

**Airline Fare Competition:
Econometric Evidence of Oligopolistic Coordination**

by

Richard R. Barth

B.S. Elec. Eng.,
United States Naval Academy
(1978)

Submitted to the Sloan School of Management
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Signature of Author



MIT Sloan School of Management
January 30, 1990

Certified by



Nancy L. Rose
Associate Professor of Applied Economics
Thesis Supervisor

Accepted by



Jeffrey A. Barks
Associate Dean, Master's and Bachelor's Programs

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ABSTRACT

A cross-sectional econometric model of airline fares is developed and presented to evaluate the possibility of oligopolistic fare coordination among the largest airlines. The model is estimated on Department of Transportation Origin and Destination Database 1A for the second calendar quarter of 1986. Statistical tests reject the hypothesis that fares are independent of the identity of the carriers serving a given market. Specifically, fares on routes dominated by carriers serving many different markets are higher than are fares on routes where smaller carriers have a substantial market share, even after controlling for the number of actual competitors on the route.

Oligopoly theory demands the competitors in an oligopolistic market be able to detect cheating and punishing the cheaters to achieve a collusive market price. (The collusive price is higher than non-cooperative oligopoly pricing solutions.) When the competitors operate in many different markets, non-cooperative actions by one competitor in one market can bring retribution from the other competitors in other markets. The largest carriers, then, can enforce a coordinated price as long as their competitors share many different markets. The results of the regression are consistent with the interpretation that the largest carriers are able to successfully coordinate their fares at higher than purely competitive levels as long as they can effectively exclude smaller, "spoiler" carriers from the market. When these smaller carriers capture a large enough share of the market (about 10% total), the large carriers can no longer effectively discipline the higher price because they don't face the small carrier in enough other markets to effectively punish the price cutting.

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Title: Associate Professor of Applied Economics

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Chapter 1

Introduction: Purpose and Scope

Substantial anecdotal evidence exists that airlines successfully coordinate their fares. For example, in May, 1989, Continental Airlines withdrew plans to boost summer air fares after other competitors refused to match the increases.¹ In July, Eastern Airlines cancelled fare cuts on several new routes after their competitors began matching the discounts.² Then, early in August of the same year, Continental Airlines instituted broad cuts in fares that were quickly "studied or matched" by other airlines.³ Just three weeks later, the Wall Street Journal reported that last minute squabbling by the major airlines was temporarily delaying widespread fare increases.⁴ Other apparent cases of airlines indirectly coordinating fares are cited frequently in the business press.⁵ The fare structures of the major airlines on most routes appear to move up and down in near synchronization.

¹"Continental Airlines Withdraws Plans to Boost Summer Fares," *The Wall Street Journal*, May 17, 1989, page B2, column 1.

²"Eastern Airlines Retreats from Fare Cuts," *The Wall Street Journal*, July 20, 1989, page B1, column 3.

³"Continental Airlines Cuts Fares," *The Wall Street Journal*, August 2, 1989, page B5, column 5.

⁴"Airline Squabbling Delays Fare Increases," *The Wall Street Journal*, August 24, 1989, page A2, column 4.

⁵See, for example: "TWA, United Won't Increase Summer Fares," May 15, 1989, *The Wall Street Journal*, page A5, column 1; "American and NW Match Continental Fares," *The Wall Street Journal*, July 15, 1989, page C9, column 1; "Major Airlines Announce Price Promotions," *The Wall Street Journal*, August 15, 1989, page B1, Column 3.

The observation that fares charged by airlines seem to move together over time does not necessarily imply that airline markets are imperfectly competitive or that those airlines are successfully capturing oligopolistic rents. The fare changes certainly could reflect changing operating costs across the entire industry. Fuel costs, for example, make up a substantial portion of all airlines' operating costs and all airlines face roughly the same price for fuel. Similarly, general economic conditions can depress (or inflate) demand for all airlines at the same time. When the national economy contracts, all airlines face decreasing demand at the same time and can reasonably be expected to drop fares at roughly the same time.⁶ The apparently coordinated movement of fares, then, may be no more than airlines reacting independently to changing common economic conditions. One or more airlines could be following what Michael Porter calls an overall cost leadership strategy⁷, setting fares at the lowest possible level, with other carriers following the leader to a near perfectly competitive price.

However, the same pattern of synchronized fare changes would also occur in a smoothly functioning oligopoly market. The difference between the two cases is that oligopolists can effectively limit competitive entry and capture excess rents by coordinating fares above the perfectly competitive level. The most infamous indication that airlines might at least believe anti-competitive collusion is economically possible was the February 21, 1982 phone call from Robert Crandall, CEO of American Airlines, to his counterpart at Braniff Airways, Howard Putnam. In the phone conversation, recorded by

⁶See, for example, "Airlines, Facing Sluggish Demand, Likely to Slash Fares," *The Wall Street Journal*, January 3, 1990, page B1, column 3.

⁷Porter (1980), pages 34-46.

Mr Putnam and turned over to the Justice Department, Mr Crandall offered to raise American's fares 20% if Braniff followed suit.⁸ There is apparently enough evidence of anti-competitive collusion among the major airlines to prompt several U.S Government investigations. In June, 1989, the Department of Transportation began looking into airlines frequent flyer programs as part of a broad examination of airline competitive behavior.⁹ The Justice Department began a formal antitrust investigation of several major carriers in December.¹⁰ Are the major airlines able to, in fact, exploit some economic imperfection in their markets to limit competition and effectively collude on higher than competitive fares?

This paper investigates the thesis that airlines operating in many different markets are able to maintain higher fares in markets where they face only each other than in markets that include smaller airlines as competitors. I test the thesis by constructing a cross-sectional econometric model of the airline industry supply curve and confirming that the average fare in markets with several larger airlines competing is significantly higher than the average fare when one or more of the competitors is a smaller airline. By "larger airline", I mean an airline serving many different markets, and by "smaller", I mean an airline serving relatively fewer markets. (Service over a route between any two endpoints is an airline market. Thus,

⁸"American Air Accused in Anti-Trust Violation," *New York Times*, February 24, 1983, Section I, page 1, column 1.

⁹"U.S. Probes Frequent Flyer Programs," *The Wall Street Journal*, June 6, 1989, page C6, column 3.

¹⁰"U.S. Probes Whether Airlines Colluded on Fare Increases," *The Wall Street Journal*, December 14, 1989, page B1, column 3.

the route between Chicago O'Hare and Atlanta is a single market, which in Spring 1986 was served by American, Delta, Eastern, Ozark, Piedmont, and United; the route between Chicago and Dallas-Ft Worth is another market which was served by American, Braniff, Continental, Delta, Ozark, and United.) By the nature of operating in many markets, the "larger" airlines also turn out to be larger by most other measures: they supply more revenue-passenger miles and have higher revenues than the "smaller" carriers, and are, by and large, the traditionally defined "major" carriers that grew out of what were the national trunk carriers before deregulation.

The definition of "large" based on number of markets served is, however, important in understanding why this econometric model may indicate that the larger carriers are operating successfully as colluding oligopolists. The primary economic requirements before oligopoly competitors can reach a collusive fare are some market imperfection that limits free competitive entry and a mechanism for the competitors to detect and punish cheating in the market. Because the large airlines, by this definition, operate in many markets, they also overlap operations in many markets. Any large airline in any single market will also face the same large competitors in many other markets. Since the cost of providing service in any single market is similar for all the major airlines¹¹, any competitor cheating on a coordinated price can be easily detected. (The advent of computerized reservation systems may have made this detection even easier -- and faster -- and may also have made punishment faster to implement.) The cheater can

¹¹Different airlines do operate under different cost structures as will be discussed in greater detail later. However, the largest dozen carriers all have relatively similar operating costs per revenue passenger-mile. (See, for example, Salomon Brothers Stock Research Report, Airlines, May 3, 1989.)

then be punished by cutting fares in other markets common to both competitors.

If, on the other hand, the cheater is a smaller airline, the competitors may not face that same cheater in enough markets to make fare cuts in those other markets an effective punishment. As long as smaller airlines don't capture too great a share of the market, larger airlines can effectively ignore them and maintain the higher coordinated fare among themselves. The small carriers' low market share doesn't substantially reduce the large carriers' revenues -- even if the small carrier cut her fares in the market. Further, since many of the smaller carriers have lower operating costs than the major airlines, a large carrier that tried to discipline a smaller carrier through aggressive fare cut would have to offer a fare substantially below that large carrier's costs to eliminate the smaller carrier's profit margin. The total revenue loss to the larger carrier would be much greater than the smaller carrier's loss ($\Delta P \cdot Q_{BIG} > \Delta P \cdot Q_{SMALL}$). What makes predatory pricing possible if the small carrier captures too much market share, however, is that the revenue lost by the larger carrier, while absolutely greater than that lost by the smaller carrier, is a smaller fraction of the large carrier's total revenue stream. Thus, the larger carrier can hurt a smaller carrier through predatory pricing, but only at substantial cost to itself. Where the small carrier has only limited market share, the larger carriers will find it less costly to just ignore the small carrier's lower fares.

When small airlines capture a substantial market share, however, any fare cutting by them now significantly reduces the larger carriers' revenues. The large carriers can no longer simply ignore the price cutting. This may result in a breakdown in the coordinated oligopoly pricing of the large

carriers as they are forced to match the lower fares in the primary market. The lack of an effective discipline mechanism forces the market to operate closer to a competitive fare level than to an oligopolistically coordinated level.

If airlines can limit competitive entry, and the discipline mechanism described above is correct, then airline markets dominated by several larger carriers should result in a collusive fare level. When smaller carriers reach a critical level of market share, the discipline mechanism breaks down and the markets move closer to pure competition. An econometric model of airline industry supply across many markets should include a statistically significant coefficient related to the size of the carriers operating in each market. The model presented in chapter 4 does, in fact, find that markets dominated by larger carriers have significantly higher fares than do markets in which small carriers account for 10% or more of the traffic volume.

One unexpected result of the model in chapter 4 is that monopoly market fares in general do not appear to be significantly higher in than are fares in the more competitive markets. The *a priori* expectation is that fares on monopoly routes should be highest, oligopoly fares slightly lower, and fares on routes with substantial small carrier competition lower still. The results of the econometric model show, however, that fares in monopoly markets are not significantly different than fares in more competitive markets. It is difficult to account for this apparently perverse result. Neither the statistical model nor the economic theory behind it provide a strong rationale. Chapter 4 presents a more detailed discussion of this result.

Theoretical Basis for the Thesis

Chapter 2 provides background for the model, the results of earlier work, and an overview of the competitive conditions in the airline industry. In the space of just over ten years, the industry has gone from tight government control over routing and fares to total deregulation. The carriers themselves, however, remain divided into two general competitive groups much as they were during the regulated environment -- even the identities of the major carriers remain the same.¹²

Before deregulation, the government divided carriers into trunk and regional lines. (There were also intra-state carriers not subject to Civil Aeronautics Board control. For purposes of the competitive evolution of the industry, however, these airlines can be grouped with the regulation-era regional carriers.) Trunk carriers operated nationally between the largest airports. Within regions, and feeding the trunk carrier markets were the regional carriers. The Civil Aeronautics Board controlled airline expansion into new markets so the trunk carriers and regional carriers were not in direct competition for the same markets. (The CAB also restricted competition between trunk carriers or between regional carriers.)

In the ten years since deregulation, the industry has evolved into a set of major national carriers and smaller regional-based carriers. While the two groups can, theoretically compete for the same markets since deregulation, in practice there is very little broad based competition between the two. There are a substantial number of routes since deregulation where former regional

¹²Levine (1987).

and trunk carriers compete (about 41% of the 1823 markets used in the model in chapter 4). However, the competition between them is rarely in a national scale. When US Air, a former regional carrier concentrated along the East Coast, competes with United, a former trunk carrier, the competition is generally on routes within US Air's regional strength. US Air and United compete in the Boston to Washington, D.C. market, but not in the Denver to Los Angeles market. The former regional carriers remain generally smaller in terms of revenue-passenger miles, total revenues, and number of markets served. They continue to operate primarily in markets with lower demand density concentrated in a single geographic region. The former trunk carriers are often identified as major carriers, are larger in terms of revenue-passenger miles, total revenues, and number of markets served, and compete nation-wide.

Shortly after the airline industry was fully deregulated, economists predicted that airline fares should be very near competitive levels despite the apparently limited number of competitors in any single market because each route was contestable.¹³ Traditional economic theory demands a large number of participants for a market to approach pure competition, the primary requirement being that no single participant can influence the prevailing market price -- suppliers (in this case, but more generally any participant) are price takers. The other requirements for perfect competition are unrestricted mobility of capital, an homogeneous product, and equal information by all participants.¹⁴ The most obvious imperfection for airline markets in terms of pure competition is the limited number of suppliers. Even

¹³Bailey and Baumol (1984).

¹⁴Browning and Browning (1986), pages 252-253.

those markets with the highest demand density have no more than a half dozen airlines serving them.

Contestability theory addresses itself to the degree of competition in markets with a limited number of suppliers. Contrary to traditional competition theory, contestability postulates that under conditions of free entry and exit, even a limited number of market participants will operate as perfect competitors. If a market meets the requirements for perfect contestability, and the existing competitors begin to capture excess rents by forcing the price above competitive levels, the economic profits in the market will attract new participants and force the price back down to competitive levels. The key requirement of contestability theory is perfect capital mobility: an existing competitor can costlessly leave a market when prices fall below competitive levels, and new competitors can costlessly enter when profit levels rise.

While airline markets were originally proposed as examples of near perfect contestability, recent economic work suggests they are subject to substantial imperfections.¹⁵ A significant portion of airline capital is totally immobile. This lack of perfect capital mobility creates a market imperfection that airlines can potentially exploit to increase fares above competitive levels.

The most visible items of airline capital, airplanes, crews, and ground equipment, are indeed highly mobile. Entering a new market that's currently enjoying large profits is not, however, as simple as moving the airplanes, crews and equipment to a new airport and opening up for business. Airlines

¹⁵See, for example, Borenstein (1989a and b), Hurdle et al (1988), Levine (1987), and Peteraf (1988).

face huge costs to establish themselves in any particular market. Until customers learn that an airline is operating in the market, at substantial information cost to the customer and financial cost to the entrant, the new market entrant cannot effectively compete with already established airlines. The process of educating passengers about a new carrier's presence in a market usually take a long time (measured in months) during which the new entrant faces operating losses due to low load factors in addition to high marketing expenses.

Other constraints on free capital mobility in airline markets include landing restrictions at some crowded airports and limited gate availability at many others. Computerized reservation systems create a client-agent problem with the dominant airline in an area maintaining large market share through non-linear ticket commissions. (Travel agents often earn increasing commission rates as they direct more passengers to the dominant airline.) Frequent flyer programs create a client-agent problem between business travellers, who enjoy the benefits of the programs, and employers, who pay for the tickets.

