THE EFFECTS OF NON-STOP DISTANCE AND ROUTE CIRCUITY ON FARES OVER THE FIRST TEN YEARS OF U.S. AIRLINE DEREGULATION

Peter Louis Rodriguez

University Undergraduate Fellow, 1989-1990

Texas A&M University

Department of Economics

APPROVED

Fellows Advisor ______________________

Honors Director ______________________

THE EFFECTS OF NON-STOP DISTANCE AND ROUTE CIRCUITY ON FARES OVER THE FIRST TEN YEARS OF U.S. AIRLINE DEREGULATION

> It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things. For the reformer has enemies in all those who profit from the old order, and only lukewarm defenders in all those who profit from the new order, this lukewarmness arising partly from fear of their adversaries, who have the laws in their favour; and partly from the incredulity of mankind, who do not truly believe in anything new until they have had actual experience of it. Thus it arises that on every opportunity for attacking the reformer, his opponents do so with the zeal of partisans, the others defend him only halfheartedly, so that between them he runs great danger.
>
> Machiavelli, The Prince

I. Introduction

Since the deregulation of the U.S. airline industry eleven years ago, economists and airline officials have come to appreciate the unqualified veracity of the above quote. Today, airline deregulation is once again under attack. Pointing to a recent wave of mergers between airlines, some observers claim that deregulation has failed. These critics say that the rise of dominant airlines at large airports has decreased competition dramatically, signaling the emergence of higher fares, reduced choice, and a non-competitive market.

At an autumn 1989 U.S. Senate hearing, Arizona Senator John McCain, ranking Republican on the Senate Aviation Subcommittee, stated that deregulation has allowed the major airlines to block competition and bring about de facto regulation--without the regulators. "That," he said "is the worst of all possible worlds."[1] Furthermore, many legislators, fed up with complaints of fare increases, assert that deregulation has not worked in cities of 100,000 or less.[2] The battle cry arising out of Congress is in favor of governmental intervention which will prevent airport dominance, limit fares, control routing and, therefore, increase competition.

The facts, however, describe an industry far more healthy and efficient than it was during the days of regulation. Still, there is a growing need for evidence of the successes and failures of airline deregulation since 1983, the last year of complete data published by the Civil Aeronautics Board (CAB). Prior to 1983, the CAB supplied a veritable cornucopia of data on the airline industry, ranging from the operating costs of a Boeing 747 to the fuel efficiency rating of a Piper Cub Twoseater. Since that time, however, airline researchers have been saddled with the problem of evaluating the performance of the deregulated airlines on the basis of scarcely available data. In fact, very few, if any well received studies of the status of airline deregulation cover any periods after 1983.

This paper will investigate the effects on fares of non-stop flight distance and route circuity over the first ten years of airline deregulation. It will be shown that, even without detailed flight information, a number of inferences can be made about the sources of fare changes solely on the basis of non-stop flight distance and route circuity.

Section II reviews the major contributions to research on airline deregulation that will serve as the structural foundation for understanding changes in the effects of non-stop distance and route circuity over the first ten years of airline deregulation. Section III describes the estimation technique and functional form of the equations used to estimate the effects of non-stop distance and route circuity during the time period covered by the study. Section IV describes the sample set and data used in this study. The results of the two regressions are presented in Section V. Finally, conclusions of this study and suggestions for further research are presented in Section VI.

II. Survey of the Literature

The Airline Deregulation Act of 1978 represents a significant departure from the traditional reform strategies in other industries, which have generally sought to preserve the system of administrative regulation. Effective in 1982, the Civil Aeronautics Board's control of routes ended; in 1983 its pricing power stopped; and on January 1, 1985 its life ended permanently. Essentially, the market for domestic air travel was given competitive freedom and, subsequently, has undergone a decade of careful scrutiny.

Since the late 1970s, economists have studied a seemingly intractable number of consequences of this airline deregulation. Amidst the resulting multitude of monographs, three areas of research particularly apply to the study of the effects of non-stop distance and route circuity over the first ten years of airline deregulation. They are as follows:

(1) the theory of contestable markets and U.S. airline deregulation,

(2) the rise of the hub and spoke network, and

(3) the economic welfare of U.S. airlines under deregulation.

It is these topics that provide the basis for deriving an explanation of the effects of non-stop distance and route circuity over the first decade of airline deregulation.

The Theory of Contestable Markets and U.S. Airline Deregulation

Economists' ideal market structure from the point of view of efficient resource allocation has been "perfect competition." A perfectly competitive market fulfills the criteria for Pareto optimality and is characterized by free entry and exit, a large number of buyers and sellers, homogeneous products, and perfect knowledge on the part of buyers and sellers about the conditions in the market. Although theoretically ideal, most markets, in reality, are not perfectly competitive ones. Consequently, there has been much interest in the ability of a deregulated air travel market to approximate the resource allocation of a perfectly competitive market.

The theory of contestable markets was developed to define a type of market that produces the same desirable results as does perfect competition. The theory was conceived by Baumol, Panzar, Willig (1982) and others during the late 1970s and early 1980s. A contestable market is a market into which entry is absolutely free and from which exit is absolutely costless. Three characteristics of such markets are noteworthy. First, Baumol, Panzar, and Willig (1982) have shown that, in equilibrium, economic profits are reduced to zero. Any positive profit induces entry and results in the undercutting of incumbents' prices by entrants. This process continues until all profits above normal profits are reduced to zero. Second, such markets are characterized by lowest costs of production. Otherwise, new entrants will undercut incumbents' prices, thereby forcing incumbents to either exit or reduce costs of production. Third, in a contestable market with two or more sellers, price at equilibrium will be equal to marginal costs.

