average Aircraft Size		
	ORD-LAX	ORD-ONT	Total	ORD-LAX	ORD-ONT	W.Average	ORD-LAX	ORD-ONT	Total	ORD-LAX	ORD-ONT	Total	ORD-LAX	ORD-ONT	Total
1987	923,080	130,260	1,053,340	$184.20	$198.87	$186.01	163	42	205	37,804	5,523	43,327	232	132	211
1988	1,029,260	163,230	1,192,490	$167.34	$191.47	$170.65	124	48	172	28,804	7,024	35,828	232	146	208
1989	907,580	165,480	1,073,060	$237.27	$238.57	$237.47	138	56	194	30,825	8,176	39,001	223	146	201
1990	987,810	158,110	1,145,920	$247.85	$251.97	$248.42	156	55	211	34,692	7,698	42,390	222	140	201
1991	972,540	171,770	1,144,310	$220.48	$213.69	$219.46	165	62	227	36,300	8,426	44,726	220	136	197
1992	1,043,050	206,050	1,249,100	$206.23	$196.03	$204.55	146	63	209	33,008	8,687	41,695	226	138	199
1993	909,760	180,030	1,089,790	$246.83	$223.81	$243.03	161	63	224	34,769	8,547	43,316	216	136	193
1994	927,590	171,190	1,098,780	$230.60	$214.84	$228.14	173	49	222	34,682	6,559	41,241	200	134	186
1995	914,930	150,720	1,065,650	$229.93	$205.10	$226.42	264	42	306	46,163	5,698	51,861	175	136	169

Market Rank # 10: Los Angeles - Seattle

Year	LAX-SEA				
	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	792,870	$165.14	182	26,114	143
1988	655,030	$155.53	157	24,623	157
1989	602,920	$189.31	157	23,468	149
1990	751,530	$170.42	212	31,208	147
1991	749,420	$169.49	209	29,849	143
1992	817,430	$144.30	192	27,141	141
1993	870,730	$130.25	196	28,329	145
1994	928,240	$106.68	154	21,056	137
1995	1,037,610	$93.31	159	22,844	144

Market Rank # 11: Chicago - San Francisco

Year	Passenger Demand			CPI Adjusted Airfare			Weekly Nonstop Freq. (August)			Weekly Seat Capacity (August)			Average Aircraft Size		
	ORD-SFO	ORD-OAK	Total	ORD-SFO	ORD-OAK	W.Average	ORD-SFO	ORD-OAK	Total	ORD-SFO	ORD-OAK	Total	ORD-SFO	ORD-OAK	Total
1987	585,460	118,510	703,970	$212.71	$213.85	$212.90	112	35	147	22,379	4,893	27,272	200	140	186
1988	648,620	109,520	758,140	$180.12	$190.35	$181.60	123	21	144	24,861	3,059	27,920	202	146	194
1989	583,300	112,790	696,090	$279.92	$288.03	$281.24	109	28	137	24,363	4,088	28,451	224	146	208
1990	609,970	140,770	750,740	$293.01	$287.14	$291.91	117	56	173	24,913	8,330	33,243	213	149	192
1991	604,710	113,990	718,700	$269.72	$280.29	$271.39	118	28	146	27,206	4,046	31,252	231	145	214
1992	743,890	124,950	868,840	$226.53	$245.36	$229.24	126	28	154	29,267	4,970	34,237	232	178	222
1993	669,820	133,510	803,330	$264.78	$261.22	$264.19	132	28	160	29,297	4,970	34,267	222	178	214
1994	720,960	118,820	839,780	$261.94	$264.46	$262.30	140	28	168	30,436	4,641	35,077	217	166	209
1995	742,240	118,220	860,460	$256.94	$254.30	$256.58	138	28	166	30,489	3,444	33,933	221	123	204