The aggregate of these market-specific capital costs creates imperfections in the airline markets that can constrain contestability. The degree of market imperfection may not be very high. Airline operating costs have historically (through the decade of the 1980's) been about 65% of revenues.¹⁶ Airline profitability is highly variable with stock market betas for the larger airlines in the range of 1.3 to 1.5. According to the Capital Asset Pricing Model, a fair economic return on airline capital would be in the

¹⁶Salomon Brothers report *supra* note 11.

neighborhood of 20%.¹⁷ If airlines were perfectly competitive, were earning a fair market return on their capital, and the operating costs referenced above were the total costs faced by the airline, then the average airline fares are about 10% higher than perfectly competitive levels.

Certainly this is a very crude calculation, and if it were accurate the additional 10% pure profit would make airlines a very attractive investment indeed. Most of this unaccounted for 10% goes to non-operating costs. Working with the rough approximations above hides the fact that some airlines are extremely profitable (such as Southwest Airlines) and other are spectacularly unprofitable (for example, Eastern and Continental Airlines). Profitability of the airline industry as a whole varies from year to year -- in the recession years of 1981-1982, most airlines lost money; in the expansion from 1984 through 1988 most airlines were quite profitable. The point is simply that market imperfections created by the competitive actions in the airline industry are not huge industry-wide. Each imperfection is rather small and often specific to a subset of markets and airlines. Where competitors can take advantage of failures in the necessary conditions for perfect contestability, further entry is effectively limited.

For competitors to collude on an oligopolistic price, free entry must be limited and they must be able to discipline cheaters as discussed above. In some markets, the contestability failures are significant enough that further entry is effectively limited and the existing competitors face each other in enough other markets to provide an opportunity to discipline cheaters. About 31% of the markets used in this study meet those criteria and are hypothesized

¹⁷See Brealey and Myers (1988), pages 125-133, and 175-196.

to have higher oligopolistic fares. In most markets (about 61% of this sample), the imperfections are small enough that competitive entry can't be limited, or the competitive conditions are such that oligopolistic discipline can't be enforced. In those markets, the average fare should be nearer the competitive level. The remaining eight per cent of the sample markets are monopolies. As mentioned above, I expected the fares on these routes to be higher than in the oligopoly markets -- they turn out to be generally indistinguishable from competitive fares.

Data Used to Estimate the Model

Chapter 3 discusses the data used for this study and the the method of analysis. The data are drawn from a subset of the Department of Transportation Origin and Destination Database 1A for the second calendar quarter of 1986. In original form, this database consists of a 10% sampling of all domestic U.S. airline ticket sales. The subset I used for this study was obtained from Severin Borenstein and Nancy Rose and provides the average passenger fare on the largest 521 domestic direct service routes.¹⁸ The markets are served by 35 carriers and cover the 200 largest airports in the country (from Chicago O'Hare to Deadhorse, Alaska). Some markets are served by a single carrier (23% of them), others are served by as many as six. The result is a sample of average passenger fares over 1823 carrier-route combinations.

Using these 1823 data points and standard econometric techniques, I construct a reduced form of an airline industry fare equation for the second quarter of 1986. The average passenger fare charged by each carrier in each

¹⁸Borenstein and Rose (1989).

market is a function of supply, demand, and market structure variables. The carrier costs are captured by variables for the distance covered by the route, the carrier's dominance at the endpoint airports and share of total traffic in the market describe market conditions, a measure of the fraction of market made up of tourists influences demand, and the total number of passengers flying on the observed airline in that market depends on both demand and supply considerations. Because both the number of passengers and the observed airline's dominance over the route are determined endogenously, I use the method of two-stage least squares in the regression analysis.¹⁹

Regression Results

Chapter 4 presents an econometric model to test the hypothesis that the fares captured by larger carriers (those serving the largest number of markets) are higher when they compete among themselves than the fares realized by carriers competing in markets with substantial participation by smaller carriers. Using dummy variable techniques, I evaluate the differences in fares between monopoly markets, markets dominated by two or more larger carriers, and markets with substantial participation by smaller carriers. I apply the appropriate F-tests to determine the statistical significance of the dummy variables, and fail to reject the hypothesis.²⁰ Fares in markets dominated by two or more larger carriers are indeed higher than fares in other markets.

¹⁹Pindyck and Rubinfeld (1981), pages 175-192.

²⁰Pindyck and Rubinfeld (1981), pages 111-119.

Further evidence of oligopolistic coordination by the largest airlines is provided by regressions including dummy variables for the presence of very low-cost competitors in the market and for markets with Federal Aviation Administration imposed take off and landing restrictions. People Express Airlines had a reputation for extraordinarily low fares. The regressions show the fares in markets that include People Express are significantly lower than fares even in competitive markets. Since fares in competitive markets are near cost (exactly equal to marginal cost if the markets were perfectly competitive), the continued presence of higher cost airlines in markets with PE, charging fares below cost, implies predatory pricing by the high cost airlines. Such activity is consistent with the thesis that larger airlines attempt to discipline markets to higher collusive fares by punishing cost cutters (such as PE).

Fares in markets with FAA restrictions are, on the other hand, higher than in markets without the restrictions. This, again, is consistent with the collusive pricing thesis. The FAA restrictions further limit entry by new carriers into the market. New entrants are constrained not just by the substantial sunk costs necessary to establish themselves in a market, but also by the physical limitation on participation. If incumbents could collude on their fares, they should be able to drive the average fares higher before reaching the limit at which a new entrant could afford to "buy" her way into the market based on expected future profits.

Conclusions and Further Work

Finally, chapter 5 presents the conclusions of this thesis. The major airlines do appear to successfully capture excess rent through oligopolistic

coordination. In markets where they face each other, they have taken advantage of failures in the conditions for contestability to limit further entry and colluded on higher fares by punishing cheaters in ancillary markets. When the market imperfections are substantial, as in the case of FAA restrictions, the incumbents can capture even higher rents. Where a low-cost competitor presents a possible long-term threat, the major carriers appear to engage in predatory pricing -- either to "encourage" the low-cost airline to raise fares or to destroy it (and its future threat).

Substantial opportunity for further work in the relationship between airline route structure and pricing decisions exists. The unusual monopoly results found in the regressions of this paper could be network rather than market based. Two specific questions arise: do smaller regional airlines also collude when they compete exclusively among themselves, and do larger carriers price below the theoretical monopoly fare to stimulate demand feeding into higher traffic density routes?

Chapter 2
The Structure of the Industry and
the Nature of Competition

Transition from Regulation to Deregulation

With passage of the Civil Aeronautics Act of 1938²¹ through the Airline Deregulation Act of 1978²², the U.S. air transportation industry was comprehensively regulated. This regulation generally served to inhibit the creation of new large airlines and to protect existing airlines from "excessive" competition between themselves. Airline markets coming under the direction of the Department of Transportation (all inter-state markets) were divided between trunk and regional carriers. Trunk carriers operated on long-haul routes between larger population centers nationally. Regional carriers served the smaller airports in specific geographical regions and fed transcontinental passengers to the trunk lines. The resulting structure subsidized short-haul routes at the expense of long-haul routes and fares were generally higher than those expected under pure competition. Because airlines on the same routes were restricted to charging identical fares, service competition was substituted for price competition.²³ Consequently, airlines employed excess capacity during the regulated era.²⁴

²¹Public Law 75-706, 52 Stat. 977.

²²Public Law 95-504, 92 Stat. 1705.

²³Douglas and Miller (1974).

²⁴See Graham, Kaplan, and Sibley (1983).

Mainstream economic thought during the first half of the twentieth century suggested that government interference in the air transportation industry was necessary to assure an orderly market. A strong air transportation industry was considered vital to the economic growth of the U.S. Some economists suggested that regulation was needed to insure that air transportation was available in all markets, not just those with high demand. They feared that without regulation, airlines would stop serving routes with lower demand density. Under regulation, these routes were cross-subsidized by the high prices on routes with greater demand density. Without government interference in the airline markets, some predicted free entry would so depress prices that few carriers could survive, larger airlines might take advantage of some scale economies to destroy their competitors, or airlines would engage in cream skimming -- concentrating on the most lucrative high demand markets and withdrawing from lower demand markets.

By the late 1960's, economists began to favorably compare the competitive performance of the relatively unregulated intra-state airlines in California and Texas with the regulated national environment. Their analysis suggested that rather than a near natural monopoly, the air transportation industry was closer to perfectly competitive. American economic thought evolved away from a general bias for government intervention to maintain orderly transportation markets (for inter-state trucking as well as for airlines) and towards the power of free markets to order themselves. One of the earliest academic references to deregulating the airline industry came in 1965.²⁵ Through the late-1960's and early-1970's, U.S. political and economic

²⁵Levine, Michael E. "Is Regulation Necessary? California Air Transportation and National Regulatory Policy," *Yale Law Journal*, July 1965, Vol. 74.

thinking shifted away from government interference in markets and toward deregulation. This shift was supported by seminal work in oligopoly theory suggested that a limited number of firms participating in a market need not necessarily lead to economic profits and restricted output -- that markets could be contestable by potential entrants even if there are few existing competitors.²⁶ The new contestability theory predicted that in any industry with no sunk costs the threat of entry would force incumbents to keep prices at competitive levels. If the incumbents raised prices above perfectly competitive levels, new entrants would be attracted to the industry and compete prices back down. In what Levine describes as a "remarkable" translation from academic consensus to regulatory practice, the industry was virtually completely deregulated by the Airline Deregulation Act of 1978.²⁷

Initial experience with the unregulated environment seemed to support the expectation that airlines would behave more like perfect competitors than like traditional oligopolists. Early on, there was entry by several new carriers including People Express and New York Air in the east and rapid expansion of the formerly intra-state Southwest Airlines in the west. As expected, industry load factors started to climb²⁸ and total welfare of both the traveling public and the airlines increased.²⁹ In 1981, the low-cost new entrants had fare

²⁶The theory of contestable markets was consolidated largely using the example provided by the early years of airline industry deregulation. Baumol (1982).

²⁷Levine (1987).

²⁸Graham, Kaplan, and Sibley (1983).

²⁹Morrison and Winston (1986). They found that traveler welfare increased due to both generally lower fares and increased departure frequency on high-density routes and that fare increases on low-density routes was offset by gains from increased departure frequency.

structures on the order of 25% lower than the industry average for regulation-era airlines. From 1980 to 1981, average industry fares increased by only 11% despite that fact that fuel costs increased by 20%.³⁰

Substantial industry consolidation through the 1982 recession and the highly visible failure of such low-cost competitors as People Express and New York Air have rekindled questions about the degree to which airline markets are contestable. At the end of the 1980's and beginning of the 1990's the structure of the U.S. air transportation market is remarkably similar to its structure under government regulation in the 1960's. There remain two general classes of carriers -- now separated by economics and strategy rather than government regulation. One group operates nationally between the larger population centers over routes with higher demand density. The other continues to serve primarily regional markets with lower demand densities. While some of the original trunk carriers have failed, all of the major airlines competing today on a national scale began as regulation-era trunk lines. The vast majority of passenger traffic is carried by airlines that began business under regulation -- few new entrants have survived.³¹

Were the earlier predictions of near perfect contestability for airline markets overly optimistic?³² Levine points out that "contestability theory is

³⁰Harvard Business School Case 483-103, People Express (A), 1983.

³¹Levine (1987) points out that despite generally higher costs than their new entrant rivals, holdover airlines from the regulated era controlled 94.6% of the industry passenger miles in 1986.

³²Bailey and Baumol (1984). They suggest that "because of technological economies of scale with respect to aircraft size, the majority of U.S. city-pair markets are natural monopolies" (page 128). They predict that fares will, however, settle at near competitive levels due to the contestable nature of airline markets.

an interesting starting place to discuss the performance of deregulated airline markets... It has the virtue ... of focusing relatively precisely on the conditions necessary to to achieve competitive performance from markets with few sellers... And it turns out to be wrong as a predictor of the behavior of deregulated airline markets."³³ Contestability theory does provide a powerful framework for analyzing the airline industry. Airline market power exists where the requirements for perfect contestability are violated. Airlines can potentially take advantage of market conditions that interfere with contestability to limit competition. Some airline strategic actions (such as the development of computerized reservation systems) exacerbate market imperfections. Where airlines can take advantage of market imperfections to limit new entry, they have the opportunity to act as traditional oligopolists and potentially collude on higher fares.

The theory of contestable markets applies to industries with no sunk costs and few participants. An incumbent in such an industry potentially faces a downward-sloping demand curve. The traditional oligopolist in such a situation increases price and reduces quantity to capture more consumer surplus. Because there are assumed to be no sunk costs, however, firms can enter a market freely whenever prices exceed average costs and profits are being made. The new entry increases supply and forces prices back down to competitive levels. If prices fall below average costs, firms in the market can exit without cost, contracting supply and pushing prices back to those existing under perfect competition. Since prices can never diverge from competitive levels without inviting entry and immediate return to competitive prices,

³³Levine (1987), page 405.

incumbents will not be able to take advantage of the downward-sloping demand curve they face. Contestability theory does not depend on the number of participants to establish a competitive equilibrium price, but on the no cost entry and exit of firms to police markets with few participants. The technical conditions necessary for perfect market contestability are:

equal access by all firms to economies of scale and the same technology
-- incumbents and potential entrants have the same cost structure;

the existence of a market-clearing price that can provide a fair economic return to both incumbents and new entrants after entry;³⁴

and no sunk costs -- capital is perfectly mobile and firms can enter or leave the market without penalty.³⁵

Equal Access to Economies of Scale and Technology

For purposes of contestability, access to economies of scale and technology are not restricted to the narrow definition of larger airplanes or

³⁴Some economists have suggested that, even if there's no sustainable market price that would allow both incumbents and a new entrant to earn a fair return, "hit and run" entry could prevent prices from rising above competitive levels. If the incumbent did raise prices to earn a positive economic profit, the new entrant could instantly capture the market by offering a slightly lower price. This winner take all approach to market share may not be a reasonable model for airline markets. As discussed below, passengers' choice of airline seems to depend on more than just the lowest possible fare -- considerations such as schedule, frequent flyer programs, reputation and service, and computerized reservation systems influence the decision. These same limitations on "hit and run" entry create the sunk costs that limit competitive entry.

³⁵Levine (1987), page 404.

more fuel efficient engines. In general, any carrier has equal access to the specific technologies necessary to realize the limited scale economies available in air travel. As illustrated by People Express, acquiring the jet aircraft necessary to operate at the minimum efficient scale on any route is possible for even a new carrier.³⁶

The requirement for equal access is a cost argument. All market participants, and potential participants, must be able to deliver their product to market at a similar cost. That extends beyond the narrow definition of technology as "equipment" and to how that equipment is employed. If, for example a new entrant and an incumbent were both operating with the same model of airplanes, but the incumbent had an existing labor contract that required a three-person cockpit crew and the new entrant was using a two-person crew, the new entrant has a clear cost advantage. While both airlines are using the same equipment, the different labor costs keep them from having equal access to the economic technology to deliver similar cost products.