The following is a discussion of the major studies regarding the applicability of the theory of contestable markets to the airline industry with particular emphasis on how this theory may help explain changes in the incidence of fares under deregulation.

Bailey and Panzar (1981) were the first to discuss the applicability of the theory of contestable markets to the airline industry. They examined the pricing behavior of local carriers who faced the threat of potential competition by trunk carriers. Using data for the two years immediately following deregulation, the authors showed that the actual competition of trunks acted as a check on prices of local service carriers for city-pair markets with a distance of less than 400 miles whereas potential competition from trunks for city-pair markets with a distance of more than 400 miles was a check on prices of local service carriers. In the authors' view, local service monopolists were pricing competitively on longer routes after deregulation. This finding suggests that from 1977, when downward price flexibility was first allowed, until 1980, fares approximated competitive levels in long-haul city markets serviced by local carriers.

Graham, Kaplan, and Sibley (1983) questioned the assertion that the newly deregulated market was contestable and would establish fares at their competitive levels. The authors tested two hypotheses. First, many economists thought that the previous regulation by the Civil Aeronautics Board had been conducive to a strategy of service competition which resulted in excess capacity. If this hypothesis were true, then, under deregulation, fares should fall to competitive levels and produce better capacity utilization. Second, the threat of new entry in the deregulated market was supposed to push fares to competitive levels even in highly concentrated markets because of the high mobility of capital in the airline industry.

The authors tested the excess capacity hypothesis by comparing the relationships among load factor, distance, concentration, and traffic volume for 1976 and 1980 with the relationships reported by Douglas and Miller (1972) for 1969. The authors found that load factors and density were positively correlated for all three years. The higher coefficient of density (passengers per day) for 1980 was indicative of a greater increase in load factors in dense markets. The authors interpreted the market concentration coefficient for 1980 as a decline in service competition resulting from increased price competition. This result supports the notion that the airline industry might be a contestable market.

To test the threat-of-entry hypothesis, the authors compared the fare of firms in highly concentrated markets with those in less concentrated but otherwise similar markets. The results showed that market concentration had a positive impact on fares in the relatively unconcentrated markets. Potential competition was not serving as a check on fares as predicted by the contestability theory. Thus, travelers in relatively unconcentrated markets faced fares above competitive levels. So, this result does not favor the contestable markets hypothesis.

Bailey, Graham, and Kaplan (1985) argued that airline markets were not perfectly contestable. They believed that the contestability of airline markets was supported by the high degree of mobility of aircraft and because ground facilities needed to operate airlines in a city-pair market can be easily leased. However, they noted that the hypothesis of contestability is somewhat undermined by the presence of some sunk costs (e.g., advertising costs). Therefore, applying the theory of contestable markets to the airline industry is questionable.

The authors tested the contestability of airline markets by asking the question: Is the market structure endogenous; i.e., is it jointly determined with fares and traffic in a market? Or is it exogenous; i.e., determined only by other factors? They estimated fare levels using an econometric model including a system of simultaneous equations. They compared estimated fare levels produced under an exogenously determined market structure with estimated fare levels produced under an endogenously determined market structure. The results indicated that established carriers did not reduce fares because of any fear of potential entry. Only when entry had already occurred did these airlines match the new carrier's price. Also, the study showed that fares varied with the time sensitivity of passengers and the presence of new carriers. The authors concluded that the market structure should be considered exogenous. This last result is consistent with the findings of Graham, Kaplan, and Sibley (1983).

Overall, the study by Bailey, Graham, and Kaplan did not fully support the contestability hypothesis, at least during the first few years after deregulation. During these years, carriers operating in concentrated markets apparently possessed sufficient power to set fares above costs. The degree of this power, however, was not very high.

The relationship of fare levels to a measure of market concentration is crucial as a test of contestability. Moore (1986) regressed coach fares for a number of carriers competing in the market against dummy variables for various market structures, population of the city of origin, and dummy variables for major cities of destination. The results showed that fares were lower for markets with five or more carriers. When compared with those in 1976, coach fares in 1983 rose by 40 percent in real terms for markets served by only one or two carriers, whereas markets served by five or more carriers experienced a rise of only 3 percent in real coach fares during the same period.

In another test of contestability, Moore (1986) regressed the ratio of 1983 fares to 1976 fares against air miles and the change in the number of carriers from 1976 to 1983. The results showed that adding one carrier would reduce fares in 1983 by 15 percent relative to fares in 1976 in all except long-haul markets. These results do not support the applicability of the contestability theory to air travel markets.

Morrison and Winston (1986) added a new dimension to the controversy by distinguishing between "perfect contestability" as developed by Baumol, Panzar, and Willig, and "imperfect contestability," as developed by Bain (1949; 1959). Morrison and Winston tested for both perfect contestability and imperfect contestability using compensating variation as a measure of welfare. Using a procedure developed by Small and Rosen (1981), Morrison and Winston calculated the difference between the welfare of passengers in the deregulated environment prevailing during 1983 and the optimal level of welfare. Perfect contestability implies that the difference in welfare would be equal to zero for markets having at least one potential competitor. The authors found that deregulated welfare and socially optimal welfare differed by approximately 2.5 billion dollars. Therefore, they concluded that airline markets were not perfectly contestable.

Imperfect contestability is a weaker hypothesis, implying only that, for a given route, the welfare change measure is influenced by the number of actual and potential carriers on the route. Again, using compensating variation, Morrison and Winston found that every additional actual competitor reduced the difference between optimal welfare and actual welfare per traveler by .44 cents per mile, while every additional potential competitor reduced the difference per traveler by .15 cents per mile. Therefore, one actual competitor added to the market has the same influence on welfare as three potential competitors. Thus, imperfect contestability is a characteristic of airline markets.