Market Rank # 12: Dallas/Fort Worth - New York

	Passenger Demand				CPI Adjusted Airfare				Weekly Nonstop Freq. (August)				Weekly Seat Capacity (August)			
Year	DFW-EWR	DFW-JFK	DFW-LGA	Total	DFW-EWR	DFW-JFK	DFW-LGA	W.Average	DFW-EWR	DFW-JFK	DFW-LGA	Total	DFW-EWR	DFW-JFK	DFW-LGA	Total
1987	312,440	59,680	555,900	928,020	$232.92	$177.71	$223.84	$223.93	49	21	87	157	9,170	3,101	18,290	30,561
1988	338,410	54,050	544,360	936,820	$253.29	$192.98	$250.89	$248.41	70	14	91	175	13,594	2,114	18,752	34,460
1989	311,040	84,070	467,980	863,090	$306.27	$181.12	$315.90	$299.30	56	35	90	181	11,508	5,285	18,988	35,781
1990	343,500	69,560	554,650	967,710	$317.50	$206.08	$327.11	$315.00	70	21	90	181	13,384	3,101	19,170	35,655
1991	331,130	60,600	513,280	905,010	$297.57	$172.53	$313.71	$298.35	69	22	90	181	13,144	3,376	18,807	35,327
1992	331,140	63,300	532,870	927,310	$268.21	$209.07	$274.35	$267.70	63	34	104	201	9,520	4,978	19,169	33,667
1993	316,600	44,990	515,490	877,080	$331.39	$247.23	$342.67	$333.70	70	21	97	188	11,746	3,535	17,138	32,419
1994	333,080	46,360	531,690	911,130	$325.12	$228.29	$323.50	$319.25	83	21	119	223	12,570	3,745	19,586	35,901
1995	387,610	39,230	508,310	935,150	$281.41	$229.21	$320.12	$300.26	91	21	161	273	14,490	3,052	22,750	40,292

	Average Aircraft Size			
Year	DFW-EWR	DFW-JFK	DFW-LGA	Total
1987	187	148	210	195
1988	194	151	206	197
1989	206	151	211	198
1990	191	148	213	197
1991	190	153	209	195
1992	151	146	184	167
1993	168	168	177	172
1994	151	178	165	161
1995	159	145	141	148

Market Rank # 13: Las Vegas - New York

	LAS-JFK				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	65,910	$212.96	0	0	0
1988	116,920	$204.10	14	2,590	185
1989	164,820	$190.58	14	2,590	185
1990	227,720	$176.90	14	3,997	286
1991	211,240	$156.23	14	2,660	190
1992	224,620	$169.88	14	2,660	190
1993	247,210	$164.08	14	2,660	190
1994	271,280	$168.99	14	2,660	190
1995	262,460	$166.58	14	2,660	190

Market Rank # 14: Chicago - Phoenix

	ORD-PHX				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	512,970	$120.40	98	15,519	158
1988	572,020	$122.71	78	13,206	169
1989	446,820	$190.13	77	13,762	179
1990	551,650	$173.72	96	16,463	171
1991	639,190	$152.23	90	13,234	147
1992	574,750	$168.29	91	13,678	150
1993	581,500	$185.17	84	14,161	169
1994	644,990	$164.51	97	14,075	145
1995	720,870	$136.10	98	15,330	156

Market Rank # 15: Boston - Chicago

	BOS-ORD				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	593,910	$154.77	116	25,125	217
1988	604,630	$115.60	135	27,166	201
1989	585,080	$154.67	109	22,706	208
1990	602,880	$196.36	107	23,105	216
1991	655,150	$168.80	121	24,309	201
1992	666,450	$189.42	123	23,466	191
1993	659,200	$220.18	136	25,593	188
1994	692,050	$190.28	158	26,414	167
1995	734,430	$198.59	207	31,045	150

Market Rank # 16: New York - West Palm Beach

	Passenger Demand				CPI Adjusted Airfare				Weekly Nonstop Freq. (August)				Weekly Seat Capacity (August)			
Year	EWR-PBI	JFK-PBI	LGA-PBI	Total	EWR-PBI	JFK-PBI	LGA-PBI	W.Average	EWR-PBI	JFK-PBI	LGA-PBI	Total	EWR-PBI	JFK-PBI	LGA-PBI	Total
1987	395,460	142,370	579,570	1,117,400	$112.19	$109.46	$123.74	$117.83	35	14	42	91	5,740	1,890	6,468	14,098
1988	490,300	119,490	688,780	1,298,570	$116.44	$110.28	$128.90	$122.48	56	14	49	119	7,882	2,114	7,637	17,633
1989	447,290	34,540	733,530	1,215,360	$131.75	$136.42	$143.78	$139.15	42	0	42	84	5,166	0	6,552	11,718
1990	558,660	58,220	889,980	1,506,860	$112.66	$133.17	$124.46	$120.42	35	14	70	119	5,208	2,044	10,367	17,619
1991	475,370	14,310	818,850	1,308,530	$128.89	$136.93	$141.26	$136.72	35	0	62	97	5,210	0	8,982	14,192
1992	499,470	27,090	757,830	1,284,390	$129.06	$120.62	$145.22	$138.42	35	14	55	104	4,934	1,988	8,488	15,410
1993	462,570	24,670	691,910	1,179,150	$127.21	$136.25	$144.44	$137.51	34	0	56	90	4,938	0	8,483	13,421
1994	637,070	63,110	718,480	1,418,660	$110.37	$123.60	$123.32	$117.52	49	7	42	98	7,665	812	6,406	14,883
1995	621,720	59,630	681,480	1,362,830	$122.42	$132.79	$130.00	$126.66	49	0	41	90	7,140	0	6,046	13,186