It was actually the holdover carriers that, arguably, didn't have equal access to the economies of scale and technology -- the economic technology that allowed free substitution of capital for labor. They were almost

³⁶As one of the first new airlines to apply for certification after deregulation, and with less than \$1 million in starting capital, People Express raised over \$25 million in an initial public offering of stock and acquire 17 used Boeing 737's from Lufthansa. (HBS People Express (A) case *supra* note 30.) Access to scale economies was not a problem for new entrants in 1981. Today, with order lead-times for new aircraft approaching five years, access to the aircraft to take advantage of scale economies is certainly more expensive, but still possible. The supply of available airplanes today is smaller relative to the demand than in 1981, airplanes are still available at a price. The incumbent airline is paying the same higher economic price in terms of opportunity cost for that airplane she contracted for three years ago as the new entrant would pay to be moved higher on the delivery schedule.

universally burdened by capital structures and labor costs that had evolved under the artificial form of competition that had existed before deregulation. Average holdover airline costs were 7.2 cents per passenger mile compared with 6.2 cents for new entrants in the early 1980's.³⁷ Some econometric studies on the effects of deregulation on competition from the same period were qualified because the holdover airlines' capital structures had inhibited their flexibility in responding to competitive action.³⁸ Yet, the holdover airlines, with their disadvantageous capital structures, survived where, for the most part, the new entrants did not.³⁹

Several technologies have been used by the hold-over airlines to overcome their cost disadvantages. The computerized reservation systems owned by the six largest domestic airlines allow them to more effectively take advantage of third-degree price discrimination. Frequent flyer programs take advantage of the agent-client relationship between business flyers and their employers. And, the national market coverage of the major airlines allows their passengers to reach more destinations without changing carriers.

Computerized reservation systems are owned exclusively by the major airlines and have a massive influence on air travel. Seventy percent of travel agencies use either the Sabre (owned by American Airlines) or Apollo (owned by United) reservation systems, and nearly two-thirds of all tickets are sold

³⁷Levine (1987), page 407. See also Graham, Kaplan, and Sibley (1983), table on page 136.

³⁸Bailey and Baumol (1984), and Graham, Kaplan, and Sibley (1983).

³⁹Levine (1987) points out that none of the new entrant survivors generates more than one percent of industry revenues (page 418).

through one of the systems.⁴⁰ Every one of the five national computerized reservation systems is owned by a hold-over airline.⁴¹ Using a CRS, an airline can quickly reprice unsold seats to take advantage of the different demand elasticities.

When faced with a single homogeneous customer population, the supplier can charge only a single price. Consumers with lower demand elasticities would, however, have a higher reservation price for the same product. Third-degree price discrimination takes advantage of the different elasticities of segregated customer groups to capture the maximum possible consumer surplus for the supplier. The difference between first-class and tourist fare on airlines is a classic example of third-degree price discrimination. The difference in service between the two classes is far less than the difference in fares. The customers buying the two classes of tickets, however, have different demand elasticities.⁴²

The airlines owning CRSs receive rapid feedback on their pricing policies. If, for example, a low-cost carrier is offering a lower fare, the airline owning the CRS gets that information quickly (faster than the flying public) and can make a block of seats with an even lower fare available. Thus, the major airline can always offer as low or lower fares than the new entrant -- on a subset of seats. The major carrier subsidizes those lower priced seats with higher fares for the passengers with a smaller demand elasticity. The net

⁴⁰Levine (1987).

⁴¹Trans-World Airways and Northwest Orient Airlines jointly own PARS. The other four systems are owned by single airlines.

⁴²Pindyck and Rubinfeld (1989).

result is that the average fare for the low-cost carrier is lower than for the incumbent major carrier, but the incumbent has more effectively captured consumer surplus as profit.

The airline CRSs also provide other value to their owners. Until 1985, they were sometimes used to distort the information received by travel agents about competitors' fares and flight availability.⁴³ The computerized reservation systems provide their owners with a clear and nearly instantaneous picture of the competitive environment -- schedules, fares, and seats sold for all their competitors. Finally, CRSs have made travel agent overrides feasible and exploited the principle-agent relationship between travellers and travel agents. The sliding commission scale for incremental increases in market share encourages travel agents to book less cost-sensitive travellers on the national airlines. The net result is not clearly quantifiable, but is an increase in ticket sales for the higher cost national airline at the expense of the low-cost entrant.

Frequent flyer programs also exploit the principle-agent problem -- now between the employer who pays for the tickets and the business traveller who reaps the rewards of the program. The rewards to the flyer are paid on a non-linear scale. The payoff for a relatively few miles may be a free upgrade, and the payoff for a few more miles is a much more valuable free ticket. This encourages the traveller to stick with an airline on which she has accumulated a few miles even if the fares are slightly higher -- especially since the business traveller isn't paying for the ticket out of her pocket. The flyer is also bias toward the national airlines because they serve more

⁴³Levine (1987).

destinations: the traveller can accumulate miles and rewards faster because all travel can be on a single carrier, and the rewards are more valuable because there are more destinations available for the free tickets.

Finally, the broad market coverage of the major airlines encourages passengers to travel with them. Several studies have shown that passenger prefer flying on a single airline on several legs of a trip rather than changing carriers between legs.⁴⁴ The preference makes sense in light of the cost to the traveller in terms of time and convenience associated with changing airlines. It's a pecuniary cost, but no less economically real to the traveller. On balance, travellers are generally willing to pay a somewhat higher fare to avoid that cost. Except, then, for travel exclusively on the comparatively small set of markets served by a new airline, passengers will prefer travelling on an existing national airline serving a broad cross-section of markets.

In summary, clearly incumbents and new entrants do not have equal access to economies of scale and technology in the broad economic sense. The degree to which this unequal access influences airlines ability to deliver their products at a similar cost (the real concern as far as contestability of the market) depends on the specific market. For example, in markets with a high concentration of tourist traffic, and a correspondingly fewer business flyers, the major airlines' frequent flyer program will provide less advantage than in a high-density business market. Tourist travellers are less likely to value the frequent flyer miles than they value the lower airfare. Their extreme price elasticity will also make the major airlines' CRSs a competitive advantage.

⁴⁴Graham, Kaplan, and Sibley (1983).

Such markets should be more nearly competitive because a low-cost new entrant can provide a similar value (transportation from one city to another) for a lower price.

At the other extreme, a market between a small city with a significant manufacturing economy and a larger hub city may be effectively closed to new entry. A large percentage of the travellers in such a market are likely to be more time sensitive than price sensitive, will value the benefits of frequent flyer miles more than the difference in ticket prices, and will prefer an airline with numerous destinations beyond the hub city. Unless the new entrant is another major national airline, the passenger may value the service they receive from the incumbent (not just transportation, but convenience, frequent flyer rewards, the indirect benefits of travel agent overrides, and through travel) more than the difference in ticket costs. In this case, the new entrant who is not another major airline faces a clear disadvantage in access to economic technology.⁴⁵

Price Sustainability in the Airline Industry

Price sustainability means that there exists a price in the market such that both the incumbent and any new entrant can make a fair economic return. It's an integer problem caused by production indivisibilities in the airline industry. If production in a market can only be provided in discrete "chunks" (integer quantities), and demand is such that even one additional competitor's minimum production at marginal cost above average cost would

⁴⁵As will be developed later, a new entrant who is a major national airline may be discouraged by the incumbent major carrier by predatory pricing in other markets. See Bulow, Geanakoplos, and Klemperer (1985).

force the market price below all competitors' minimum profitable production, any new competitor can only enter by displacing an incumbent. In classic economic analysis where the lowest price producer supplies all, any attempt by incumbents to raise price above pure competitive levels invites entry and displaces one or more incumbents. Under these conditions, incumbents will be constrained from raising prices.

As discussed in the preceding section, however, passenger purchase decisions are not always based solely on the lowest fare. In these markets, incumbents can capture rents up to the amount that potential passengers value their "additional" services (frequent flyer miles, convenience, etc.) without inviting entry. Further, there are clear diffusion effects associated with new entrants capturing market share.⁴⁶ Even in highly price sensitive markets, a low-cost new entrant faces some period of reduced load factors until potential passengers become aware of the new carrier. The lost revenues associated with the initially low load factors and low fares represent a sunk cost the entrant must expect to recover if entry is to be profitable.

The existence of production indivisibilities in the airline industry does provide rationale for the existence of natural monopolies in smaller markets with lower demand densities.⁴⁷ Minimum efficient scale for a modern airline is about one hundred seats per flight.⁴⁸ Production indivisibilities in the

⁴⁶See John D. Sterman, *People Express Management Flight Simulator*, 1988, for discussion of diffusion effects in the airline industry. Richardson and Pugh (1981) have a more general discussion on the effects of time delays on population growth (such as a customer population).

⁴⁷Bailey and Baumol (1984).

⁴⁸A Boeing 737 carries between 90 and 113 passengers depending on configuration.

industry, then, are on the order of hundreds of passengers per week. (The potential for schedule-based competition and the capability of individual airplanes to serve more than one market makes a general determination of minimum scale impossible.) On routes with such low demand densities, only a single airline can profitably operate.

Airline Capital Mobility

The requirement of capital mobility for market contestability assures that a competitor may freely enter any market in which the incumbents are making extraordinary returns and earn a similar return without having to cover sunk costs. Similarly, any competitor must be able to freely leave a market in the event of predation -- to return when prices again rise above zero economic profit. With perfect capital mobility, then, prices should never be significantly higher or lower than the competitive level. When prices are higher, new carriers will enter until excess profits are competed away; if prices are too low, carriers will exit until fares rise.

In terms of physical capital, airlines have comparatively low sunk costs. While airline operations require large capital investments, most of the airlines' physical capital is not tied to any specific market. The airplanes themselves are certainly mobile -- they can be moved from market to market as required. Ground service operations such as maintenance and baggage handling can be subcontracted from other carriers,⁴⁹ so they are not necessarily sunk costs. Passenger reservation and most other administrative services don't have to be tied to any specific market.

⁴⁹ People Express, for example contracted for all airplane maintenance.

Air terminal gates can be a substantial market specific cost to airlines. There has been some popular suggestion that the scarcity of gates at crowded airports has resulted in higher than competitive fares in those markets.⁵⁰ Gate space under such conditions is a scarce economic resource with a correspondingly high economic cost -- to either a new entrant or an incumbent. An entrant faces the direct cost of acquiring access to a gate, but the incumbent faces the equal economic opportunity cost of keeping the gate. If the incumbent cannot gain as much rent from using the gate (through higher fares in that market), she would be better advised to sell the gate to a potential entrant. The high economic costs of scarce gate access is not a sunk cost.

The existence of a finite resource such as crowded terminal access will, however, place a natural limit on the number of competitors in a market. The huge cost of creating additional space at crowded airports gives incumbents an opportunity to exclude potential entrants by investing in overcapacity. The classic oligopolist's response to a market that effectively excludes entry would be to increase price and reduce quantity supplied -- in this case reduce the number of flights from the crowded airport. Such an action would encourage the municipality to invest in additional airport space to provide more flights. If, instead, the existing competitors provided more capacity than predicted by traditional oligopoly theory, the additional airport space would be deferred and competitive entry would continue to be effectively limited.⁵¹

⁵⁰See Levine (1987).

⁵¹Spence (1977).

Similarly, Federal Aviation Administration restrictions on the number of take-offs and landings at some airports limits the potential for competitive entry in those markets.⁵² Several studies have shown a positive correlation between routes serving slot controlled airports and fares.⁵³ Just like the case of constrained airport capacity, FAA restrictions represent a scarce resource with high economic cost to incumbents or potential entrants. It's not a sunk cost because any airline withdrawing from such a market could sell its rights to the slots at fair market value. Higher fares in markets with constrained resources could represent simply a fair return on the high opportunity cost of the scarce resource (either gates or slots).

Of course, limiting competitive entry is one of the necessary conditions for collusion between the existing competitors.⁵⁴ It is not, however, a strictly sufficient condition -- there must also exist some mechanism to discipline the market. In the general oligopoly problem, each participant has the incentive to cut price if her competitors continue to charge a higher price. Without a way for participants to detect and punish cheating (price shaving by one or more participants) the market price will collapse toward the competitive price. This will be covered in more detail later. At this stage I simply want to point out that higher prices on routes constrained by scarce resources do not necessarily mean that the competitors are earning economic profits.

⁵²La Guardia and Kennedy in New York, O'Hare in Chicago, and National Airport in Washington, D.C.

⁵³See, for example, Graham, Kaplan, and Sibley (1983), and Peteraf (1988). The regressions in chapter 4 of this thesis also show a significant correlation between markets with slot controls and higher fares.

⁵⁴Bernheim and Whinston ().

Scarce economic resources represent one way in which some airline markets are imperfect, but do not represent a failure of contestability due to high sunk cost. The costs of these resources are recoverable if a competitor decides to leave the market. Airlines, however, have non-physical capital that is not mobile and does represent a non-recoverable sunk cost. The slow diffusion of potential passengers in a new market, discussed in the previous section, is an example of customer information costs that an airline makes substantial investment to overcome. An incumbent cannot successfully sell that investment to a competitor if she decides to leave the market.⁵⁵

A potential passenger's knowledge that a particular airline serves a market represents an investment by the airline. As discussed above, passenger decisions about which carrier to fly are usually based on more than simply the lowest fare. (There is, in fact, some evidence that remarkably low fares may discourage rather than encourage passengers! Passengers are naturally concerned with airline safety, and unusually low fares may signal a less safe airline -- a low quality product.⁵⁶ The correlation is complicated by the fact that, in most cases, the very low fares have come from carriers in severe financial difficulty and often occur at the same time as frequent new reports about that carrier's cost trimming measures -- including maintenance "cut backs."⁵⁷) Passenger carrier choices also depend on schedule convenience, frequent flyer programs, carrier routing, perhaps indirectly on

⁵⁵ Arguably, an incumbent can "sell" her market presence in a merger or acquisition by selling the airline's trade name. It's questionable if this represents new entry or simply a change in command at the original airline.

⁵⁶ Levine (1987).

⁵⁷ World Airways, Continental Airlines, and Eastern Airlines bankruptcies are recent examples.

the airline's reservation system (and the travel agent's commission), and the passenger's past experience with the airline.

Schedule, frequent flyer miles, routing, and computerized reservation systems have been discussed as technologies that allow airlines to deliver a particular level of service for a particular fare. They all represent non-price discriminators that passengers use when selecting an airline. Communicating an airline's service in any of these areas is more complex than listing a lowest fare in the newspaper. Passengers invest their own time and experience to "learn" which airline offers the best such service for them. This investment is an information cost that passengers don't lightly abandon in favor of a lower fare airline. An airline's investment in "educating" passengers about the level of service provided is a sunk cost specific to each market.

Time sensitive travellers, such as business flyers will often select a more convenient departure time over a lower fare. This is the basis of the third-degree price discrimination in advanced purchase requirements for most airline's economy fares.⁵⁸ Business flyers are often required to travel on short notice. Since they are also less price sensitive than vacation travellers (who can plan far in advance), airlines can capture more consumer surplus by pricing tickets with no advance purchase requirements higher.

Just as business travellers will pay more for tickets that don't require advance purchase, they will pay more for a flight that departs or arrives at a convenient time -- typically near the start or end of a business day. A business flyer who has discovered an airline that will deliver her at the

⁵⁸Pindyck and Rubinfeld (1989).

desired location at a convenient time will be reluctant to switch airlines for a lower fare even if the competing airline offers a schedule only a few minutes different. The cost to the traveller if the competing airline fails to deliver on the scheduled arrival is greater than the cost difference between the tickets.