A perusal of the literature on contestability and airline markets reveals diverse opinions among economists on the subject. In general, the studies suggest that actual competition is more influential in determining fares than is potential competition. Morrison and Winston added that potential competition is by no means insignificant in determining fares in a given market. Though none of these studies cover periods after 1983, they do reveal the relationship among fares and market structure during the first five years of airline deregulation.

The Rise of the Hub and Spoke Network

The significant increase in the proportion of passengers who are able to accomplish their travel by using the services of a single carrier is the result of the expansion of carriers from limited CAB-imposed route structures to national service networks which use connecting hub complexes, more commonly referred to as hub and spoke networks. This change to hub and spoke networks has resulted in significant expansions of service and competition and subsequently in lower real fares in many medium and smaller-sized markets.

When airlines were regulated, their routing systems were similar to those of railroads, with aircraft making stops at several various cities during a flight. Realizing the inefficiencies of this system, deregulated airlines restructured their routing to create a more efficient hub and spoke network. Under the hub and spoke system, passengers are flown to a central hub airport, from which they travel to their final destination.

Through the hub and spoke system, airlines have realized cost savings over the CAB-imposed routing system by benefitting from what is technically referred to as "economies of scope." Economies of scope are present since airlines are able to increase aircraft size, and thus lower costs, by routing passengers through hub airports. These cost savings derive from a more efficient use of labor and fuel associated with larger aircraft, and from the fact that some airline labor practices and aircraft aerodynamics are more efficient for larger aircraft than for smaller aircraft (Bailey, Graham, Kaplan, 1985). Additionally, the hub and spoke system allows airlines to exploit significant economies of scale in ground and maintenance facilities, which further reduces unit costs.

When the airline industry was regulated, observers of the industry were aware of, and often critical of the effects of regulation on airline operations. In 1974, Douglas and Miller (1974) argued that although travelers benefitted from the increased flight frequency, that benefit was more than offset by the resulting higher fares. Douglas and Miller developed the concept of "schedule delay" as a measure of the convenience of scheduled air transportation service. Schedule delay equals the sum of frequency delay (the difference between the traveler's desired departure time and the closest scheduled departure) and stochastic delay (the additional delay encountered if a seat is not available on the best scheduled flight). The authors compared passengers' valuation of schedule delay and attendant higher fares under regulated versus probable deregulated routing systems. The results showed that passengers would be better off under a deregulated routing system, even with lower frequency of service. Thus, deregulation would produce lower fares and a resulting net welfare gain under a hub and spoke system of routing.

In a similar study, Keeler (1978) estimated the welfare effects on passengers of CAB-imposed routing systems. Keeler's results showed that the welfare loss to travelers caused by CAB regulation was significantly greater than $1 billion per year. This welfare loss to travelers did not reflect a direct transfer from travelers to carriers because carriers competed away, through greater service frequency, the excess profits they were naively expected to earn in the regulated environment.

Peltzman (1976) added that the welfare loss to travelers was not influenced significantly by trip distance or by route traffic density, but was relatively higher for coach than for first class travel. Peltzman's finding is based on 1974 data, similar to that used by Douglas and Miller. These results suggest that a change to a hub and spoke routing system would produce similar fare reductions on flights of various distances and route densities.

Carleton, Landes, and Posner (1983) ascribed the merger mania of the late 1970s to the development of a hub and spoke system of routing. They argued that, under the competitive environment encouraged by deregulation, the development of a hub and spoke system had become an essential marketing tool. Carleton, Landes, and Posner found that passengers much prefer single-carrier service to changing airlines mid-journey. Because most city-pair markets are not large enough to support frequent direct service, carriers have developed hub and spoke networks to increase their ability to offer single-carrier service to connecting passengers--an ability that was limited under regulation because of entry restrictions. Therefore, the development of the hub and spoke system of routing increases travelers' welfare not only through lower fares but also through the increased provision of single-carrier service.

Lastly, Morrison and Winston (1986), again using compensating variation as a measure of welfare, estimated the welfare effects on travelers resulting from a change to the hub and spoke routing system. The results showed a $6 billion (in 1977 dollars) annual improvement in the welfare of travelers, with the greatest net benefits going to business travelers. The authors concluded that the overwhelmingly positive effects on travelers' welfare were the results of the more efficient routing system and the unexpected increase in flight frequency.

Students of the hub and spoke system of routing, both before and after airline deregulation, agree that regulation created numerous inefficiencies and resulted in a loss in traveler and airline welfare. Under the freedom of a deregulated environment, travelers on flights of all distances and routing densities benefitted from lower real fares and suffered no significant losses in service frequency. Thus as airlines adjust their routing to meet traveler demands and to lower unit costs, fares should more closely approximate efficient levels.

The Economic Welfare of U.S. Airlines Under Deregulation

Following the passage of the Civil Aeronautics Act in 1938, the U.S. air transport industry operated in an environment of tight regulation, overseen and enforced by the Civil Aeronautics Board. Beginning in the early 1960s, many economists questioned the ability of the CAB to serve the public interest. A decade later there was sufficient economic evidence of the damaging effects of airline regulation that momentum for deregulation began to gather in the political arena. One of the principal arguments put forth by the proponents of airline deregulation was that it should lead to improved economic efficiency for the industry. As a result, airlines could offer lower fares and better service and thus increase welfare. The following summarizes some of the major studies reviewing the course of growth in economic efficiency and profitability under deregulation.