	Average Aircraft Size			
Year	EWR-PBI	JFK-PBI	LGA-PBI	Total
1987	164	135	154	155
1988	141	151	156	148
1989	123	0	156	140
1990	149	146	148	148
1991	149	0	145	146
1992	141	142	154	148
1993	145	0	151	149
1994	156	116	153	152
1995	146	0	147	147

Market Rank # 17: Chicago - Orlando

	ORD-MCO				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	369,310	$127.90	42	7,875	188
1988	441,830	$106.32	56	8,638	154
1989	426,600	$139.46	56	8,515	152
1990	492,420	$135.59	42	7,175	171
1991	514,270	$142.02	49	7,560	154
1992	563,950	$151.88	56	9,569	171
1993	552,940	$153.03	70	12,208	174
1994	588,220	$126.41	70	10,500	150
1995	597,340	$127.14	71	11,230	158

Market Rank # 18: New York - Tampa

	Passenger Demand				CPI Adjusted Airfare				Weekly Nonstop Freq. (August)				Weekly Seat Capacity (August)			
Year	EWR-TPA	JFK-TPA	LGA-TPA	Total	EWR-TPA	JFK-TPA	LGA-TPA	W.Average	EWR-TPA	JFK-TPA	LGA-TPA	Total	EWR-TPA	JFK-TPA	LGA-TPA	Total
1987	305,500	269,490	243,750	818,740	$146.77	$144.29	$159.89	$149.86	21	41	28	90	3,409	6,107	4,151	13,667
1988	396,600	192,400	361,550	950,550	$153.49	$144.32	$162.93	$155.22	42	35	49	126	5,882	5,285	7,063	18,230
1989	359,080	122,400	376,370	857,850	$166.72	$155.93	$173.36	$168.10	42	21	42	105	5,600	3,171	6,006	14,777
1990	449,830	130,390	474,500	1,054,720	$136.35	$115.54	$139.76	$135.31	49	35	63	147	6,762	5,131	8,624	20,517
1991	377,800	70,600	399,150	847,550	$158.76	$135.23	$168.07	$161.18	41	28	62	131	5,658	4,102	8,688	18,448
1992	372,460	57,240	371,230	800,930	$160.30	$156.99	$170.11	$164.61	41	14	55	110	5,772	1,988	8,007	15,767
1993	413,760	102,990	315,570	832,320	$148.03	$135.53	$165.72	$153.19	48	28	41	117	6,926	3,836	5,978	16,740
1994	537,310	125,250	375,950	1,038,510	$110.82	$109.22	$126.15	$116.18	48	21	42	111	8,404	2,884	5,698	16,986
1995	462,500	119,630	370,480	952,610	$128.72	$118.52	$128.18	$127.23	49	21	33	103	7,224	2,912	4,612	14,748

	Average Aircraft Size			
Year	EWR-TPA	JFK-TPA	LGA-TPA	Total
1987	162	149	148	152
1988	140	151	144	145
1989	133	151	143	141
1990	138	147	137	140
1991	138	147	140	141
1992	141	142	146	143
1993	144	137	146	143
1994	175	137	136	153
1995	147	139	140	143

Market Rank # 19: San Francisco - Honolulu

	SFO-HNL				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	528,700	$178.61	86	26,401	307
1988	777,300	$164.10	91	26,479	291
1989	763,970	$156.46	95	27,244	287
1990	856,760	$150.42	88	26,285	299
1991	806,260	$170.40	85	24,688	290
1992	818,770	$166.77	85	25,014	294
1993	854,500	$156.67	80	24,351	304
1994	798,660	$153.98	78	24,251	311
1995	771,000	$155.37	58	17,516	302

Market Rank # 20: Anchorage - Seattle

	ANC-SEA				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	204,130	$292.78	147	21,175	144
1988	203,970	$292.66	133	20,083	151
1989	193,040	$268.06	147	22,169	151
1990	304,430	$227.65	168	25,172	150
1991	327,950	$225.33	193	29,510	153
1992	509,900	$161.12	227	33,700	148
1993	444,100	$181.94	234	34,950	149
1994	508,870	$158.59	205	30,587	149
1995	572,130	$175.19	191	29,754	156

Market Rank # 21: Los Angeles - Washington, D.C.