Frequent flyer miles represent a cumulative investment by the traveller in a single airline. Reward structures are non-linear. The pay-off to the traveller increases faster as she accumulates more miles with the same carrier. A passenger having significant experience with an incumbent airline will receive a much more valuable marginal reward for the next flight with that same airline than she would receive if she switched to a new carrier. The longer an airline serves a specific market, and the more often a passenger flies on that airline, the greater is the passenger's investment in the airline and the greater is the price differential necessary to lure that passenger to a new carrier. The incumbent's long-term presence in the market (that creates the passenger's investment) is a non-recoverable sunk cost.

Several studies have shown that passengers prefer multi-leg trips on the same carrier to switching carriers on different legs.⁵⁹ The incumbent airline's investment in establishing and maintaining its route structure is another non-recoverable sunk cost. A major national carrier who serves many inter-connected markets offers passengers from any single origin numerous possible destinations without having to change airlines. Passengers value this level of service and will be willing to pay higher fares compared to airlines with route structure that would necessitate having to switch carriers in the middle of a trip. In this case, an incumbent's withdraw from one market

⁵⁹Graham, Kaplan, and Sibley (1983), Morrison and Winston (1986), and Levine (1987).

would not only force her to abandon the sunk cost of educating passengers about the network of available destinations from that origin, but also to abandon the sunk cost of educating all other markets about the availability of that destination.

Finally, computerized reservation systems represent a substantial airline investment -- not only in and of itself, but as a cumulative investment in specific market presence. The investment in development and maintenance of the CRS is large,⁶⁰ but doesn't represent a non-recoverable sunk cost. If an airline chose to abandon their CRS, they could recover most of their investment by selling the system to another carrier at fair market value.⁶¹ The greatest value of a CRS, however, is the cumulative distortion it creates in a market the longer it is used. Like frequent flyer rewards, most travel agents work on a non-linear commission system. The agents marginal commission increase from selling one more ticket on the dominant carrier in a market is greater than the marginal commission from selling a ticket on another airline. When combined the ability to override discount fare limitations (only possible with a CRS), travel agents are incentivized to book more passengers on the CRS owner.

All these market imperfections are the result of customers' information search costs that are larger than the fare differentials. With experience,

⁶⁰Levine (1987) estimates American Airlines invested more than \$100 million to bring their Sabre system on line.

⁶¹A CRS's greatest value is in capitalizing on distorted market conditions and allowing the owner to capture excess rents through higher ticket prices in those markets. The return to the owner in terms of fees for using the system are nonexistent. Therefore, a CRS would be less valuable to a non-airline than to another airline.

customers gain information about airlines on which they fly.⁶² The information represents a non-financial cost (time invested and opportunity cost) that passengers balance against the fare differential between carriers. For example, a time sensitive flyer who has experience on American Airlines (which a reasonably good on-time record) will be reluctant to try a new carrier even if the fare is lower. The potential cost in lost time and frustration to the traveller if the new carrier doesn't perform as well as American is substantial.

If gaining this information represents a cost to the passenger, it also represents a sunk cost to the carrier. Because customers will pay higher fares to an airline on which they've had positive experiences up to the value they place on that service, those carriers can capture rents from those customers. IF the airline decides to leave the market, those rents are a non-recoverable sunk opportunity cost. Further, the passengers gain the information that allows airlines to capture excess rents from continued operation by the airline in the market. The losses experienced by the new entrant from low load factors until it overcomes the information costs of its potential passengers are a non-recoverable sunk costs.

Short run losses in profitability are also non-recoverable sunk costs. An incumbent could face a short-term loss as a result of competitive action (a

⁶²The diffusion process that gathers potential passengers to a new entrant is slow because personal experience is given substantially more weight than word of mouth as customers gather information. Potential passengers are gained (or lost) by their direct experience with only one or two flights or the longer accumulation of word of mouth from many other flyers. Most potential customers with experience on other airlines must hear good news about a new entrant from several people who have flown the carrier before they will try the entrant. Thus there's substantial lag between a carrier's entry into a market and the accumulation of a substantially loyal customer base.

low-cost entrant gains substantial market share) or a recession that depresses total demand. The incumbent faces a substantial cost to withdraw from the market and re-enter after the period of losses is over. By withdrawing, the incumbent both loses its existing customer base (they can't be loyal to a carrier that's not in the market) and establishes a reputation for unreliability. When the airline re-enters, it will face a more difficult job of convincing former customers that it can be depended upon to deliver service in the future. Therefore, an incumbent cannot freely withdraw from markets where it faces losses.

Incumbent airlines, then, make a substantial sunk investment to establish a clientele. The investment is market specific and cannot be recovered if the incumbent exits. However, the investment should give the incumbent some market power -- the loyal, "educated" passengers concerned with their own information search costs are less price sensitive than customers with very low information search costs (for example time insensitive travellers such as tourists). Dominant incumbents should realize a fair return (rent) on their investment in establishing a market identity. Borenstein has found a strong correlation between an airline's dominance in terms of passengers enplaned at an endpoint and the fares that airline can command.⁶³ He has also found that airport dominance by one airline does not allow other airlines serving the same route to raise fares an equal amount.⁶⁴

The magnitude of rents captured by an airline, then is correlated with the relative magnitude of that airline's dominance in the market. Dominance

⁶³Borenstein (1989a).

⁶⁴Borenstein (1989b).

is measured as the observed carrier's fraction of total number of passengers in all markets with that endpoint -- it's a city-based measure, not strictly a market-based measure. The dominant incumbent airline collects rents in proportion to its relative dominance, and relative to its non-recoverable sunk cost. This can be seen in two ways. The airline must make an investment in differentiated service to establish its presence in a marketplace and overcome passenger information search cost barriers. The airline's sunk cost is the cost associated with establishing that reputation or the lost rents if that airline were to leave the market. Similarly, if a new carrier tries to enter the same marketplace, it will face a protracted period of low profitability as it gathers a population of potential passengers. The new entrant must offer service similar to that of the incumbent at the same or lower price, but has lower load factors until it can overcome passengers' information cost investment in the incumbent.

Deficiencies in Contestability Theory for Airline Competition

Recall that the theory of contestable markets suggests a mechanism to maintain competitive pricing in markets with few suppliers. The potential for costless entrance of a new supplier with a homogeneous product and similar cost structure prevents incumbents from realizing monopoly rents. Airline markets fail to meet the requirements for contestability in several ways. Not all airlines are equal: some have the advantage of very low cost structures; others have technologies that allow them to deliver differentiated service (or more effectively capture consumer surplus). Market entry is far from costless -- airline competition is not strictly price based and the substantial passenger information search costs represent a significant sunk investment by

incumbent airlines. Finally, in markets with very low demand densities, profitable competitive entry can occur only by totally displacing the incumbent after investing the associated sunk cost.

Several empirical studies have confirmed that airline markets are not perfectly contestable. Airline fares have been shown to depend on the number of competitors, their concentration, and competitor dominance at route endpoints or in share of passengers carried.⁶⁵ Further, airline contestability is not robust.⁶⁶ The existence of any significant sunk costs means that contestability alone will not force fares to competitive levels.

The concern about sunk costs required to enter a market is that incumbents ignore sunk costs when making pricing decisions. Once an airline is committed to a market (it has made the sunk investment), it no longer has to be concerned with sunk costs. The sunk costs are lost to the airline regardless of future pricing or strategic actions. The carrier will, however, make a fair return on continuing operations as long as price is greater than average cost.

Now consider a potential entrant in a market with substantial sunk costs. The entrant must expect to cover both average cost and amortized sunk cost after entry. The potential entrant, however, cannot be sure fares will remain that high because the incumbents will continue to earn a fair return when fares just cover average cost. Assuming both carriers have similar cost structures, the incumbents' can continue to earn a fair return at fares below

⁶⁵Graham, Kaplan, and Sibley (1983), Morrison and Winston (1986), Hurdle, *et al* (1988) and Borenstein (1989a andb).

⁶⁶Peteraf (1988).

those the entrant needs to cover both not-yet-sunk costs and average operating costs.

The decision to enter a new market will hinge on the potential entrant's expectation about price level after entry. What will be the incumbent's reaction to entry? If prices can be expected to settle at or above the critical level that will allow the entrant to recover her sunk costs, entry will occur. Otherwise, the potential entrant can expect to lose money and will not enter.

When both participants are rational and the market is isolated (actions in one market have no impact on actions in another), both participants will choose a profit maximizing price after entry (if it occurs). The incumbent will prefer the potential entrant believe the equilibrium price to be below the critical value that makes entry attractive, and may threaten to drop the price below that level. Such a threat by the incumbent is not by itself economically credible and won't discourage entry. (Again, assuming the incumbent is rational and there are no external market influences.)

Depending on the economic assumptions, prices after entry can settle at the competitive level, at a Cournot equilibrium or at a collusive solution. Both Bertrand and Cournot are non-cooperative solutions. Bertrand competitors end up at the same fares as pure competition by competing in price when the lowest price take the entire market. As discussed previously, the "winner take all" approach is not representative of most airline markets. The Cournot equilibrium provides somewhat greater profits for the competitors. It's defined as the price and output combination selected by each competitor such that each is making the most possible profit given the other competitor's choice of price and output.

In collusive pricing, both competitors choose price and output jointly to maximize profits. Both competitors would prefer the collusive solution given that entry will occur since that results in higher profits for both. In the U.S., however, colluding to restrict competition is illegal. A collusive outcome can sometimes be arrived at indirectly.

The collusive solution requires that competitive participation be restricted, that the parties have some method to signal price moves, and they can detect and punish cheating by other competitors.⁶⁷ The restriction on the number of market participants is because as more and more competitors enter, the market becomes more and more difficult to coordinate. Airline markets naturally limit the number of potential competitors. Depending on the demand conditions in each market, there's a natural limit on the number of competitors that market will support. With that number in the market, a potential entrant sees that entry will depress prices below the level at which they can expect to recover sunk costs and won't enter. The lower the total demand density in a market, the fewer competitors that market can support.

A collusive outcome also requires some way for the participants to signal price moves. Classically, economists have considered that the lowest price will capture a market. If competitors couldn't unambiguously signal price moves, one or more may not increase price at the same time and will gain a larger portion of the market and greater profits. As discussed above, airline markets are not purely price competitive (lowest price does not capture the market), but one carrier with a lower price will gain higher profits at the expense of the other carriers all things being equal. Since collusion in

⁶⁷Browning and Browning (1986), Pindyck and Rubinfeld (1989).

restraint of trade is illegal, and direct contact between competitors when setting prices is relatively easy for the Justice Department to notice,⁶⁸ airlines must have some other way of signalling price moves.⁶⁹

Airlines have tried several ways to signal prices. In 1983, American Airlines proposed a uniform fare structure based on flight distance.⁷⁰ The fare to be charged was calculated as a fixed charge per mile times the flight distance. The set of fixed charges was published; lower rates for longer trips, higher rates for shorter trips. Most other large airlines initially agreed to the American plan.⁷¹ Such a plan would allow easy price signalling by changing only a few numbers (the rates to be charged for different distances). Pan American World Airways, however, wanted a larger share of the market and refused to go along with the new structure. The simplified pricing plan collapsed when other carriers feared Pan Am would capture too much of their market shares.⁷² Recently, the larger airlines (American, United, Northwest, etc.) have begun to express a major portion of fare increases as an explicit fuel

⁶⁸ As Mr Crandall found out in the phone conversation referenced in the first chapter (*supra* note 8).

⁶⁹ Collusion in restraint of trade is illegal in the U.S. whether the price moves are directly coordinated or indirectly signalled. Indirect coordination, however, is more difficult to prove.

⁷⁰ "American to Base Fares on Mileage," *New York Times*, March 15, 1983, section IV, page 1, column 3.

⁷¹ "Most Big Airlines Back American's Fare Plan," *New York Times*, March 17, 1983, section IV, page 1, column 4.

⁷² "Pan Am Drops Its U.S. Fares," *New York Times*, March 31, 1983, section IV, page 31, column 6.

surcharge.⁷³ By relating at least a portion of price changes to a readily calculated rate (distance and fuel price), the airlines are making price signalling easier to coordinate.

The other way airlines have signalled price changes is through price leadership. As noted in chapter one, a casual observation of airline fares suggests that they move together. One major carrier will announce a fare change, and, in short order, either the other major carriers will follow suit, or the original carrier will abandon its proposed price change. The complexity of airline fares still makes coordination difficult (there is not a single price for a ticket between, say, Chicago and Atlanta -- the fare depends on such things as advance purchase, Saturday night stays, day of week, travel class, perhaps government discounts, etc.). Here, the computerized reservation systems owned by the largest airlines may help. Since each system must contain all competitors' fares, the larger airlines are in no doubt about their competitors prices. Again, the purpose of price signalling is so every competitor knows what the "right" price is. The simplified pricing structures discussed above make that message easier to transmit, but a CRS may make the simplification unnecessary.

Finally, a collusive solution depends on the ability for each competitor to detect and punish cheating. Collusion is the classic Prisoners' Dilemma: every competitors has an incentive to cut prices as long as they expect the other competitors stick to the higher collusive price.⁷⁴ With no mechanism to discipline cheaters, the market price will quickly fall and end up at the

⁷³"Air Fares Rise Faster Than Fuel Costs," *The Wall Street Journal*, January 17, 1990, page B1, column 3.

⁷⁴Browning and Browning (1986), Pindyck and Rubinfeld (1989).

Cournot equilibrium⁷⁵ where each competitor is doing as well as they can given the other competitors' (price-cutting) actions.

The complexity of airline fare structures not only complicates signalling, but also make detecting cheating more difficult. However, the major airlines' computerized reservation systems again help to solve the problem. Each major carrier knows (from their CRS) the planned number of seats at each fare level that their competitors have. Travel agent overrides can distort the real situation slightly, but in general, the largest airlines know their competitors' fares quite accurately. Among smaller airlines that don't own CRS's, however, the complexity of fare structures makes detecting cheating difficult. The major airlines can detect cheating among themselves and by smaller airlines easily; smaller airlines have greater problems identifying cheaters among themselves.

Maintaining market discipline also requires that competitors can punish cheating once it's been detected. Cutting fares in the market where the cheating occurs does nothing to discourage cheating because all competitors (the carrier trying to discipline the market and the cheater) suffer equally from a fare war in shared markets. (There is some evidence that market discipline can be maintained by cutting prices sharply in response to cheating and not raising them until after the cheater does, but this requires stable markets with no signalling ambiguity⁷⁶ -- there are more efficient alternatives for the larger airlines.) Since airline markets are not

⁷⁵As mentioned previously, pure price competition would devolve to the Bertrand equilibrium where price equals marginal cost. Competition on purely price is not typical of airline markets.