The transition to deregulation of the U.S. air transport industry began in 1976. Using data from the first five years of the transition (1976-1980), Caves, Christensen, and Tretheway (1983) measured the total factor productivity growth in the transition years with that of the preceding years. The authors cite total factor productivity as the best measure of productive efficiency, where total factor productivity is defined as output per unit of total resources expended. The study reviewed the growth in total factor productivity for both trunk and local service airlines. The results showed that productivity growth accelerated from 2.8% per year to 5.1% per year. Using an analysis of covariance model with individual airlines as observations, they concluded that, for the trunk airlines, nearly all of the acceleration can be explained by increases in output and load factor and decreases in the growth of capacity. For the local service airlines, however, less than half of the acceleration may be so explained. Therefore, these findings support the results of studies on the hub and spoke system and may indirectly explain fare reductions in the first five years of the transition to deregulation.

On the other side of the market, Moore (1986) examined the stock prices of the ten trunks and thirteen regional airlines from 1976-1983. Moore found that in spite of the bankruptcy of Branniff and the poor performance of Continental, TWA, and Western, the real value of the ten trunk airlines remained virtually unchanged from December 1, 1976, to December 1, 1983. For comparison, the real value of all stocks on the New York Stock Exchange fell 3 percent over the same period. Some airlines such as American, which tripled in value, did very well in this newly deregulated environment, when their success was measured by the stock value of the company.

The big gainers, however, were the regional carriers. The thirteen regional carriers witnessed the value of their companies increase nearly sixfold in real terms. Moore concluded that the relatively good performance of the ten trunks and the outstanding performance of the thirteen regional carriers reflected the market's assessment of future prospects of the firms and predicted a growing ability of regional carriers to serve as a check on fares of trunk airlines.

Finally, Van Scyoc (1988) examined the effects of airline deregulation on profitability. One of the functions of the Civil Aeronautics Board was to regulate fares in such a way that the airline industry would have a "fair rate of return." A resulting concern about deregulation was its impact on profitability in the industry. Without CAB oversight of the industry, would cutthroat competition lead to the bankruptcy of many carriers? If losses resulted, would carriers be driven from the industry and allow a monopolistic market structure to develop? Both of these questions have serious implications about fares in a newly deregulated environment.

Van Scyoc used a two-stage regression model to try to explain the net profit margin of the ten trunk airlines over the first eight years of deregulation (1979-1986). The results suggested that it was not deregulation that adversely affected profits, but rather the sluggish economy and rapidly rising fuel costs along with higher real interest rates. In fact Van Scyoc reports that profits would have fallen further under regulation.

An obvious conclusion reached when one combines these several different measures of the economic welfare of U.S. airlines under deregulation is that more airlines are better able to provide their product more efficiently and with greater profitability under deregulation than would have been possible under regulation. Fares in the deregulated environment should reflect this trend as well as the trends towards greater competition in regional markets and single-carrier service.

III. Estimation Technique and Functional Form

On the basis of a naive model of airfares, a number of inferences can be made concerning the effects of distance-related variables on the prices that an airline charges. This paper presents two approaches to analyzing the effects of these variables over the first ten years of airline deregulation.

The first is an ordinary least squares estimation on a pooled cross-section sample of the net effects of non-stop distance and route circuity on airfares over the first ten years of airline deregulation, 1979 to 1988. This equation includes dummy variables for 1979 and 1980, deregulation's tumultuous first two transition years, and for 1986 when fares fell dramatically in response to plummeting crude oil prices.

The second approach is a cross-section estimation of the effects of these same variables, excluding the dummy variables, for the eight airports in the sample in each of the ten years of airline deregulation. This latter approach will be more effective in revealing trends in the effects of only the two quantitative variables on airfares, while the former should capture the overall net effect of both quantitative and qualitative variables in the first decade of deregulation. The results of the two approaches are broadly consistent.

Previous studies of airfare pricing have consistently explained fares using a multiplicative functional form (Graham, Kaplan, and Sibley, 1983; Bailey, Graham, and Kaplan 1985). Regressing the natural logarithm of the dependent variable, airfares, against the natural logarithms of the independent variables, non-stop distance and route circuity, produces parameter estimates that can be interpreted as the elasticities of airfares with respect to non-stop distance and route circuity. This particular functional form imposes constant elasticities on the effects of the independent variables on fares. This paper also adopts this form.

It seems particularly unlikely, however, that the effect on fares when a route distance changes from 100 to 200 miles is the same as when its distance changes from 1000 to 2000 miles. For this reason, both approaches were tested including squared terms for the distance and circuity variables. The results of this test however, showed that neither squared term significantly added explanatory power to the equation and thus these were eliminated from the equation. The unit of measure for both equations is a route originating or terminating at one of the airports in the sample. The first equation is, then:

$$\ln FARE_{ij} = \alpha_i + \beta_1 \ln DISTANCE_i + \beta_2 \ln RATIO_{ij} + \Gamma_{1j} ONEDUMB_j + \Gamma_{2j} TWODUMB_j + \Gamma_{3j} EIGHTDUM_j + \sigma_{ij} \quad [1]$$

where i indexes the route, j indexes the year, and the Greek letters represent the equation's coefficients. These give a rough indication of the way the variable is hypothesized to affect price: α_i is the constant term for the entire sample period, β_1 and β_2 are the route-specific variable coefficients for each route i, Γ_{1j}, Γ_{2j}, and Γ_{3j} are associated with dummy variables reflecting changes in the constant term in the first, second, and eighth year of airline deregulation, and σ_{ij} represents the stochastic component of airfare associated with each route i for each year j.

The second equation was used to reveal the trends in the elasticities of fares with respect to non-stop distance and route circuity at each of the airports in the sample over the first ten years of airline deregulation. This equation is identical to the first equation except that it excludes the dummy variables. The second equation is, then:

$$\ln FARE_{ij} = \alpha_i + \beta_1 \ln DISTANCE_i + \beta_2 \ln RATIO_{ij} + \sigma_{ij} \qquad [2]$$

where i indexes the route, j indexes the year, and the Greek letters represent the coefficients of the explanatory variables. Again, α_i is the constant term for each year of the cross-section sample, β_1 and β_2 are the route specific variable coefficients for each route i, and σ_{ij} represents the stochastic component of airfare associated with each route in the given year of the cross-section sample. The variables for both equations, which are described more completely in the next section, are defined here and their expected signs are discussed.