Year	Passenger Demand			CPI Adjusted Airfare			Weekly Nonstop Freq. (August)			Weekly Seat Capacity (August)			Average Aircraft Size		
	LAX-BWI	LAX-IAD	Total	LAX-BWI	LAX-IAD	W.Average	LAX-BWI	LAX-IAD	Total	LAX-BWI	LAX-IAD	Total	LAX-BWI	LAX-IAD	Total
1987	171,860	311,640	483,500	$197.98	$271.07	$245.09	0	55	55	0	12,325	12,325	0	224	224
1988	184,230	359,500	543,730	$211.59	$289.92	$263.38	14	55	69	2,800	11,466	14,266	200	208	207
1989	181,060	559,960	741,020	$246.48	$283.31	$274.31	21	69	90	4,200	14,196	18,396	200	206	204
1990	195,110	531,160	726,270	$256.38	$301.70	$289.52	21	62	83	3,262	14,201	17,463	155	229	210
1991	198,160	522,350	720,510	$242.12	$280.86	$270.20	21	56	77	3,836	13,531	17,367	183	242	226
1992	191,620	599,030	790,650	$213.71	$246.97	$238.91	21	63	84	2,688	14,847	17,535	128	236	209
1993	197,040	541,760	738,800	$232.92	$295.84	$279.06	21	56	77	3,220	11,860	15,080	153	212	196
1994	249,520	537,800	787,320	$203.95	$277.70	$254.33	21	63	84	3,094	14,350	17,444	147	228	208
1995	284,010	567,780	851,790	$188.46	$265.77	$239.99	21	63	84	4,373	13,398	17,771	208	213	212

Market Rank # 22: Chicago - Denver

Year	ORD-DEN				
	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	514,860	$136.57	174	30,412	175
1988	520,660	$103.68	167	32,180	193
1989	479,000	$186.15	157	29,362	187
1990	537,710	$186.41	158	29,339	186
1991	577,420	$161.67	152	27,211	179
1992	618,950	$168.13	153	26,399	173
1993	652,330	$165.23	153	30,363	198
1994	859,810	$110.60	153	30,993	203
1995	763,330	$140.65	134	25,909	193

Market Rank # 23: Chicago - Dallas/Fort Worth

Year	ORD-DFW				
	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	545,490	$174.35	139	21,342	154
1988	514,810	$219.52	151	24,348	161
1989	488,500	$252.56	144	22,535	156
1990	596,940	$248.02	158	24,861	157
1991	605,030	$216.31	145	25,440	175
1992	641,070	$222.05	137	23,101	169
1993	636,330	$258.97	203	28,148	139
1994	814,230	$183.90	192	27,488	143
1995	799,960	$198.64	192	27,222	142

Market Rank # 24: Boston - San Francisco

	BOS-SFO				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	488,950	$261.26	14	3,934	281
1988	511,140	$256.48	14	3,920	280
1989	566,330	$294.66	14	3,458	247
1990	553,310	$293.01	28	6,790	243
1991	562,280	$257.12	35	7,325	209
1992	590,370	$240.02	28	5,432	194
1993	604,000	$266.43	35	7,621	218
1994	612,620	$274.06	35	7,371	211
1995	676,560	$274.22	36	7,758	216

Market Rank # 25: San Francisco - Washington, D.C.

	SFO-IAD				
Year	Demand	Airfare	Freqeuncy	Capacity	A/C Size
1987	168,240	$243.72	28	7,931	283
1988	202,020	$262.12	28	7,280	260
1989	449,650	$304.91	28	7,333	262
1990	455,640	$317.56	28	6,706	240
1991	469,810	$285.81	28	7,637	273
1992	510,490	$263.99	35	9,499	271
1993	505,980	$298.09	35	10,906	312
1994	581,640	$292.93	35	11,032	315
1995	553,670	$292.70	35	10,381	297

Appendix B: Consumter-Price-Index Adjusted Airfares in terms of 1995 Dollars

Market Rank # 1: Los Angeles - New York

	Original Fare			CPI Adjusted Fare	
Year	LAX-EWR	LAX-JFK	CPI	LAX-EWR	LAX-JFK
1987	$158.44	$219.27	105.40	$209.10	$289.37
1988	$168.97	$249.84	108.70	$216.23	$319.72
1989	$220.69	$261.86	114.10	$269.05	$319.24
1990	$232.61	$277.08	120.50	$268.51	$319.85
1991	$221.31	$243.63	123.80	$248.67	$273.74
1992	$199.49	$237.77	126.50	$219.36	$261.46
1993	$243.18	$276.21	130.40	$259.41	$294.64
1994	$233.95	$253.57	134.30	$242.31	$262.63
1995	$231.66	$237.58	139.10	$231.66	$237.58