⁷⁶A "tit-for-tat" strategy. "The Importance of Being Nice, Orderly, Retaliatory, and Forgiving," *The Wall Street Journal*, November 10, 1988.

independent, however, actions by an airline in one market can influence competitive actions in other markets.⁷⁷

When airline operations overlap in several markets, one airline can punish another by dropping fares in all overlapping markets or choosing markets that will particularly hurt the cheater (such as the cheater's hub markets). The cheater loses profits not only in the market where she began to cheat, but in all markets the cheater shares with the disciplining airline. Of course, the disciplining airline also loses profitability in those overlap markets, but the cheater is paying a high price to cheat in a single market. The disciplining airline can maintain high fares in the markets that don't overlap with the cheater to finance this strategy.

When the market where the cheating occurs has several carriers, and those carriers overlap with the cheater in different markets, the cheater can be denied profitability on a substantial share of its route system while the disciplining carriers maintain high fares on routes that don't include the cheater. The key to success of this strategy is that the disciplining airlines place less of their revenue at risk than does the cheater.⁷⁸

Parenthetically, this fact that airline markets are inter-related also makes possible predatory pricing to keep low cost carriers out of a market. As discussed earlier, one of the ways that higher-cost airlines have successfully competed with lower cost airlines has been by being more efficient at extracting consumer surpluses. There is also evidence that they've engaged in predatory pricing to discourage market entry by a low-cost carrier using the

⁷⁷Bulow, Geanakoplos, and Klemperer (1985).

⁷⁸Levine (1987).

strategy outlined above.⁷⁹ As long as the incumbent places less of its revenue at risk than the entrant, such tactics are economically viable.

Economics, Strategy, and the Airline Industry Structure

Airline markets have a naturally limited number of participants, and the failure of contestability theory implies competitive entry into those markets is restricted. In addition, under certain conditions, airlines can successfully engage in predatory pricing that further limits the potential for competition. In general, then, airline markets are oligopolies (or monopolies) with the potential for carriers to extract excess rents. This alone does not mean that airlines can automatically earn abnormally high returns from their operations⁸⁰ or that consumers will be substantially worse off than if the markets were contestable.

Morrison and Winston⁸¹ have evaluated the net change in consumer welfare since airline deregulation. They conclude that in aggregate consumers and airlines are better off after deregulation. Overall, fares have decreased and airline profitability has improved.⁸² On specific routes, they

⁷⁹Levine (1987).

⁸⁰The periods of extremely poor airline financial performance during recessions (Salomon Brothers report *supra* note 11) and the theory of efficient markets (Brealey and Myers, 1988) in fact suggest that on aggregate airlines realize about the same return as the economy in general.

⁸¹Morrison and Winston (1986).

⁸²Profitability has improved despite the lower average fare level because airline load factors (the fraction of each flight that is filled with paying customers) have increased. During the regulated era, the only competitive mode available to airlines was service competition. That resulted in generally excess capacity as airlines provided more frequent departures than was socially optimal. To some degree, airlines have now substituted price competition (lower fares) for service competition.

find that fares are higher than expected under perfect competition. However, when they consider the consumer benefit or more frequent departures on those routes, they estimate a net consumer welfare gain.

By dividing the markets they consider into two groups, Morrison and Winston find that markets with major carriers are generally characterized by higher fares and more frequent departures, while markets of other carriers have generally lower fares. They suggest that airline competition is "a combination of some version of the dominant firm model and imperfect contestability."⁸³ The largest carriers establish the general market conditions, but their actions are tempered by the existence of smaller potential entrants.

As Harvard's Michael Porter⁸⁴ has suggested, firms in any industry will attempt to manipulate their competitive environment. Firms, including airlines, will take advantage of market characteristics with strategic actions intended to reduce the amount of competition they face. Levine argues that many of the "deviations from perfect contestability"⁸⁵ not predicted by traditional organization theory are the result of airlines acting strategically to insulate themselves from competition. As they reduce competition, they gain market power and can capture rents. Where the number of competitors in the market is already limited (either by the limits of contestability or prior firm

⁸³Morrison and Winston (1986), page 64.

⁸⁴Porter (1980).

⁸⁵Levine (1987), page 396.

strategic action), firms will attempt to collude to raise prices as high as possible.

At the same time, however, there are economic forces working to limit airlines' ability to shape their environment as they would wish. The differences in airlines' cost structures, the difficulties in signalling and enforcing coordinated prices, and non-price competition such as departure timing, frequent flyer reward schedules, and consumer information search costs all interfere with coordination. Successfully capturing excess rents depends on the fundamental competitive conditions in the market and an airline's appropriate selection of strategy to take advantage of those conditions.

Bailey and Williams⁸⁶ apply both economic and strategic analysis to airline competition. Their methodology is to cluster airlines into two strategic groups, compare the financial results of carriers in each group, and identify common strategies that led to unusually high returns. Building on Porter's three generic strategies,⁸⁷ they propose that airlines may successfully capture rents by either positioning themselves as local monopolists or by competing oligopolistically based on scale advantages. Airlines that cannot take advantage of either strategy are "stuck in the middle," as Porter puts it, and do not show unusual profitability -- in fact may not survive in the long run.

⁸⁶Bailey and Williams (1988).

⁸⁷Porter (1980), pages 34-40.

As a legacy of the regulated era, airlines began, and continue for the most part, operating in one of two distinct classes: either as trunk or local carriers. The original trunk carriers continue to operate nationally in mostly high-density markets. The original local carriers continue to operate primarily regionally and on less dense routes. Bailey and Williams conclude the airlines that have consistently had the best aggregate financial performance must have selected strategies that allow them to capture the maximum rents from the markets they operate in.

The most successful hold-overs from the regulation-era regional carriers continue today to compete regionally. For example, US Air (originally Allegheny Airlines), Piedmont, and Eastern all concentrate on east coast routes. Western and Republic concentrate in the west.⁸⁸ On most routes, these carriers don't compete with former national trunk carriers. They face either other regionally based carriers or hold monopolies.

The surviving former trunk carriers, which today control the majority of air travel,⁸⁹ continue to compete primarily with each other in markets with high demand densities. They can operate successfully as oligopolists because they see each other in many markets and they have computerized reservation systems that provide clear signals about price moves and cheating. In market

⁸⁸Since 1986 when the data for this study was collected, there has been some significant retrenchment among the regional carriers. US Air has recently merged with Piedmont. Eastern was acquired by the Texas Air Group; while it still operates as a separate airline, it has filed for Chapter 11 bankruptcy protection. Republic was acquired by People Express, which in turn was acquired by Texas Air and the Republic routes were merged into Texas Air's Continental Airlines system.

⁸⁹Levine (1987).

where they compete primarily with each other, they can coordinate to maintain fares at the higher collusive levels.

Airlines' ability to collude on fares depends critically on the ability to enforce market discipline through actions in other markets. Competitive entry is limited in all airline markets by the failure of contestability theory. The opportunity for predatory pricing may further limit entry, but only in unique cases. To be successful, the incumbent must have a revenue base in other markets that is not at risk from predatory prices and the entrant must lack such a base. Additionally, predatory pricing to discourage entry in an oligopoly market (as opposed to a monopoly market) may be difficult for the other competitors already sharing the market to distinguish from predatory pricing against them. For example, consider three airlines: one small, but growing rapidly in a region; one that operates on many of the same routes as the small airline, but also on other national routes, and a large national airline that shares only a few routes with the small airline, but more with the medium airline. The medium carrier may consider the small carrier a significant competitive threat and respond with predatory pricing. The large carrier, however, doesn't see the small carrier as a threat because it doesn't share many markets with the small airline. The large carrier may see the medium carrier's predatory pricing on the routes all three share as directed against not the small carrier, but the large carrier. The large carrier then responds by cutting fares on all routes it shares with the medium carrier. In the end, the medium carrier doesn't have a protected revenue stream with which to engage in predatory pricing against the small carrier. The point is simply that predatory pricing is more likely to be effective when used to maintain a monopoly route than when used to restrict entry into an oligopoly route.

Since essentially all airline markets have limited competition, an airline's success in maintaining a coordinated fare depends primarily on its ability to maintain market discipline. That in turn depends on the number of other markets the competitors share and each of their abilities to protect a portion of their revenue stream. Markets made up primarily of the larger airlines (those participating in the most different markets) should be more successful at maintaining market discipline than markets with smaller carriers.

I test the thesis that airlines operating in many markets successfully collude on prices by dividing airline market into three subsets and testing for the differences in fare levels. Markets with only large carriers should have higher fares than market with only small carriers or both small and large carriers. In markets with only a single carrier I expect to see the highest fares because those carriers should be able to capture monopoly rents.⁹⁰ Chapter 3 presents the data and methodology I use to make this test and chapter 4 presents the specific model.

⁹⁰As will be discussed in chapter 4, this expectation is not borne out.

Chapter 3

The Data and Methodology

I use an econometric model of average airline fares in each market to test my thesis that airlines operating in many markets simultaneously are successfully able to collude among themselves. The data for the model is drawn from a Department of Transportation database of airline tickets sold for every market in the U.S. The basic model is a reduced form of the industry fare equation. The existence of endogenous variables in the equation requires the use of instrumental variables to estimate the equation. I isolate the hypothesized effects of airline collusion with dummy variables and test their significance using the appropriate F-test.

The Data

The reduced form industry fare equation estimates average carrier fare in each market as a function of variables for the airline's cost of operations and factors (in addition to cost) that influence a customer's choice of airline.⁹¹ Variables that influence an airline's cost of operations are distance covered by the route and number of passengers carried. As discussed in chapter two, factors such as carrier dominance and route share reflect passengers' investment in information search costs that allow airlines to capture higher rents exclusive of collusion. A measure of tourist demand on the route

⁹¹Here I am following the work of Morrison and Winston (1986), Graham, Kaplan, and Sibley (1983), Hurdle *et al* (1988), Peteraf (1988) and Borenstein (1989b).

provides a proxy for passengers' demand elasticities. (Time sensitive travellers such as business flyers are less cost sensitive.)

The data are based on the Department of Transportation Origin and Destination Database 1A for the second calendar quarter of 1986.⁹² The O&D DB1A is a random 10% sampling of all commercial airline tickets sold in U.S. markets -- one data record with date and fare paid for each ticket sold. The individual records were combined for each airline in each market resulting in a single average fare (weighted by number of passengers at each fare) for each carrier-route. This weighted average fare is the variable FARE.

The data used covers 1823 carrier-route observations comprising the largest (highest traffic density) 521 direct service routes. The endpoints are the most active passenger airports in the U.S. from Chicago O'Hare Field (number one) to Dead Horse/Prudhoe Bay, Alaska (number 200). The carrier-route observations come from the top 1200 airline markets in terms of traffic volume.

In a perfectly competitive environment, airline fares would exactly reflect airline costs. (Under perfect competition, price is marginal cost equal to average cost.) Even in the imperfect airline markets, fares will have a positive correlation with costs. The more costly are operations in a specific market, the higher will be the fare in that market, other things equal. Variables used that influence carrier costs are route distance and number of passengers carried.

⁹²The data were obtained from Severin Borenstein and Nancy Rose, and are described in further detail in Borenstein and Rose (1989).

Airline operating costs increase as the route distance increases primarily because of fuel costs and flying-hour based maintenance costs. (Scheduled maintenance activities on airplanes is based on flying hours or engine operating hours. Airplanes flying longer routes reach the scheduled maintenance time after fewer trips than airplanes flying shorter routes.) On a "per mile" basis, however, average costs decline as route distance increases. An airplanes expend relatively more of their fuel and time climbing to altitude and landing than they do cruising. On short routes, a greater fraction of the airplane's "resources" (fuel and time between maintenance intervals) are spent on take off and landing when the airplane is at its lowest performance efficiency. The variable in this study that captures the distance based airline costs is named DISTANCE. It's the Great Circle distance between the two endpoints of the market measured in nautical miles.

Passenger volume affects an airline's average cost per passenger due to economies of scale in providing service on a route. Assuming the airlines planes aren't full, adding one more passenger to a flight will have a very small marginal cost (one more meal, a small processing charge, a miniscule change in fuel efficiency). The total number of passengers carried is directly related to the average cost of each flight. The cost difference to the airline of flying an empty airplane or a full one is relatively small. The difference in average cost per passenger is large. If an airline was faced with frequent near empty flights, its average costs would be high and fares must also be high. PAX is the number of direct-routing passengers carried per week by the observed airline.

The number of passengers carried by the airline on the observed route is also a function of the airline's average fare. (As discussed in chapter 2,

airline markets are not apparently strictly price competitive, however, the less time sensitive portions of the markets certainly are price sensitive.) The relationship between fares and passengers, then is simultaneous: more passengers carried results in lower average cost and lower fares; at the same time, lower fares attracts more customers. The market fare equation I estimate is concerned with the first relationship. Ordinary least squares, however, will not provide a best linear unbiased estimator in the presence of an endogenous right-hand variable (the second relationship).⁹³

The technique of instrumental variables does provide a best linear unbiased estimator if there exists a set of variables that is correlated with the endogenous right-hand variable but not with the left-hand variable. In this regression, I selected various combinations of endpoint populations to instrument for the passengers variable. The populations of the market endpoints do not depend on the average fare charged by the observed airline (independent of the left-hand side), but the number of passengers depends on the size of the populations from which they're drawn. Having no *a priori* knowledge of the exact relationship between population size and passengers, I chose four combinations of endpoint populations for instruments. POP1 is the population, in thousands, of the Standard Metropolitan Statistical Area that includes the larger of the two endpoint airports. POP2 is the population of the smaller airport metropolitan area.⁹⁴ AVEPOP is the arithmetic average of POP1

⁹³Pindyck and Rubinfeld (1981).

⁹⁴Population figures, like the other data were obtained from Severin Borenstein and Nancy Rose. Their original source was the 1987 Statistical Abstract of the U.S.

and POP2; PRODUCT is their geometric average (the square root of their product).

Variables that influence passenger choice of airline are that airline's dominance at endpoint airports and its overall share of passengers carried on the route.⁹⁵ As discussed in chapter 2, passengers make an investment in information search costs when they decide on an airline. After making that investment, they tend to stick with that airline even if its fares are slightly higher. Airlines that have a well-known presence in a market (are dominant either in enplanements at endpoints or in total passengers carried) have advantages in attracting new passengers.

DOMO measures the observed carrier's dominance at the endpoints of the market. It's an average of the carrier's share of enplanements at each endpoint weighted by the total number of enplanements by all carriers. American Airline's dominance in the Denver to Dallas market, for example, would be the average of American's share of passengers beginning their journey from Denver to any city and their share of passengers beginning a journey in Dallas to any other city. In this case, American's share of Denver enplanements would be relatively small (it's a United Airlines hub), but their share at Dallas would be large (Dallas/Ft Worth is an American hub). Note that dominance is a measure of the observed carrier's dominance at the endpoints of the market, not in number of passengers actually carried in that market. In the example, American would have a reasonably high dominance based on its Dallas/Ft Worth hub, but still may not carry the largest share of passengers in

⁹⁵Borenstein (1989a and b).

the market because a smaller, regional airline (not dominant at either endpoint) specializing in that market does (for example, Republic).

The observed carrier's share of the total number of passengers carried in the specific market is measured by ROUTESHR. It is the number of passengers in that specific market carried by the observed carrier divided by the total number of passengers in that market.