FARE$_{ij}$ is the one-way average ticket fare in 1983 dollars paid by passengers on a given flight i in the year j of the cross-section sample. Round trip tickets are entered as two one-way trips for which the fare on each trip is half the round trip fare reported.

DISTANCE$_i$ is the non-stop distance in miles from the airport of route i's origination to the airport of route i's termination. One would expect DISTANCE to have a positive effect on price, but that the elasticity would be less than one, since the airline's cost of transporting a passenger increases less than linearly with the distance of their trip. (expected sign +)

$AVGHAUL_{ij}$ is the average total routing mileage of passengers traveling on route i. AVGHAUL is used in the calculation of the ratio variable and not as an explanatory variable in either equation.

$RATIO_{ij}$ is a measure of the deviation from the non-stop distance as a result of passengers on route i whose tickets originate or terminate at some airport between the airport of route i's origination and the airport of route i's termination. RATIO is a measure of the circuity of travel, the average total routing mileage of passengers traveling on route i, $AVGHAUL_i$ divided by $DISTANCE_i$, the non-stop origin to destination mileage of route i. Greater circuity of travel raises production costs and lowers service quality. The former effect would tend to raise average fares, while the latter would tend to lower average fares. (expected sign -)

$ONEDUMB_j$ is the dummy variable used in equation [1] to capture the change in the constant term expected for 1979, the first year following the Airline Deregulation Act of 1978. Airlines were allowed freedom to set fares 50% below or 5% above regulated levels in 1976. However, as of 1979, the CAB still retained control over the allocation of routes. Consequently, airlines efforts in that year to woo passengers to their allotted set of routes took the form of unprecedented and still unequaled fare wars. Thus, average fares in 1979 should be significantly lower than in following years. (expected sign -)

$TWODUMB_j$ is the dummy variable used in equation [1] to capture the change in the constant term expected for 1980, the second year following the Airline Deregulation Act of 1978. As was the case in 1979, the CAB retained control over route allocation in 1980. However, in early 1980 the CAB began to relax this control and allowed some sale and purchase of routes between airlines. Thus, 1980 can be characterized as a year of transition from total route control to partial routing freedom. Though fare wars were prevalent in 1980, their intensity had begun to subside. (expected sign -)

$EIGHTDUM_j$ is the dummy variable used in equation [1] to capture the change in the constant term for the eighth year of the sample period, 1986. OPEC, the Organization of Petroleum Exporting Countries, flooded the market for crude oil in 1986 by slashing the per barrel price of crude oil by more than 60%. In turn, jet fuel and gasoline prices dropped significantly, which reduced the costs of air travel and ground travel, a substitute for air travel. The net effect of these two outcomes should be to significantly lower fares for 1986. (expected sign-)

IV. The Sample and Data

The data sample used in this study includes ticket information on the fifty most traveled domestic routes at each of the eight largest U.S. airports in the third quarter of each year of the sample period, 1979 to 1988. The eight airports are San Francisco/Oakland (SFO), Los Angeles International (LAX), Denver (DEN), Dallas/Ft. Worth (DFW), Atlanta (ATL), Miami International (MIA), Chicago O'Hare (ORD), and New York LaGuardia (LGA). These airports were the largest eight airports over the entire sample period and together handled 66.1% of all domestic passenger enplanements over the ten year sample period.[3] Both the size of the sample and the volume of enplanements handled by these airports lends significant power to this model for making inferences about the overall effects of non-stop distance and route circuity on fares for the entire U.S. air travel industry.

The Department of Transportation's Origin and Destination Air Passenger Data Bank 1A is the source of all variables used in this study. Data Bank 1A is a massive file with approximately four million records per quarter and it is the master file from which all other standard Origination and Destination survey tables are generated.[4] The third quarter of each year was chosen for several reasons. First, Data Bank 1A was first made available in the third quarter of 1979, which is the earliest accounting period for such data kept on tape. Also, the third quarter is generally the peak travel quarter for a year and, therefore, has both discretionary and business travel well represented.

In order to establish a data base suitable for the interpretation of changes in the effects of non-stop distance and route circuity on fares for each of the eight airports in the study, it is necessary to retain the same set of routes throughout the ten year period of the sample. Since the data base provided by Data Base Products included the fifty most traveled routes at each airport for each year of the sample, not all of the routes remained within the sample set of routes over the ten year period because many routes became more or less traveled as the years passed. It was found that at least thirty routes at each airport remained among the top fifty routes throughout the sample period. All but these thirty routes were excluded from the data base for each airport. Thus, for each airport, the pooled cross-section regression, equation [1], was run on a sample of three hundred routes, the thirty routes in the revised data base for the ten year sample period, and the simple cross-section regression, equation [2], was run on a sample of thirty routes for each of the ten years of the sample period.

The following is a presentation of detailed descriptions of each variable used in the two equations as well as their literal translations:

AVERAGE FARE The average fare for each route in the sample is defined as the simple average one-way ticket fare paid by passengers on the observed route whose tickets either originate or terminate at one of the endpoint airports on the route. For example, the hypothetical route originating at Dallas/Ft. Worth, stopping at Jackson, Mississippi, then continuing on to its destination, Atlanta, will be listed in the sample as the Dallas to Atlanta route (DFW-ATL). The passengers whose fares will be used to calculate this route's AVERAGE FARE will be those whose tickets originated in Dallas and terminated in either Jackson or Atlanta, and those whose tickets originated in Jackson and terminated in Atlanta. Since this route's endpoint airports are both included in this study, this particular route and others like it will be included in the sample for each airport provided that it meets the criteria for inclusion at each airport. This in no way represents double counting since the equations are tested over samples at each airport only; that is, there is no pooling of routes across airports. Fares for each year of the sample were expressed in 1983 constant dollars using the transportation deflator of the Consumer Price Index (U.S. Department of Labor, 1988). The transportation deflator seemed the most logical index because it reflects changes in the relative costs of air travel and its primary substitute, ground travel. To comply with the functional form of the study, the 1983 constant dollar average fares were expressed as their natural logarithms.