Market Rank # 2: New York - San Francisco

	Original Fare			CPI Adjusted Fare	
Year	EWR-SFO	JFK-SFO	CPI	EWR-SFO	JFK-SFO
1987	$175.63	$235.57	105.40	$231.79	$310.89
1988	$178.25	$267.12	108.70	$228.10	$341.83
1989	$236.00	$259.82	114.10	$287.71	$316.75
1990	$246.76	$268.97	120.50	$284.85	$310.49
1991	$238.12	$241.02	123.80	$267.55	$270.81
1992	$222.65	$233.20	126.50	$244.83	$256.43
1993	$262.56	$293.45	130.40	$280.07	$313.03
1994	$258.02	$275.31	134.30	$267.25	$285.15
1995	$255.41	$259.80	139.10	$255.41	$259.80

Market Rank # 3: Miami - New York

	Original Fare				CPI Adjusted Fare		
Year	MIA-EWR	MIA-JFK	MIA-LGA	CPI	MIA-EWR	MIA-JFK	MIA-LGA
1987	$106.02	$111.54	$119.99	105.40	$139.91	$147.21	$158.36
1988	$120.27	$119.60	$126.51	108.70	$153.91	$153.05	$161.89
1989	$132.72	$132.44	$132.43	114.10	$161.80	$161.46	$161.44
1990	$115.25	$110.29	$117.21	120.50	$133.04	$127.31	$135.31
1991	$134.37	$130.14	$148.53	123.80	$150.97	$146.23	$166.88
1992	$141.84	$133.87	$156.97	126.50	$155.97	$147.20	$172.60
1993	$142.58	$127.26	$167.47	130.40	$152.09	$135.75	$178.64
1994	$114.03	$109.10	$136.59	134.30	$118.11	$113.00	$141.47
1995	$122.64	$107.12	$151.71	139.10	$122.64	$107.12	$151.71

Market Rank # 4: New York - Orlando

	Original Fare				CPI Adjusted Fare		
Year	EWR-MCO	JFK-MCO	LGA-MCO	CPI	EWR-MCO	JFK-MCO	LGA-MCO
1987	$103.39	$102.87	$105.18	105.40	$136.45	$135.76	$138.81
1988	$105.65	$104.56	$105.36	108.70	$135.19	$133.81	$134.83
1989	$112.71	$119.33	$116.20	114.10	$137.40	$145.47	$141.66
1990	$103.57	$100.55	$105.78	120.50	$119.56	$116.08	$122.11
1991	$127.26	$114.98	$133.41	123.80	$142.99	$129.19	$149.90
1992	$128.00	$129.53	$133.63	126.50	$140.75	$142.43	$146.94
1993	$109.37	$121.31	$129.07	130.40	$116.67	$129.40	$137.68
1994	$104.59	$107.47	$115.60	134.30	$108.32	$111.31	$119.74
1995	$118.73	$120.28	$127.29	139.10	$118.73	$120.28	$127.29

Market Rank # 5: New York - San Juan

Year	Original Fare EWR-SJU	Original Fare JFK-SJU	CPI	CPI Adjusted Fare EWR-SJU	CPI Adjusted Fare JFK-SJU
1987	$116.34	$115.46	105.40	$153.54	$152.38
1988	$148.22	$143.79	108.70	$189.67	$184.01
1989	$161.24	$147.12	114.10	$196.56	$179.35
1990	$166.10	$155.99	120.50	$191.74	$180.07
1991	$174.45	$156.93	123.80	$196.01	$176.32
1992	$171.41	$156.48	126.50	$188.49	$172.07
1993	$157.78	$153.03	130.40	$168.31	$163.24
1994	$151.13	$140.63	134.30	$156.53	$145.66
1995	$137.76	$133.20	139.10	$137.76	$133.20