ROUTESHR may indirectly depend on the fare charged by the carrier. Because of the time delays involved in building a customer base, one would not expect low fares to quickly be translated into large shifts in share of passengers carried. Over time, however, such shift will likely occur if a low-cost carrier can survive and maintain lower fares. ROUTESHR is likely to be particularly sensitive in markets with a significant fraction of non-time-sensitive passengers.⁹⁶ To avoid the concern that ROUTESHR may be endogenous, I instrument for it with a variable measuring airline size. SIZE is the fraction of total revenue passenger-miles carried by the observed airline relative to the total revenue passenger-miles carried by the largest airline in the study. Revenue passenger-miles are calculated from only the markets used in this study.⁹⁷ (Total carrier revenue passenger-miles per week is the sum over all markets in the study of passengers times distance. The "per week" is

⁹⁶People Express' rapid growth in new markets would be an example. People's entry into a new market probably didn't change incumbent's passenger shares immediately, but certainly did within a matter of months. See Serman, *supra* note 46.

⁹⁷SIZE, and the dummy variables discussed later, are derived as described from the data obtained from Severin Borenstein and Nancy Rose but are not described in Borenstein and Rose (1989). The data are available from the author. (AVEPOP and PRODUCT are simple mathematical manipulations of data described in Borenstein and Rose (1989).)

because passengers is reported as per week -- it results in a constant scale factor that drops out when the ratio SIZE is calculated.)

Finally, TOURISM measures the time sensitivity of travellers in the observed market. Again, as discussed in chapter 2, many of the market imperfections that create sunk costs and allow airlines to capture consumer surplus depend on the time sensitivity of business flyers. In markets with a large portion of tourist traffic, airlines can less successfully offset lower tourist fares with higher short purchase lead-time business fares. Some studies have used a dummy variable for tourist markets.⁹⁸ This has two disadvantages. One, that the definition of a tourist market in this case is somewhat judgmental -- at what concentration of non-business traffic does the route qualify as tourist? Secondly, the impact of tourist travel in a market is not a binary switch between higher business fares in one market and low tourist fares in another. There is clearly a range of business flyer predominance in markets: a large fraction of unrestricted business fares and a low fraction of restricted tourist fares at one extreme, to the predominantly tourist route with few unrestricted business fares. Borenstein has created a continuous measure of tourist concentration in a market.⁹⁹ It's based on income at each endpoint derived from hotel tourist and group travel compared to the total personal income at the endpoint. The index used in this study is the

⁹⁸Graham, Kaplan, and Sibley (1983), and Peteraf (1988).

⁹⁹Borenstein (1989b).

weighted average of that measure at each endpoint truncated when the average exceeds 0.07.¹⁰⁰

Table 1 present the summary statistics for the full sample of 1823 carrier-route combinations used in this study.

Number of observations: 1823

<u>Variable</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Maximum</u>	<u>Minimum</u>
DISTANCE	636.4	482.2	2680.0	50.0
PAX	1999.1	2728.7	32341.0	1.0
ROUTESHR	0.36	0.31	1.0	0.0
DOMD	0.18	0.13	0.85	0.01
FARE	99.04	43.84	471.20	17.50
POP1	14388.5	7726.4	32712.0	424.0
POP2	15886.2	9408.7	32712.0	424.0
TOURISM	0.02	0.02	0.07	0.0

Table 1 -- Full Sample Statistical Summary

The Methodology

Beginning from the reduced form airline industry fare equation, I test whether the average fare collected by carriers depends on the competitive conditions in the market. Specifically, are fares lowest when airlines operate

¹⁰⁰Borenstein (1989a) and Borenstein and Rose (1989) further describe the index and why it's truncated. In short, however, Borenstein believes that values greater than 0.07 aren't meaningful.

in markets where they cannot successfully collude, higher when competitive conditions favor collusion, and highest when the carrier has a monopoly? I evaluate my thesis that airlines operating in many markets do successfully collude on fares in market where they compete only with each other by constructing the reduced form fare equation, creating dummy variables for the parameters of interest, and testing the statistical significance of those dummies using the appropriate F-test.

I derive the industry fare equation by regressing the average fare on the variables that influence the fare (discussed above). The basic regression is of the form:

$$\text{FARE} = \beta_0 + \beta_1 \ln \text{DISTANCE} + \beta_2 \ln \text{DOMO} + \beta_3 \ln \text{PAX} + \beta_4 \ln \text{ROUTESHAR} + \beta_5 \ln \text{TOURISM}.$$

This model follows previous work that estimates the industry fare equation using econometric methods.¹⁰¹ As discussed above, the right-hand side variables capture the discrete inputs that determine airline fares. Distance and passengers measure the cost of providing service, dominance and route share approximate non-financial consumer information costs, and tourism measures the airline's ability to capture consumer surplus through third degree price discrimination.

Passenger, endpoint dominance, and route share are endogenous variables. Not only do they help determine the fare an airline can charge, but the fare affects the number of passengers and that airline's share of the passengers.¹⁰² When the right-hand variables are not independent of the

¹⁰¹Graham, Kaplan, and Sibley (1983), Morrison and Winston (1986), Hurdle *et al* (1988), Peteraf (1988), and Borenstein (1989a and b).

¹⁰²In the worst case, consider People Express. Don Burr, People's founder, expected to attract a significant portion of the non-flying public to his airline

left-hand variable, ordinary least squares will be biased and inconsistent. I therefore use two-stage least squares to estimate the model. Two-stage least squares will yield consistent estimates of the regression coefficients.¹⁰³ As reported in the regression results of chapter 4, the coefficients do shift significantly between OLS and 2SLS, suggesting 2SLS is required.

From the basic reduced form industry fare equation, I measure the effects of differing market competitive conditions by constructing a set of dummy variables to isolate the conditions of interest. Dummy variables can stand alone in the estimated equation or can be multiplied by other variables as interaction terms. Dummy variables alone in the equation allow the average fare to shift up or down as the measured condition turns "on" or "off". When interaction terms are included, they measure how the slope of the estimated equation shifts as the data represented by a "true" dummy variable is included in the regression.¹⁰⁴

Since my primary interest is to determine if there is a difference in the fares airlines can charge on monopoly routes versus markets where they may be able to coordinate fares versus other markets, I define a set of dummy variables to create these distinctions. The variable MONOPOLY is one whenever the observed carrier is the only airline serving a market, zero otherwise. Table 2 reports the summary statistics for the 132 carrier-route combinations that qualify as monopolies in the data I used.

with very low fares. In markets served by PE, total customer market size did, in fact, increase. Sterman, *supra* note 46.

¹⁰³Pindyck and Rubinfeld (1981).

¹⁰⁴Pindyck and Rubinfeld (1981).

Number of observations: 132

<u>Variable</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Maximum</u>	<u>Minimum</u>
DISTANCE	488.6	306.6	1414.0	50.0
PAX	2580.3	2136.5	13656.0	18.0
ROUTESHR	1.0	0.0	1.0	0.0
DOMD	0.36	0.18	0.85	0.03
FARE	93.49	44.81	471.20	17.50
POP1	14433.3	9430.2	32712.0	424.0
POP2	16088.7	8881.6	32712.0	580.0
TOURISM	0.01	0.01	0.07	0.0

Table 2 -- Monopoly Observations Statistical Summary

Comparing the monopoly routes of table 2 with the full sample statistics of table 1, you can see that monopoly routes are generally shorter, have somewhat lower fares, and have a lower tourism index. Monopoly markets in this data are substantially shorter than the non-monopoly routes. (The average monopoly route is only 77% as long as the the full sample average, the standard deviation is nearly 40% smaller, and the longest monopoly route is just slightly longer than half the distance of the longest non-monopoly route.) Shorter monopoly routes are consistent with Bailey and Williams' conclusion that regional carriers capture rents by concentrating on monopoly markets in the region they dominate and national carriers compete on oligopoly

routes.¹⁰⁵ Regional markets are shorter than national markets because they are geographically constrained.

Monopoly market route share is by definition 1.0, and endpoint dominance is substantially higher on monopoly routes than in the full sample data. Again, this make sense if most monopoly markets are regional carriers exploiting a geographical dominance.

Monopoly fares are on average somewhat lower than the full sample average, but the routes are shorter. (Therefore the operating cost is less.) The average populations at both endpoints are essentially the same as for the full sample. The tourism index is substantially lower, on average, for monopoly markets and the standard deviation of the index is tighter. Many of the sunk costs discussed in chapter 2 that make airline markets incontestable are targeted at time sensitive business flyers (information search costs, frequent flier programs, CRS's, etc.). In markets with higher proportions of vacation travellers, maintaining a monopoly is simply harder to do. Therefore, most monopoly route should be in markets with lower tourism.

The other primary dummy variable I define is OLIGOPLY for those carrier-route combinations on which I hypothesize collusion is possible. As outlined in chapter 2, market in which collusion is likely are when the competitors are are all airlines that operate in many markets (I assume some of these operations overlap), and there are no small competitors to act as price spoilers. Table 3 lists the eleven carriers operating in the most markets in the data I used.

¹⁰⁵Bailey and Williams (1988).

<u>Symbol</u>	<u>Airline</u>	<u>Number of Markets*</u>
UA	United	190
DL	Delta	167
EA	Eastern	165
AA	American	145
PI	Piedmont	132
AL	US Air	106
RC	Republic	88
Ⓞ	Continental	81
TW	TWA	75
NW	Northwest	73
WN	Western	73

* Number of markets the observed airline serves of the 521 largest direct service routes.

Table 3 -- Major Carriers

Prior econometric work has divided carriers into a two groups: eight major carriers (the surviving trunk carriers from the regulated era) in one group and all others in the second.¹⁰⁶ Further, observing the number of markets in which each airline participated, there are "break points" between the sixth and seventh and between the eleventh and twelfth ranked carriers. Since Continental, TWA, and Northwest Orient were all former trunk carriers (hence classically defined "majors") and place below seventh in market

¹⁰⁶Graham, Kaplan, and Sibley (1983), Morrison and Winston (1986).

participation, I decided the break point below the eleventh carrier is more representative of my thesis than the higher break point.

I considered other ordering criteria before selecting market participation as the determinant of "large" carriers. The relative rank of the airlines remained mostly unchanged when ordered by total number of passengers, by revenue passenger-miles, or by total revenue. When ordered by these other criteria, one or another of the airline would change rank by one spot, but the break points, and the identity of "large" carriers, remained unchanged. Levine found a similar stability in airline rankings.¹⁰⁷

With the definition of "large" airline, I constructed a dummy variable, OLOGOPLY, that equaled one when the carrier-route observation was for a market in which two or more large carriers and no small carriers operated. In such markets, the large carriers may be able to collude -- without smaller airlines to act as spoilers and disciplining each other if required in other markets. Table 4 reports the statistical summary of 570 carrier-route combinations (from the total sample of 1823) that met this definition for possible collusive outcome.

Oligopoly markets are only a little shorter than the total sample average with similar standard deviation, maximum, and minimum. The number of passengers carried by the average oligopolist is significantly smaller than the total sample average, and the standard deviation is smaller. Airport dominance

¹⁰⁷Levine (1987) points out that "the ten largest firms contolled 94.6% of industry passenger miles in 1986....While use of other measures might change the percentages slightly, none would change the identity of the ten largest carriers." (Page 406, footnote 68.)

Number of observations: 570

<u>Variable</u>	<u>Mean</u>	<u>Std Dev</u>	<u>Maximum</u>	<u>Minimum</u>
DISTANCE	610.3	426.3	2445.0	127.0
PAX	1378.0	1622.6	15502.0	1.0
ROUTESHR	0.38	0.29	0.99	0.0
DOMO	0.20	0.12	0.60	0.01
FARE	117.16	39.16	250.70	32.10
POP1	15851.7	7064.1	32688.0	424.0
POP2	16839.4	9730.7	32688.0	424.0
TOURISM	0.01	0.01	0.06	0.0

Table 4 -- Oligopoly Observations Statistical Summary

and route share are similar between the oligopoly markets and the total sample. Fares are, as expected, substantially higher than for the total sample. Endpoint populations are also larger. If oligopoly conditions exist only on routes served by the largest airlines, who also have higher cost structures, high population densities and correspondingly higher demand makes sense. Finally, the tourism index is only half the average of the full sample. Again, collusion is made more likely when passenger time sensitivity reduces the threat of pure cost competition.

The model constructed, then, regresses average fare in each airline-market combination on those factors that influence fare level independent of market competitive conditions (airline costs, passenger information search costs and time sensitivity) and two dummy variables for the competitive

conditions (MONOPOLY and OLIGOPLY). The markets in which both MONOPOLY and OLIGOPLY equal zero are the "competitive" baseline. (Such markets are not perfectly competitive, of course, and the actual fare is probably closer to the Cournot solution than competitive. They do represent that subset of markets in which competitive conditions don't favor collusive oligopoly or monopoly fares.) The test of the my thesis that large airlines can and do coordinate fares under the proper competitive conditions is the coefficient on OLIGOPLY. Monopolists should earn the highest rents, so I expected the coefficient on MONOPOLY to be statistically significant and positive. It measures the deviation from "average" fare that the "average" monopolist earns. If my thesis were correct, I expected the coefficient for OLOGOPLY to be statistically significant, positive, and somewhat smaller in magnitude than the coefficient for MONOPOLY.

A *t*-test will properly evaluate a coefficient's significance when ordinary least squares or two-stage least squares is the regression technique. To test hypotheses with more than one parameter under ordinary least squares, an F-test is used. It's appropriate, for example, to determine if blocks of coefficients, individually insignificant, contribute to the explanatory value of the model or if two or more coefficients are equal to each other. In the regression discussed above, an F-test could be used to determine if OLIGOPLY and MONOPOLY were substantially different (under ordinary least squares).¹⁰⁸

When two-stage least squares is used, however, the commonly used F-statistic does not follow an F-distribution.¹⁰⁹ An approximately correct F-

¹⁰⁸Pindyck and Rubinfeld (1981).

¹⁰⁹Phone conversation with Dr. Charles Nelson, Economics Department, University of Washington. Dr. Nelson and Dr. Richard Starts have done some recent work on the common F-statistic under two-stage least squares.

statistic can, however, be derived. Let x_{i1} and x_{i2} be vector of the right-hand variables in the regression (some of them endogenous), and \hat{x}_{i1} and \hat{x}_{i2} be the regression vectors fitted on the appropriate instruments. Let \hat{u}_i be the residuals from the restricted two-stage least squares regression (the regression with the null hypothesis, H_0 , installed). Regress \hat{u}_i on \hat{x}_{i1} and \hat{x}_{i2} and compute the R^2 . The Lagrange multiplier (LM) under the null hypothesis is $N \cdot R^2$ (where N is the number of data points) and is distributed approximately as Chi Square with degrees of freedom equal to the number of restrictions.¹¹⁰ As in the usual F-statistic calculation, SSR_R is the sum of the squared residuals from the restricted model, and SSR_{UR} is the sum of the squared residuals in the unrestricted model. The corrected F-statistic is defined as:

$$F = \frac{(N-K)}{N} \cdot \frac{SSR_R}{SSR_{UR}} \cdot \frac{LM}{K_2},$$

where K is the number of right-hand side variables and K_2 is the number of restrictions. This corrected F-statistic follows approximately an F-distribution with K_2 , $N-K$ degrees of freedom.¹¹¹

According to Dr. Nelson, they have not yet determined what its proper distribution is, but "it's clearly not an F-distribution." Dr. Jeffery Wooldridge, Economics Department, Massachusetts Institute of Technology has experimented with the common F-statistic under two-stage least squares and found it can result in a negative number -- a meaningless result. I am indebted to Dr. Wooldridge for the derivation that follows of a corrected F-statistic.