DISTANCE The distance variable is simply defined as the direct non-stop distance in miles between the two endpoint airports on the route. The variable was added to the data base using data from The United States Official Airline Guide (Air Transport Association, 1990). Since the air traffic routing did not change significantly over the sample period and the airports continued to report the same non-stop distances to the Air Transport Association, the DISTANCE for each route remained constant for each route over the entire sample period.

AVG. DISTANCE Though not used directly as an explanatory variable in the model, this variable is used to calculate the RATIO variable. The average on distance on a given route is defined as the simple average distance in miles covered by the ticket of a passenger on the route. As was the case for AVERAGE FARE, only those passengers whose tickets originate or terminate at one of the endpoint city-pair airports are included in the computation of this variable. Depending on the number of passengers whose tickets terminate or originate at an airport between the two endpoint airports, the AVERAGE DISTANCE on a given route could be greater or less than the DISTANCE for that route.

RATIO The ratio variable measures the circuity of travel on a given route or, more simply, the deviation of the route from its non-stop mileage. It is called RATIO because it is the ratio of AVERAGE DISTANCE to DISTANCE, calculated as AVG. DISTANCE/DISTANCE. To comply with the functional form of the study, the RATIO value for each route was expressed as its natural logarithm.

ONEDUMB ONEDUMB is the dummy variable used in equation [1] to capture the effect of the fare wars that occurred during the first year of airline deregulation, 1979. The ONEDUMB variable is defined for each route as follows:

1 - for routes in the third quarter of 1979

0 - otherwise

TWODUMB TWODUMB is the dummy variable used in equation [1] to capture the effect of the change that occurred in the second year of airline deregulation, 1980, from CAB route allocation to freedom of routing. TWODUMB is defined for each route as follows:

1 - for routes in the third quarter of 1980

0 - otherwise

EIGHTDUM EIGHTDUM is the variable used in equation [1] to capture the effect of the dramatic drop in crude oil prices that occurred in the eighth year of airline deregulation. EIGHTDUM is defined as follows:

1 - for routes in the third quarter of 1986

0 - otherwise

V. The Results of the Regressions

The results from the estimation of equation [1] shown in Table 1 indicate that real fares have remained inelastic with respect to non-stop distance, DISTANCE, at each of the eight airports in the study over the entire ten year period of airline deregulation. The effects of route circuity as measured by the RATIO variable, however, indicate that fares have remained inelastic with respect to route circuity at four of the airports, Dallas/Ft. Worth, Los Angeles, LaGuardia, and Atlanta, and elastic with respect to route circuity at the remaining airports in the study, Denver, Miami, San Francisco,

TABLE ONE

POOLED CROSS-SECTION TIME-SERIES RESULTS

AIRPORTS	LNDIST	LNRATIO	ONEDUMB	TWODUMB	EIGHTDUM	Rsquared	DW-STAT
LAGUARDIA	0.696 [87.45]*	0.648 [8.91]	-0.571 [-23.32]	-0.206 [-8.43]	-0.093 [-3.84]	0.965	1.931
DALLAS/FT. WORTH	0.762 [40.82]	0.681 [10.61]	-0.613 [-14.32]	-0.285 [-6.67]	-0.138 [-3.23]	0.867	1.967
LOS ANGELES	0.671 [46.53]	0.694 [7.11]	-0.559 [-13.71]	-0.271 [-6.64]	-0.153 [-3.76]	0.891	1.778
SAN FRANCISCO/OAKLAND	0.607 [35.27]	1.803 [2.61]	-0.628 [-14.84]	-0.248 [-5.87]	-0.125 [-2.96]	0.842	1.858
CHICAGO	0.356 [16.33]	3.203 [4.75]	-0.755 [-16.92]	-0.333 [-7.49]	-0.091 [-2.02]	0.695	1.876
MIAMI	0.579 [32.43]	2.906 [6.34]	-0.607 [-21.01]	-0.242 [-8.37]	-0.147 [-5.09]	0.884	1.551
DENVER	0.551 [20.06]	4.089 [4.35]	-0.352 [-7.66]	-0.251 [-6.42]	-0.278 [-7.11]	0.716	1.352
ATLANTA	0.484 [27.92]	0.441 [8.36]	-0.882 [-25.21]	-0.419 [-12.00]	-0.031 [-0.88]	0.836	0.833

*Figures in brackets represent t-statistics

and Chicago. As predicted, dummy variables are negative and significant for all of the airports with the possible exception of Atlanta, where the 1986 dummy variable EIGHTDUM produced a two-tailed significance of only 0.376. The sign of the constant term was positive at all but Dallas/Ft. Worth and LaGuardia airports. The constant at both of these airports was small and negative and only statistically significant at Dallas/Ft. Worth. Interpretation of the constant should be taken more as an indicator of the accuracy of this model's functional form than it should be given any literal interpretation since none of the flights in the data set are of non-stop distances close to zero.