Market Rank # 6: Atlanta - New York

Year	Original Fare ATL-EWR	Original Fare ATL-JFK	Original Fare ATL-LGA	CPI	CPI Adjusted Fare ATL-EWR	CPI Adjusted Fare ATL-JFK	CPI Adjusted Fare ATL-LGA
1987	$135.31	$117.08	$147.28	105.40	$178.57	$154.51	$194.37
1988	$192.83	$127.78	$186.47	108.70	$246.76	$163.52	$238.62
1989	$193.62	$147.58	$193.00	114.10	$236.04	$179.92	$235.29
1990	$189.58	$141.22	$196.58	120.50	$218.84	$163.02	$226.92
1991	$202.28	$140.48	$204.24	123.80	$227.27	$157.84	$229.48
1992	$175.50	$138.47	$211.99	126.50	$192.98	$152.26	$233.11
1993	$129.57	$138.45	$215.07	130.40	$138.22	$147.69	$229.42
1994	$111.65	$126.07	$182.23	134.30	$115.64	$130.58	$188.74
1995	$138.43	$145.02	$228.13	139.10	$138.43	$145.02	$228.13

Market Rank # 7: Los Angeles - Honolulu

Year	LAX-HNL Orig. Fare	LAX-HNL CPI	LAX-HNL CPI Fare
1987	$132.04	105.40	$174.25
1988	$125.04	108.70	$160.00
1989	$136.48	114.10	$166.39
1990	$135.42	120.50	$156.32
1991	$163.97	123.80	$184.23
1992	$162.71	126.50	$178.92
1993	$152.59	130.40	$162.77
1994	$149.91	134.30	$155.27
1995	$149.59	139.10	$149.59

Market Rank # 8: Fort Lauderdale - New York

Year	Original Fare FLL-EWR	Original Fare FLL-JFK	Original Fare FLL-LGA	CPI	CPI Adjusted Fare FLL-EWR	CPI Adjusted Fare FLL-JFK	CPI Adjusted Fare FLL-LGA
1987	$111.68	$110.28	$117.03	105.40	$147.39	$145.54	$154.44
1988	$116.95	$114.65	$122.96	108.70	$149.65	$146.72	$157.35
1989	$129.53	$128.85	$139.15	114.10	$157.91	$157.09	$169.63
1990	$112.70	$105.61	$115.75	120.50	$130.09	$121.91	$133.61
1991	$133.21	$126.45	$144.34	123.80	$149.67	$142.08	$162.18
1992	$128.31	$130.25	$141.00	126.50	$141.09	$143.23	$155.05
1993	$117.94	$125.79	$140.29	130.40	$125.80	$134.18	$149.65
1994	$110.71	$114.48	$121.18	134.30	$114.67	$118.57	$125.51
1995	$123.60	$117.52	$130.84	139.10	$123.60	$117.52	$130.84

Market Rank # 9: Chicago - Los Angeles

	Original Fare			CPI Adjusted Fare	
Year	ORD-LAX	ORD-ONT	CPI	ORD-LAX	ORD-ONT
1987	$139.57	$150.69	105.40	$184.20	$198.87
1988	$130.77	$149.63	108.70	$167.34	$191.47
1989	$194.63	$195.69	114.10	$237.27	$238.57
1990	$214.71	$218.28	120.50	$247.85	$251.97
1991	$196.23	$190.18	123.80	$220.48	$213.69
1992	$187.55	$178.27	126.50	$206.23	$196.03
1993	$231.39	$209.81	130.40	$246.83	$223.81
1994	$222.64	$207.43	134.30	$230.60	$214.84
1995	$229.93	$205.10	139.10	$229.93	$205.10

Market Rank # 10: Los Angeles - Seattle

	LAX-SEA		
Year	Orig. Fare	CPI	CPI Fare
1987	$125.13	105.40	$165.14
1988	$121.54	108.70	$155.53
1989	$155.29	114.10	$189.31
1990	$147.63	120.50	$170.42
1991	$150.84	123.80	$169.49
1992	$131.23	126.50	$144.30
1993	$122.10	130.40	$130.25
1994	$103.00	134.30	$106.68
1995	$93.31	139.10	$93.31

Market Rank # 11: Chicago - San Francisco

	Original Fare			CPI Adjusted Fare	
Year	ORD-SFO	ORD-OAK	CPI	ORD-SFO	ORD-OAK
1987	$161.17	$162.04	105.40	$212.71	$213.85
1988	$140.75	$148.75	108.70	$180.12	$190.35
1989	$229.61	$236.26	114.10	$279.92	$288.03
1990	$253.83	$248.75	120.50	$293.01	$287.14
1991	$240.05	$249.46	123.80	$269.72	$280.29
1992	$206.01	$223.14	126.50	$226.53	$245.36
1993	$248.22	$244.88	130.40	$264.78	$261.22
1994	$252.91	$255.33	134.30	$261.94	$264.46
1995	$256.94	$254.30	139.10	$256.94	$254.30