¹¹⁰Engle (1984).

¹¹¹Wooldridge (1990).

Chapter 4

Model and Results

As discussed in chapter 3, the basic regression model is a reduced form of the airline industry fare equation. Carrier fare on each route is hypothesized to be a function of route distance, number of passengers carried, that carrier's endpoint dominance and share of total market traffic, the degree to which tourism is a factor in the market, and a set of dummy variables that describe competitive conditions in the market. Because passengers and route share are endogenous variables, the technique of instrumental variables, or two-stage least squares, is used in the regression. The instruments for passengers are combination of the population statistics at both endpoints; the instrument for route share is carrier size.

Table 5 on the next page presents a summary of the variable definitions. In summary, FARE is the dependent variable, the average fare charged by each carrier in each market. DISTANCE is the length of the route in nautical miles, and is a proxy for the airline's market specific operational cost. PAX is the number of passengers carried each week by the observed carrier. DOMO is the weighted average of the airline's share of enplanements at each endpoint airport, and ROUTESHR is the observed carrier's share of all passengers carried in the market. Together they variation in the magnitude of passengers' sunk information search costs in the observed carrier. TOURISM is an index that measures the amount of non-business traffic in the market. Non-business traffic is less time sensitive, and markets with higher values of TOURISM will be more price competitive than other markets.

Expected signs on the coefficients for DISTANCE, DOMO, and ROUTESHR are all positive. As discussed in chapters 2 and 3, DISTANCE is positively correlated with the airline's cost of providing service. DOMO and ROUTESHR are positively correlated with passengers' sunk information search costs and allow the observed airline some market power in pricing.¹¹² On the other hand, the expected signs for both PAX and TOURISM are negative. As PAX increases, as the denominator in the average cost formula, average costs decrease and the competition-based fare decreases. As discussed above, higher values of TOURISM indicate a smaller percentage of business travellers, less time sensitivity on the part of average passengers, and greater price elasticity of demand.

POP1 and POP2 are the populations of the Standard Metropolitan Statistical Areas that include each endpoint, AVEPOP is the arithmetic average of POP1 and POP2, and PRODUCT is the geometric average of the two. All four population variables are used as instruments for the endogenously determined PAX. SIZE is the size of the observed carrier in terms of revenue passenger-miles relative to the airline with the most revenue passenger-miles in this sample. It's an instrument for ROUTESHR. The dummy variables describing the market competitive conditions will be described when they are used in the regressions.

¹¹²Borenstein (1989a and b).

AVEPOP	Arithmetic average of POP1 and POP2.
DISTANCE	Great circle distance between the two endpoints of the market.
DOMO	Average of observed carrier's share of all passenger enplanements at both endpoints weighted by portion of observed carrier's passengers who began their trips from each endpoint.
FARE	Average fare received by observed carrier over route weighted by number of passengers.
MAJRMONO	Dummy variable for single major (large) carrier serving a market.
MONOPOLY	Dummy variable for only a single carrier serving market.
OLIGOPLY	Dummy variable for two or more major airlines and no smaller airlines serving market.
OLIG2	Dummy variable for exactly two major airlines and no smaller airlines serving market.
OLIG3	Dummy variable for exactly three major airlines and no smaller airlines serving market.
OLIG4	Dummy variable for four or more major airlines and no smaller airlines serving market.
PAX	Number of direct routing passengers carried per week by observed airline on the route.
PEROUTE	Dummy variable for markets served by People Express.
POP1	Population, in thousands, of Standard Metropolitan Statistical Area for endpoint with the larger airport.

Table 1 -- Variable Definitions

POP2	Population, in thousands, of Standard Metropolitan Statistical Area for endpoint with the smaller airport.
PRODUCT	Square root of the product of POP1 and POP2.
RESTRICT	Dummy variable for markets with FAA take off and landing slot restrictions.
ROUTESHR	Number of direct routing passengers carried by observed airline divided by total number of direct passengers travelling in the market.
SIZE	Observed airline's revenue passenger miles relative to largest airline.
SMALL10	Dummy variable for small carrier market share greater than 0% but less than 10%.
SMALONLY	Dummy variable for small carrier share greater than or equal to 10% but less than 20%.
TOURISM	Borenstein's measure of tourism demand on market. A weighted average of hotel tourist/group income relative to personal income at each endpoint.

Table 1 (continued) -- Variable Definitions

Before evaluating the significance of differing market competitive conditions on airline fares, I determined an appropriate form of the basic fare equation. I had no *a priori* theoretical reason to believe the fare equation should be linear, semi-log, or log-linear in the dependent variables. Earlier econometric analyses of airline fares have assumed either a semi-log relationship or a log-log one.¹¹³ With no *a priori* theoretical model and no clear recommendation from earlier econometric work to suggest the proper form of the equation, I decided to use the log-log form. There is some evidence that the price elasticity of demand for airline travel is constant over a reasonable range of values,¹¹⁴ and the log-log form of the fare equation corresponds to the constant demand elasticity model. Table 6, however, presents the regression results for both semi-log and log-log forms of the basic fare equation and for ordinary and two-stage least squares regression techniques. (Standard errors for the coefficients are presented in parentheses below the value of each coefficient.) As argued in chapter 3, both DOMO and PAX are likely endogenously determined and two-stage least squares is the correct estimation technique.

To test my thesis that airlines that operate in many different markets can successfully collude on fares when they compete only with each other, I introduce dummy variables for competitive market conditions. For the initial tests, I construct dummy variables to distinguish between the hypothetical competitive, monopoly and large carrier oligopoly markets. From these regressions, I further test the limits of airlines' ability to collude by

¹¹³Graham, Kaplan, and Sibley (1983), Morrison and Winston (1986) assume semi-log form; Peteraf (1988) and Borenstein (1989 a and b) use log-log.

¹¹⁴Sterman, *supra* note 46.

	<u>Ordinary LS</u>		<u>Two-Stage LS</u>	
Dependent variable:				
	<u>FARE</u>	<u>ln FARE</u>	<u>FARE</u>	<u>ln FARE</u>
<u>Variable:</u>				
Constant	-89.910 (11.010)	2.380 (0.109)	1142.761 (936.031)	3.264 (0.450)
ln DISTANCE	38.198 (1.073)	0.434 (0.011)	62.869 (19.307)	0.454 (0.015)
ln DOMO	4.959 (1.108)	0.059 (0.011)	67.621 (45.938)	0.196 (0.054)
ln PAX	-9.540 (0.851)	-0.116 (0.008)	-156.327 (112.025)	-0.213 (0.053)
ln ROUTESHR	7.721 (0.954)	0.098 (0.009)	86.646 (68.498)	0.081 (0.053)
ln TOURISM	-8.643 (1.109)	-0.107 (0.011)	25.398 (26.070)	-0.078 (0.017)
* Instruments for two-stage least squares: ln AVEPOP, ln POP1, ln POP2, ln PRODUCT, ln SIZE.				

Table 6 -- Basic Fare Equation Regression

introducing variables to isolate specific market conditions that should influence to successful collusion. These include the presence of very low-cost carriers, FAA take off and landing restrictions, and a piecewise linear test of when small carrier presence destroys large carrier collusion.

The first set of regressions tests the basic competitive conditions. OLIGOPLY is equal to one when the observed carrier is one of the large airlines identified in table 3 and the only other carriers competing in that market are also large airlines and is zero otherwise. If my thesis is correct, I expect the coefficient for OLIGOPLY to be positive and statistically significant. I also introduce the dummy variable MONOPOLY to measure the impact on fares of

airlines with monopoly market power. MONOPOLY is equal to one when the observed carrier is the only airline serving the market and is zero otherwise. Table 7 presents the two-stage least squares regression results.

Table 7 also includes a regression that breaks down OLIGOPLY by the number of large airlines in the market. OLIG2 is one when only two large carriers compete, zero otherwise; OLIG3 is one when exactly three large carriers compete, zero otherwise; OLIG4 is one when four or more large carriers compete, zero otherwise.

With the addition of monopoly and oligopoly dummy variables, the coefficients for DISTANCE, ROUTESHR, and TOURISM remain relatively stable. There's no reason to believe that the effects of distance and tourism should be better described by one or both of the dummy variables. As shown in the summary statistics for the samples presented in chapter 3, both monopoly and oligopoly markets have lower tourism indices than the overall population. A high tourism index makes limiting competitive entry difficult because the market is more price elastic. Distance measures the cost of providing airline service, and that cost is similar for the monopolist or the oligopolist. Similarly, route share does not particularly depend on the oligopoly dummy. While larger airlines can be expected to have greater route shares when they compete with smaller airlines, some will have small route shares when they compete among themselves, and some smaller airlines will have large route share when they compete among themselves. (Route share is certainly captured by MONOPOLY, but that is only on seven percent of the sample, and MONOPOLY turns out to be insignificant in explaining average fares.)

Dependent variable: ln FARE

Instruments: ln AVE, ln POP1, ln POP2, ln PRODUCT, ln SIZE

<u>Variable:</u>	<u>OLIGOPLY Only</u>	<u>OLIG Breakout</u>
Constant	2.195 (0.482)	2.789 (0.507)
ln DISTANCE	0.426 (0.014)	0.418 (0.014)
ln DOMO	-0.004 (0.057)	-0.070 (0.062)
ln PAX	-0.089 (0.056)	-0.159 (0.060)
ln ROUTESHR	0.109 (0.048)	0.239 (0.071)
ln TOURISM	-0.082 (0.014)	-0.078 (0.014)
MONOPOLY	0.004 (0.052)	-0.019 (0.060)
OLIGOPLY	0.217 (0.038)	0.131 (0.048)
OLIG2	---	0.096 (0.028)
OLIG3	---	0.206 (0.045)
OLIG4	---	0.186 (0.061)

Table 7 -- Effect of Basic Market Conditions
on Fare Equation Regression (TSLs)

DOMO becomes insignificant when the market dummies are added to the equation. Its effect may be better captured by OLIGOPLY. Remember that dominance is a measure of how "big" an airline is at the endpoint airports in the market -- how large a share of the passengers at those airports use the observed carrier. At most airports, the dominant carriers are also the

financially biggest airlines (in terms of revenues). These financially powerful airlines are also the large carriers described by OLIGOPLY. Therefore, DOMO loses its explanatory power when the oligopoly markets are stripped from the sample -- a substantial portion of the remaining carrier-route observations have similarly low dominance because they're smaller airlines.

If DOMO is dropped from the regression, all coefficients and standard errors remain stable except for ROUTESHR. The coefficient of ROUTESHR in this restricted model shifts slightly (-0.090) and becomes significant at only the 35% level (standard error 0.096). The corrected F-test described in chapter 3 rejects the null hypothesis that both DOMO and ROUTESHR are zero at the 5% level of significance.

The effect of passengers carried remains marginally significant, but shifts markedly. I have no reasonable explanation for the shift. The intercept also decreases in value, but that's because the oligopoly markets have a higher average fare than the more competitive markets.

OLIGOPLY, as expected is positive and significant. Clearly, average fares charged by the large carriers for markets in which they compete only with themselves are substantially higher than fares in other markets. Through collusion, large airlines are able to increase average fares by more than 20%. The effect of OLIGOPLY is consistent with my thesis.

When OLIGOPLY is broken down by number of large airlines competing, the coefficients for DOMO, ROUTESHR, and OLIGOPLY shift. Both DOMO and ROUTESHR are related to competitive conditions in the market. Breaking OLIGOPLY into further subsets may capture some of those competitive

conditions that DOMO and ROUTESHR describe in the absence of OLIG2, OLIG3 and OLIG4. A corrected F-test, however, fails to reject the null hypothesis that the coefficients for OLIG2, OLIG3 and OLIG4 are jointly zero. The break down of OLIGOPLY into OLIG2, OLIG3 and OLIG4 does not contribute substantially to the model.

Unexpectedly, oligopoly fares also turn out to be higher than monopoly fares. In fact, MONOPOLY contributes effectively no explanatory power to the regression. A corrected F-test rejects the null hypothesis that the coefficients for MONOPOLY and OLIGOPLY are equal at the 5% level of significance. According to theory, average fares on monopoly routes should be higher than fares in either oligopoly or more competitive markets. There are four possible explanations for this result.

Airline network considerations may be dominant in the sample used for this study. Local travel between the two endpoints on the 132 monopoly routes in this data set may be quite thin, but the monopolist serves a major trunk route from one of the endpoints (for example Atlanta to Chicago). To stimulate demand on the thinner traffic route, the monopolist may keep fares low with the expectation that a substantial number of those passengers will continue on the higher fare (and higher margin) trunk route. The monopoly market is served for its feed potential to the more lucrative oligopoly routes.¹¹⁵ This would imply that most of the monopoly markets in this sample are served by larger carriers.

¹¹⁵Peteraf (1988).

A second possibility is that monopoly carriers are in competition with other modes of transportation. Particularly when the monopoly route distance is short, the airline may actually be competing with train, bus, and private automobile travel. From the summary statistics presented in chapter 3, this doesn't seem a very likely explanation.

In low demand density markets, the monopolist may operate in the region of a flat demand curve. At very small quantities, below a reasonable scale of operations, demand elasticity may be relatively low. However, in the area where quantity demanded is near the efficient scale of operations, the demand elasticity could be high. For example, the market may have few business travellers (low elasticity) and many casual travellers (high elasticity). Particularly in more rural markets, the tourism index would not pick up this demand elasticity difference.¹¹⁶ This would suggest that the monopolists are smaller airlines serving lower demand density markets.

Finally, it is also possible that the monopolist is keeping fares low to discourage entry. Peteraf found some indication that this strategy may exist in some markets, but the effects were not consistent.¹¹⁷ Game theory suggests that such a strategy is not a credible deterrent to entry.¹¹⁸ The potential entrant knows that the incumbent will raise fares after entry, so low fares before entry only serves to reduce the incumbent's profits. It may be argued that potential entrants do not have perfect information about market

¹¹⁶See Sterman, *supra* note 46 for a discussion of differing demand elasticities and customer mix.

¹¹⁷Peteraf (1988).

¹¹⁸Pindyck and Rubinfeld (1989).

conditions, and the incumbent's low fares signal low potential profits (or highly uncertain profits).

The proposed mechanism for airline oligopolistic collusion is that those airlines operating in many different market overlap in some but not in others. The large airline can use the markets in which they overlap to discipline each other while the revenue streams from the markets in which they don't overlap protect their overall profitability. Any market condition, then, that allows the oligopolists to more effectively exclude competition should lead to higher average fares. Similarly, any market condition that allows undisciplined "spoiler" airlines to compete in a market will lower fares.