A more detailed discussion of the results of each equation at each of the eight airports will be presented later in this section. Still, is should be stated early on that the results of this equation were sound and possessed very high explanatory power at five of the airports in the study, LaGuardia, Los Angeles, Dallas/Ft. Worth, San Francisco, and Chicago. The results of equation [1] at the three other airports also demonstrated a strong relationship among the variables, but each failed the test for the presence of first-order autocorrelation. On a sample of time series data, a Durbin-Watson statistic below the lower bound is sound evidence of the presence of first-order autocorrelation. In samples of pooled cross-section data, Durbin-Watson statistics below the lower bound generally indicate problems in functional form.[5] Thus at Denver, Atlanta, and Miami airports equation [1] is a somewhat inaccurate description of the functional form of fares against the independent variables over the sample period.

The results from the estimation of equation [2] are shown in Table 2 and are expressed graphically in Figures 1 through 8. These results are consistent with the findings of equation [1] and indicate that real fares have remained inelastic with respect to non-stop distance at each of the airports in the study over the ten-year sample period. Furthermore, by plotting the path of change in the mean of the dependent variable, LNFARE, the natural logarithm of the real average fares, along with the path of change in its elasticity with

TABLE TWO

CROSS-SECTION RESULTS

YEAR	AND VARIABLES	LAGUARDIA	DALLAS/FT. WORTH	LOS ANGELES	SAN FRANCISCO	MIAMI	ATLANTA	DENVER	CHICAGO
1979	LNDIST	0.748	0.593	0.764	0.734	0.687	0.595	0.524	0.537
		[24.640]*	[13.490]	[13.040]	[12.250]	[11.570]	[36.900]	[3.680]	[13.880]
	LNRATIO	1.451	0.650	-1.410	-1.019	2.997	0.457	4.473	0.835
		[1.290]	[4.280]	[-0.370]	[-0.270]	[1.940]	[0.810]	[0.670]	[0.610]
	ADJUSTED Rsquared	0.954	0.863	0.856	0.837	0.875	0.988	0.387	0.877
	DURBIN-WATSON STAT.	1.395	1.984	2.046	2.196	2.140	1.700	1.463	1.410
1980	LNDIST	0.703	0.746	0.643	0.680	0.589	0.597	0.604	0.382
		[24.480]	[12.810]	[19.250]	[14.740]	[17.940]	[26.470]	[8.760]	[7.640]
	LNRATIO	1.217	0.857	5.447	2.520	2.858	0.440	6.989	1.926
		[1.110]	[4.250]	[2.670]	[0.950]	[3.610]	[-0.220]	[1.880]	[1.200]
	ADJUSTED Rsquared	0.954	0.851	0.936	0.894	0.951	0.981	0.808	0.688
	DURBIN-WATSON STAT.	1.535	2.028	1.330	1.275	2.250	2.100	1.589	1.840
1981	LNDIST	0.716	0.785	0.701	0.717	0.663	0.567	0.662	0.443
		[34.810]	[16.540]	[22.940]	[16.740]	[18.660]	[14.890]	[7.260]	[8.850]
	LNRATIO	1.746	0.855	0.639	3.316	0.778	1.710	4.327	0.798
		[2.400]	[5.230]	[4.920]	[1.500]	[0.896]	[1.510]	[1.050]	[1.660]
	ADJUSTED Rsquared	0.976	0.905	0.948	0.916	0.951	0.929	0.792	0.744
	DURBIN WATSON STAT.	1.759	1.778	1.996	1.636	1.660	1.740	1.810	1.980
1982	LNDIST	0.675	0.768	0.676	0.700	0.669	0.278	0.531	0.398
		[28.050]	[15.070]	[22.660]	[19.080]	[2.270]	[13.260]	[7.210]	[6.012]
	LNRATIO	0.587	0.701	7.343	5.546	3.179	0.589	-0.149	2.026
		[7.970]	[4.040]	[4.980]	[3.100]	[2.270]	[0.210]	[-0.090]	[0.970]
	ADJUSTED Rsquared	0.964	0.887	0.962	0.941	0.900	0.923	0.730	0.591
	DURBIN-WATSON STAT.	1.630	1.765	1.444	1.740	1.930	1.840	2.210	2.580
1983	LNDIST	0.717	0.814	0.740	0.687	0.584	0.552	0.557	0.487
		[35.230]	[13.440]	[21.760]	[96.650]	[9.030]	[17.470]	[6.060]	[8.590]
	LNRATIO	0.502	0.734	5.052	4.230	4.867	-0.731	3.275	2.442
		[0.610]	[3.530]	[3.200]	[2.100]	[2.540]	[-0.720]	[1.080]	[1.260]
	ADJUSTED Rsquared	0.977	0.861	0.947	0.905	0.860	0.947	0.635	0.758
	DURBIN-WATSON STAT.	2.001	2.101	1.637	1.890	1.730	1.630	1.360	1.790