Market Rank # 12: Dallas/Fort Worth - New York

	Original Fare				CPI Adjusted Fare		
Year	DFW-EWR	DFW-JFK	DFW-LGA	CPI	DFW-EWR	DFW-JFK	DFW-LGA
1987	$176.49	$134.66	$169.61	105.40	$232.92	$177.71	$223.84
1988	$197.93	$150.81	$196.06	108.70	$253.29	$192.98	$250.89
1989	$251.23	$148.57	$259.13	114.10	$306.27	$181.12	$315.90
1990	$275.04	$178.52	$283.37	120.50	$317.50	$206.08	$327.11
1991	$264.84	$153.55	$279.20	123.80	$297.57	$172.53	$313.71
1992	$243.91	$190.13	$249.50	126.50	$268.21	$209.07	$274.35
1993	$310.67	$231.77	$321.24	130.40	$331.39	$247.23	$342.67
1994	$313.90	$220.41	$312.33	134.30	$325.12	$228.29	$323.50
1995	$281.41	$229.21	$320.12	139.10	$281.41	$229.21	$320.12

Market Rank # 13: Las Vegas - New York

	LAS-JFK		
Year	Orig. Fare	CPI	CPI Fare
1987	$161.37	105.40	$212.96
1988	$159.49	108.70	$204.10
1989	$156.33	114.10	$190.58
1990	$153.24	120.50	$176.90
1991	$139.05	123.80	$156.23
1992	$154.49	126.50	$169.88
1993	$153.82	130.40	$164.08
1994	$163.16	134.30	$168.99
1995	$166.58	139.10	$166.58

Market Rank # 14: Chicago - Phoenix

	ORD-PHX		
Year	Orig. Fare	CPI	CPI Fare
1987	$91.23	105.40	$120.40
1988	$95.89	108.70	$122.71
1989	$155.96	114.10	$190.13
1990	$150.49	120.50	$173.72
1991	$135.49	123.80	$152.23
1992	$153.04	126.50	$168.29
1993	$173.59	130.40	$185.17
1994	$158.84	134.30	$164.51
1995	$136.10	139.10	$136.10

Market Rank # 15: Boston - Chicago

	BOS-ORD		
Year	Orig. Fare	CPI	CPI Fare
1987	$154.77	105.40	$204.26
1988	$115.60	108.70	$147.93
1989	$154.67	114.10	$188.55
1990	$196.36	120.50	$226.67
1991	$168.80	123.80	$189.66
1992	$189.42	126.50	$208.29
1993	$220.18	130.40	$234.87
1994	$190.28	134.30	$197.08
1995	$198.59	139.10	$198.59

Market Rank # 16: New York - West Palm Beach

	Original Fare				CPI Adjusted Fare		
Year	EWR-PBI	JFK-PBI	LGA-PBI	CPI	EWR-PBI	JFK-PBI	LGA-PBI
1987	$112.19	$109.46	$123.74	105.40	$148.06	$144.45	$163.31
1988	$116.44	$110.28	$128.90	108.70	$149.01	$141.12	$164.95
1989	$131.75	$136.42	$143.78	114.10	$160.62	$166.31	$175.29
1990	$112.66	$133.17	$124.46	120.50	$130.05	$153.73	$143.68
1991	$128.89	$136.93	$141.26	123.80	$144.82	$153.85	$158.72
1992	$129.06	$120.62	$145.22	126.50	$141.92	$132.63	$159.68
1993	$127.21	$136.25	$144.44	130.40	$135.69	$145.34	$154.08
1994	$110.37	$123.60	$123.32	134.30	$114.32	$128.02	$127.73
1995	$122.42	$132.79	$130.00	139.10	$122.42	$132.79	$130.00

Market Rank # 17: Chicago - Orlando

	ORD-ORL		
Year	Orig. Fare	CPI	CPI Fare
1987	$96.91	105.40	$127.90
1988	$83.08	108.70	$106.32
1989	$114.40	114.10	$139.46
1990	$117.46	120.50	$135.59
1991	$126.40	123.80	$142.02
1992	$138.12	126.50	$151.88
1993	$143.46	130.40	$153.03
1994	$122.05	134.30	$126.41
1995	$127.14	139.10	$127.14