As discussed in chapter 2, other econometric studies of airline fares have found a positive correlation between FAA slot-controlled airports and fares. I define an additional dummy variable, RESTRICT, to equal one when the observed market serves one of the four slot-controlled airports and zero otherwise. 386 carrier-route combinations in this data set served one or more of the restricted airports. The take off and landing restrictions imposed by the FAA effectively limits competitive entry and should help the oligopolists collude. The coefficient for RESTRICT is expected to be positive.

Other studies have found that the presence of a low-cost carrier (such as People Express) in a market substantially depresses average fares.¹¹⁹ People Express was specifically committed to providing the lowest fare of any carrier for the markets in which they operated.¹²⁰ When PE operates in an airline

¹¹⁹Graham, Kaplan, and Sibley (1983) and Peteraf (1988).

¹²⁰Harvard Business School case 483-103, People Express (A), 1983, *supra* note 35.

market, then, they act as a spoiler and depress the average fare. I define PEROUTE to equal one for any carrier-route combination where PE also serves the same market and zero otherwise. 150 carrier-route combinations in the total sample were also served by PE. I expect the sign on PEROUTE to be negative.

Finally, I constructed two dummy variables to measure the point at which a spoiler airline effectively broke down the oligopolists' collusion. As constructed, OLIGOPLY is true only for markets with no smaller carrier competition. If smaller carriers do act as market spoilers, it is unreasonable to suppose that the effect is immediate in the sense that even the most limited competition from a small airline will collapse the coordination. As the smaller airlines capture more and more market share, the oligopolists will find it more and more difficult to enforce the collusive price on each other -- they can each point to the undisciplined smaller carriers as the reason for cheating. SMALL10 is one for those carrier-route combinations where two or more large carriers are competing and small airlines have more than 0 but less than 10% of the market share. Similarly, SMALL20 is one when two or more large carriers compete in a market and smaller carriers have captured more than 0 but less than 20% of the market share. I expect the coefficients for both SMALL10 and SMALL20 to be positive, but SMALL 20 should be very small and insignificant. I cannot predict if SMALL10 will be significant -- 10% market share may be large enough to destroy the collusion.

The regression results with RESTRICT, PEROUTE, SMALL10 and SMALL20 are shown in table 8. The table also shows the results of the regression when SMALL20 is dropped.

Dependent variable: ln FARE

Instruments: ln AVE, ln POP1, ln POP2, ln PRODUCT, ln SIZE

Variable:	With SMALL20	Without SMALL20
Constant	1.353 (0.811)	1.302 (0.814)
ln DISTANCE	0.395 (0.017)	0.396 (0.018)
ln DOMO	-0.074 (0.070)	-0.074 (0.071)
ln PAX	0.026 (0.094)	0.030 (0.094)
ln ROUTESHR	0.067 (0.072)	0.062 (0.072)
ln TOURISM	-0.082 (0.020)	-0.083 (0.020)
MONOPOLY	0.073 (0.075)	0.072 (0.075)
PEROUTE	-0.095 (0.052)	-0.102 (0.051)
RESTRICT	0.091 (0.046)	0.091 (0.047)
OLIGOPLY	0.082 (0.039)	0.084 (0.040)
SMALL10	0.185 (0.064)	0.213 (0.052)
SMALL20	0.032 (0.037)	--

Table 8 -- Effect of Small Carrier Competition
on Fare Equation Regression (TSLs)

SMALL20 turns out to be statistically insignificant implying that when small airlines have captured 20% of the total market share the oligopolists can no longer effectively discipline the market. Fares drop back to competitive levels. SMALL10 is significant and has the proper sign. I cannot explain,

however, why the coefficient for SMALL10 is so much larger than the coefficient for OLIGOPLY. I would expect then to be equal if the presence of small carriers in 10% of the market had no impact on large airlines' ability to collude, or that SMALL10 would be slightly smaller if there was a slight breakdown in coordination. A corrected F-test rejects the hypothesis that SMALL10 equals OLIGOPLY at the 5% significance level.

The coefficients of all remaining variables are stable after dropping SMALL20 from the regression. Again, MONOPOLY is statistically insignificant. The regression contributes no further insight into why. DOMO continues to be insignificant, and now PAX and ROUTESHR are also insignificant. A corrected F-test rejects the hypothesis that all three are equal to zero at the 5% level of significance.

To further evaluate why MONOPOLY remains insignificant, I construct a dummy variable MAJRMONO to replace MONOPOLY. MAJRMONO is equal to one when the carrier-route observation is a large carrier (as defined in table 3) serving a monopoly market and zero otherwise. If the insignificance of MONOPOLY is due to the network effects of large carriers using monopoly routes to feed high margin oligopoly routes, then the coefficient for MAJRMONO should be negative (or at least smaller than the coefficient for OLIGOPLY). If, on the other hand, the reason is that low demand density on monopoly routes is preventing smaller carriers from capturing substantial consumer surplus, the average fare on MAJRMONO routes should be unambiguously positive.

I also include a dummy variable, SMALONLY, equal to one when the observed market is served by no large airlines. If Bailey and Williams are correct that some smaller carriers gain market power by concentrating in a

geographic region,¹²¹ then these smaller carriers should be able to enforce their own market discipline within the region they operate. The same market mechanisms that allow large carriers to collude should work for small airlines when they are competing with each other and they overlap operations in several markets (they presumably do as regional carriers). Table 9 presents the results of this regression and the regression with ROUTESHR, which turns out to be insignificant, dropped.

The coefficients remain reasonably stable after ROUTESHR is dropped from the regression. While DOMO becomes insignificant and PAX becomes marginally significant after ROUTESHR is dropped, a corrected F-test rejects the null hypothesis that both DOMO and PAX are zero at the 5% level of significance. The coefficients for the dummy variables common to this set of regressions and the last (OLIGOPOLY, PEROUTE, and RESTRICT) shift slightly in magnitude. The difference between both the collusive oligopoly fare and the fare when up to 10% of the market share is captured by smaller airlines and the competitive fare is greater when markets with only small carriers and large airline monopolies are controlled for. The total oligopoly premium is now nearly 35% of the average competitive fare and oligopoly markets with some small carrier competition are still capturing almost 25% additional markup.

¹²¹Bailey and Williams (1988).

Dependent variable: ln FARE

Instruments: ln AVE, ln POP1, ln POP2, ln PRODUCT, ln SIZE

Variable:	With ROUTESHR	Without ROUTESHR
Constant	0.968 (0.819)	0.860 (0.497)
ln DISTANCE	0.395 (0.017)	0.394 (0.015)
ln DOMO	-0.056 (0.068)	-0.054 (0.067)
ln PAX	0.067 (0.094)	0.080 (0.054)
ln ROUTESHR	0.013 (0.080)	--
ln TOURISM	-0.090 (0.020)	-0.092 (0.016)
MAJRMONO	0.127 (0.081)	0.138 (0.045)
PEROUTE	-0.114 (0.050)	-0.12 (0.036)
RESTRICT	0.073 (0.047)	0.067 (0.028)
OLIGOPLY	0.098 (0.040)	0.102 (0.032)
SMALL10	0.230 (0.052)	0.235 (0.045)
SMALONLY	0.098 (0.059)	0.106 (0.036)

Table 9 -- Evaluating the Monopoly Mechanism
in the Fare Equation Regression (TSLS)

The relatively large magnitude and statistical significance of the coefficient for MAJRMONO suggests that large carriers are not depressing fares to competitive levels on routes where they have monopolies to gain some network advantage. The fares on such routes still average less than on

oligopoly routes (a 14% premium on large carriers' monopoly routes compared to a 33% premium on oligopoly routes). The fact that large carrier monopoly fares are at least higher than competitive fares is somewhat comforting. Large carriers may be using their monopoly routes as feeders for the higher fare oligopoly routes, but they are not keeping fares as low on such routes as competition would.

When only smaller carriers compete in a market, average fares are 10% higher than when they compete with larger carriers. As discussed above, this may be because all the the airlines competing in these markets are regional-based and can take advantage of the same market discipline paradigm proposed for large carrier collusion. Conjecturally, many of these regional carriers will overlap in some of the markets they serve but not in others. Where small airlines compete with each other, their competitors are likely to have the same regional affiliation (Air Wisconsin will not often, if ever, compete in the same market with Pacific Southwest Airways). These small carriers can use their protected revenue streams from monopoly markets and markets in which they don't face the specific "cheating" airline to enforce a market discipline. This paradigm won't help maintain market discipline when small and large carriers compete together because their protected revenue streams and cost structures are different. Large carriers may not successfully enforce market discipline on smaller carriers because their market overlap is too small and the smaller airlines' lower cost structure allows them to sustain profitable operations at lower fare levels than large airlines. Similarly, smaller airlines cannot impose discipline when competing with larger airlines because their overlap is small and the smaller airlines' protected revenue stream from non-overlap markets is less than that of large airlines.

The coefficient of SMALONLY may also show predatory pricing by larger airlines when they compete with smaller airlines rather than successful coordination by small airlines competing among themselves. Using their greater protected revenue streams, larger carriers could be driving fares down in market where they compete with smaller carriers to either drive them from the market or to discourage entry in other markets. Since larger airlines have access to more resources than smaller airlines, predatory pricing may successfully drive a smaller carrier from a market -- a "deep pockets" argument. Perhaps more likely is that the large airlines' predatory pricing actions in some markets establishes a reputation that effectively discourages competitive entry in other markets.¹²²

¹²²Bulow, Geanakoplos, and Klemperer (1985).

Chapter 5

Conclusions

My thesis that airlines operating in many different markets can successfully collude on fares when they compete only with each other is supported by the results of the regressions in chapter 4. The average fare in such markets is about 30% higher than average competitive fares. (The actual difference between competitive and collusive fares depends on the regression model and is discussed further below.) When observed markets include smaller airline competitors, the rents collected by the oligopolists decrease because the smaller airlines act as spoilers. They do not share enough markets with the large competitors to be effectively punished for price cutting. When smaller carrier market share reaches 20%, oligopolistic coordination is effectively impossible and fares drop to competitive levels.

The competitive fare referenced above are most probably not purely competitive in the sense that they're equal to marginal cost at average cost. Because airline markets involve significant sunk costs, competitive entry is effectively limited, and the theory of contestable markets fails. In the absence of costless entry, all airline markets are, to a greater or lesser degree oligopolies and the average fare depends on the market conditions. Where conditions don't favor collusion, the fare is likely a Cournot equilibrium. In markets with a high percentage of business travellers, price elasticity of demand is low and the Cournot solution fare is substantially higher than fares under pure competition. When a substantial portion of the market demand is

from tourist traffic, price elasticity is lower, and the Cournot fare is closer to the purely competitive fare.

Conditions such as FAA landing slot restrictions help incumbent airlines exclude potential entrants. This additional limitation on the number of competitors in the market make indirectly coordinating fares easier for the incumbents. Average fares are substantially (about 10%) higher in markets with FAA restrictions. While this regression hasn't specifically evaluated the impacts of other restrictions on airport access, the paradigm that such restrictions make collusion more likely should be equally true no matter the source of the restrictions. About sixteen airports in addition to the four with FAA slot controls are classified as crowded and cannot readily accept more entrants. Decision makers in the communities controlling these facilities should recognize the lost consumer surplus from their citizens when evaluating the cost of expanding airport facilities.

Similarly, the current FAA air traffic control system is seriously overburdened. The limitations in the current system for handling additional traffic effectively favor incumbents over new entrants. The competitive entry paradigm discussed above suggests these restrictions also result in higher average fares and lost consumer surplus. Upgrades to the FAA air traffic control system have been planned since the late-1970's. The cost to upgrade the system are large, and the implementation of the upgrade has been deferred from the early-1990's into the next century due to budgetary considerations. Again, decision makers need to recognize the social costs associated with the delays in expanding system capacity.

The presence of very low-cost carriers in a market breaks down the discipline that allows indirect collusion to succeed. When a low-cost carrier

enters the market, price cutting by the incumbents to discipline the entrant results in unusually high losses for the incumbent. Because the incumbents' cost structure is so much higher than the entrant's the incumbent has to sustain significant losses to impose any loss on the entrant. There is some anecdotal evidence that incumbents will engage in predatory pricing to destroy or discourage low-cost entrants.¹²³ There is valid economic rationale for establishing a reputation as an aggressive price competitor when faced with low-cost entry.¹²⁴ Specifically in the case of People Express, Donald Burr's personal vision of being the lowest cost carrier in any market they entered contributed to the breakdown in market discipline among incumbents.

The regressions of chapter 4 have shown that average fares are also higher in markets where smaller airlines compete among themselves than in markets where smaller and larger airlines compete together. If Bailey and Williams are correct that regional airlines compete within their own geographic-based region,¹²⁵ the higher fares may be due to the collusion paradigm presented above. Geographically-based airlines also have non-overlapping markets to provide protected revenue streams when they engage in disciplinary price cutting on overlapping markets. The difference in fares between exclusively small airline markets and mixed markets may also reflect predatory pricing by the larger airlines in those mixed markets. Because the larger airlines have a greater protected revenue stream, they have easier access to capital and can sustain predatory prices longer than a small airline

¹²³Levine (1987).

¹²⁴Bulow, Geanakoplos, and Klemperer (1985).

¹²⁵Bailey and Williams (1988).

can. Even if the large airline does not drive the small carrier totally from the market, it will discourage future encroachment on its other routes.

Additional econometric work may help to resolve which mechanism is responsible for these fare differences. A model that specifically controls for overlapping versus non-overlapping markets between smaller carriers could show if the paradigm that airlines markets dominated by carriers with a reasonable mix between overlapping and non-overlapping have higher fares. If the paradigm is also correct for smaller airlines, those airlines with moderate overlap will be in the best position to collude. If the overlap is in too few markets, incumbents cannot place enough of the spoiler's revenue at risk; if the overlap is in too many markets, the carriers will have too few protected revenue streams to sustain a disciplinary price cut without harming themselves.

Finally, additional work is need to investigate the average fares in monopoly markets. They are unexpectedly low. The regressions of chapter 4 show that large carriers do capture higher than competitive rents when they operate in monopoly markets, but not as high as when they collude. In the case of larger airlines, this may reflect the airlines' network structure. Low fares on lower demand density monopoly routes may stimulate through traffic onto higher fare oligopoly routes. An econometric model to evaluate this mechanism would have to specifically consider each airline's network structure. Using a dummy variable for those monopoly markets that feed high margin market and another for monopoly markets that don't operate as feeders may provide a test. If the coefficient for the feeder routes were smaller than that for the non-feeder routes, the hypothesis that low monopoly fares are at least in part to encourage through traffic.

The regressions performed in chapter 4 cannot exclude the possibility that monopoly carriers on low demand density routes may be forced to operate in a region of the demand curve where price elasticity is high. Because there is a minimum efficient scale to airline operations, in very low demand density markets the quantity of air travel demanded at efficient operating scale may include an unusually high percentage of casual, non-business traffic. The price elasticity of demand for such flyers is higher than for business travellers. If this describes the market demand conditions, then the monopoly airline cannot capture large rents because the carrier's marginal revenue is near average revenue. Econometric estimation of demand specifically in low density markets could determine if price elasticity is very high compared to higher demand density markets.

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