Market Rank # 18: New York - Tampa

	Original Fare				CPI Adjusted Fare		
Year	EWR-TPA	JFK-TPA	LGA-TPA	CPI	EWR-TPA	JFK-TPA	LGA-TPA
1987	$111.21	$109.33	$121.15	105.40	$146.77	$144.29	$159.89
1988	$119.94	$112.78	$127.32	108.70	$153.49	$144.32	$162.93
1989	$136.76	$127.90	$142.21	114.10	$166.72	$155.93	$173.36
1990	$118.12	$100.09	$121.07	120.50	$136.35	$115.54	$139.76
1991	$141.30	$120.35	$149.58	123.80	$158.76	$135.23	$168.07
1992	$145.78	$142.77	$154.71	126.50	$160.30	$156.99	$170.11
1993	$138.77	$127.05	$155.36	130.40	$148.03	$135.53	$165.72
1994	$107.00	$105.46	$121.80	134.30	$110.82	$109.22	$126.15
1995	$128.72	$118.52	$128.18	139.10	$128.72	$118.52	$128.18

Market Rank # 19: San Francisco - Honolulu

	SFO-HNL		
Year	Orig. Fare	CPI	CPI Fare
1987	$135.34	105.40	$178.61
1988	$128.24	108.70	$164.10
1989	$128.34	114.10	$156.46
1990	$130.30	120.50	$150.42
1991	$151.66	123.80	$170.40
1992	$151.66	126.50	$166.77
1993	$146.87	130.40	$156.67
1994	$148.67	134.30	$153.98
1995	$155.37	139.10	$155.37

Market Rank # 20: Anchorage - Seattle

	ANC-SEA		
Year	Orig. Fare	CPI	CPI Fare
1987	$221.85	105.40	$292.78
1988	$228.70	108.70	$292.66
1989	$219.88	114.10	$268.06
1990	$197.21	120.50	$227.65
1991	$200.55	123.80	$225.33
1992	$146.52	126.50	$161.12
1993	$170.56	130.40	$181.94
1994	$153.12	134.30	$158.59
1995	$175.19	139.10	$175.19

Market Rank # 21: Los Angeles - Washington, D.C.

	Original Fare			CPI Adjusted Fare	
Year	LAX-IAD	LAX-BWI	CPI	LAX-IAD	LAX-BWI
1987	$205.40	$150.01	105.40	$271.07	$197.98
1988	$226.56	$165.35	108.70	$289.92	$211.59
1989	$232.39	$202.18	114.10	$283.31	$246.48
1990	$261.36	$222.09	120.50	$301.70	$256.38
1991	$249.96	$215.49	123.80	$280.86	$242.12
1992	$224.60	$194.36	126.50	$246.97	$213.71
1993	$277.34	$218.35	130.40	$295.84	$232.92
1994	$268.12	$196.91	134.30	$277.70	$203.95
1995	$265.77	$188.46	139.10	$265.77	$188.46

Market Rank # 22: Chicago - Denver

	ORD-DEN		
Year	Orig. Fare	CPI	CPI Fare
1987	$103.48	105.40	$136.57
1988	$81.02	108.70	$103.68
1989	$152.69	114.10	$186.15
1990	$161.49	120.50	$186.41
1991	$143.89	123.80	$161.67
1992	$152.90	126.50	$168.13
1993	$154.90	130.40	$165.23
1994	$106.79	134.30	$110.60
1995	$140.65	139.10	$140.65

Market Rank # 23: Chicago - Dallas/Fort Worth

	ORD-DFW		
Year	Orig. Fare	CPI	CPI Fare
1987	$132.11	105.40	$174.35
1988	$171.54	108.70	$219.52
1989	$207.17	114.10	$252.56
1990	$214.86	120.50	$248.02
1991	$192.51	123.80	$216.31
1992	$201.94	126.50	$222.05
1993	$242.78	130.40	$258.97
1994	$177.55	134.30	$183.90
1995	$198.64	139.10	$198.64

Market Rank # 24: Boston - San Francisco

	BOS-SFO		
Year	Orig. Fare	CPI	CPI Fare
1987	$197.96	105.40	$261.26
1988	$200.43	108.70	$256.48
1989	$241.70	114.10	$294.66
1990	$253.83	120.50	$293.01
1991	$228.84	123.80	$257.12
1992	$218.28	126.50	$240.02
1993	$249.76	130.40	$266.43
1994	$264.60	134.30	$274.06
1995	$274.22	139.10	$274.22

Market Rank # 25: San Francisco - Washington, D.C.

	SFO-IAD		
Year	Orig. Fare	CPI	CPI Fare
1987	$135.34	105.40	$178.61
1988	$128.24	108.70	$164.10
1989	$128.34	114.10	$156.46
1990	$130.30	120.50	$150.42
1991	$151.66	123.80	$170.40
1992	$151.66	126.50	$166.77
1993	$146.87	130.40	$156.67
1994	$148.67	134.30	$153.98
1995	$155.37	139.10	$155.37

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