	YEAR AND VARIABLES	LAGUARDIA	DALLAS/FT. WORTH	LOS ANGELES	SAN FRANCISCO	MIAMI	ATLANTA	DENVER	CHICAGO
	LNDIST	0.734	0.889	0.678	0.601	0.499	0.547	0.756	0.311
1		[29.160]	[14.190]	[14.800]	[10.490]	[8.160]	[12.330]	[11.800]	[5.390]
9	LNRATIO	2.104	0.824	0.451	3.562	4.880	-0.650	5.865	4.304
8		[2.270]	[3.850]	[3.200]	[1.700]	[2.590]	[-0.460]	[2.290]	[2.48]
4	ADJUSTED Rsquared	0.967	0.874	0.882	0.808	0.857	0.907	0.878	0.657
	DURBIN-WATSON STAT.	2.056	2.225	1.444	1.712	0.740	2.020	1.568	2.240
	LNDIST	0.723	0.734	0.644	0.516	0.564	0.324	0.621	0.336
1		[32.320]	[14.880]	[15.360]	[11.170]	[12.050]	[5.910]	[9.530]	[4.780]
9	LNRATIO	0.102	0.650	0.987	-0.840	2.050	0.346	5.075	4.180
8		[0.210]	[3.870]	[5.330]	[-0.730]	[1.910]	[6.540]	[2.970]	[1.990]
5	ADJUSTED Rsquared	0.973	0.884	0.895	0.808	0.899	0.647	0.822	0.565
	DURBIN-WATSON STAT.	2.095	2.271	1.558	1.738	1.760	1.900	1.290	2.137
	LNDIST	0.650	0.720	0.607	0.458	0.529	0.308	0.622	0.210
1		[26.800]	[12.890]	[14.400]	[11.520]	[8.270]	[6.830]	[11.160]	[2.860]
9	LNRATIO	1.056	0.451	3.135	1.018	3.120	2.467	4.941	5.790
8		[2.100]	[2.370]	[2.510]	[0.690]	[1.860]	[1.930]	[2.450]	[2.600]
6	ADJUSTED Rsquared	0.961	0.850	0.881	0.827	0.829	0.755	0.878	0.447
	DURBIN-WATSON STAT.	1.882	2.205	1.874	2.394	1.940	1.865	1.554	2.330
	LNDIST	*0.659*	*0.772*	0.572	0.426	0.506	0.359	0.404	0.114
1		[33.470]	[12.690]	[11.890]	[8.170]	[9.940]	[8.670]	[5.620]	[1.310]
9	LNRATIO	1.573	0.570	2.794	1.322	3.266	0.488	0.059	5.092
8		[3.770]	[2.750]	[1.430]	[0.590]	[2.560]	[0.325]	[0.019]	[2.010]
7	ADJUSTED Rsquared	0.975	0.846	0.834	0.705	0.850	0.820	0.632	0.230
	DURBIN-WATSON STAT.	1.731	2.459	1.506	2.378	1.840	1.912	1.830	2.020
	LNDIST	0.632	0.799	0.580	0.501	0.473	0.354	0.354	0.273
1		[25.980]	[12.350]	[12.580]	[9.180]	[8.990]	[7.340]	[7.825]	[3.110]
9	LNRATIO	0.834	0.454	4.200	2.053	2.990	0.286	1.924	4.484
8		[1.700]	[1.930]	[2.530]	[0.950]	[2.250]	[0.152]	[0.957]	[1.870]
8	AJDUSTED Rsquared	0.959	0.838	0.849	0.748	0.857	0.758	0.724	0.380
	DURBIN-WATSON STAT.	2.256	2.378	1.720	2.530	1.700	2.569	2.250	1.691

*Figures in brackets represent t-statistics

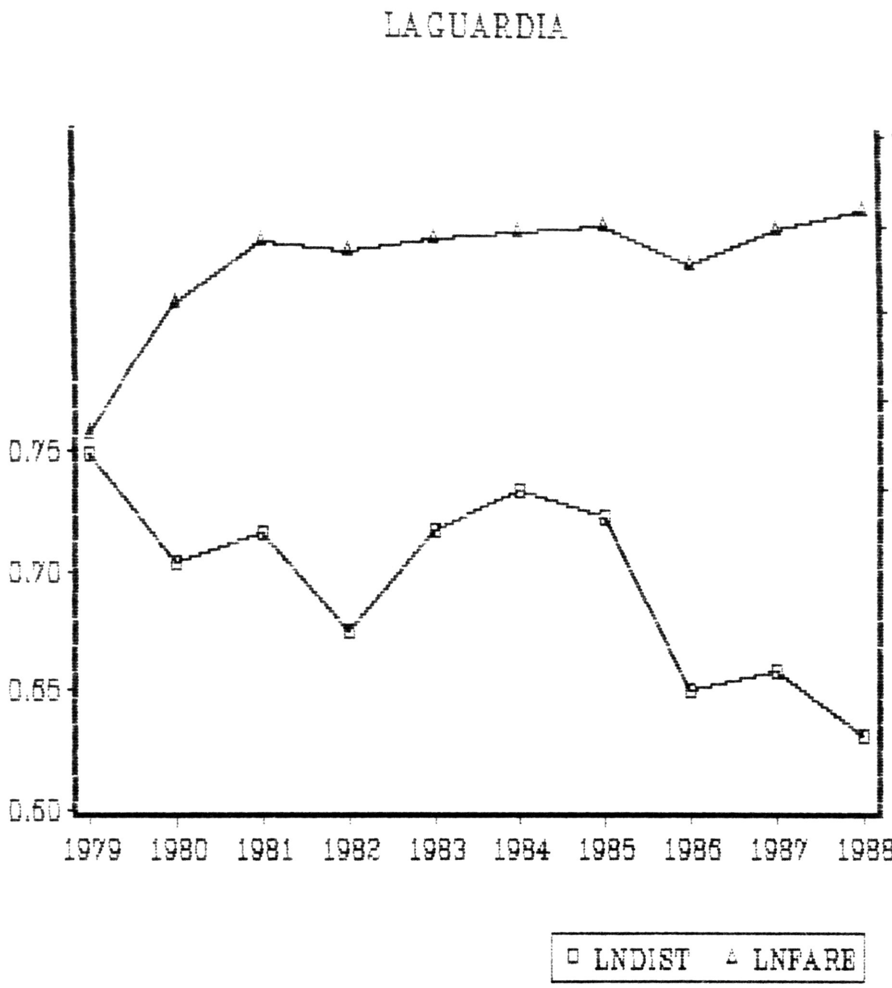
LAGUARDIA
5.00
4.75
4.50
4.25
4.00
0.75
0.70
0.65
0.60
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
LNDIST
LNFARE

FIGURE 1

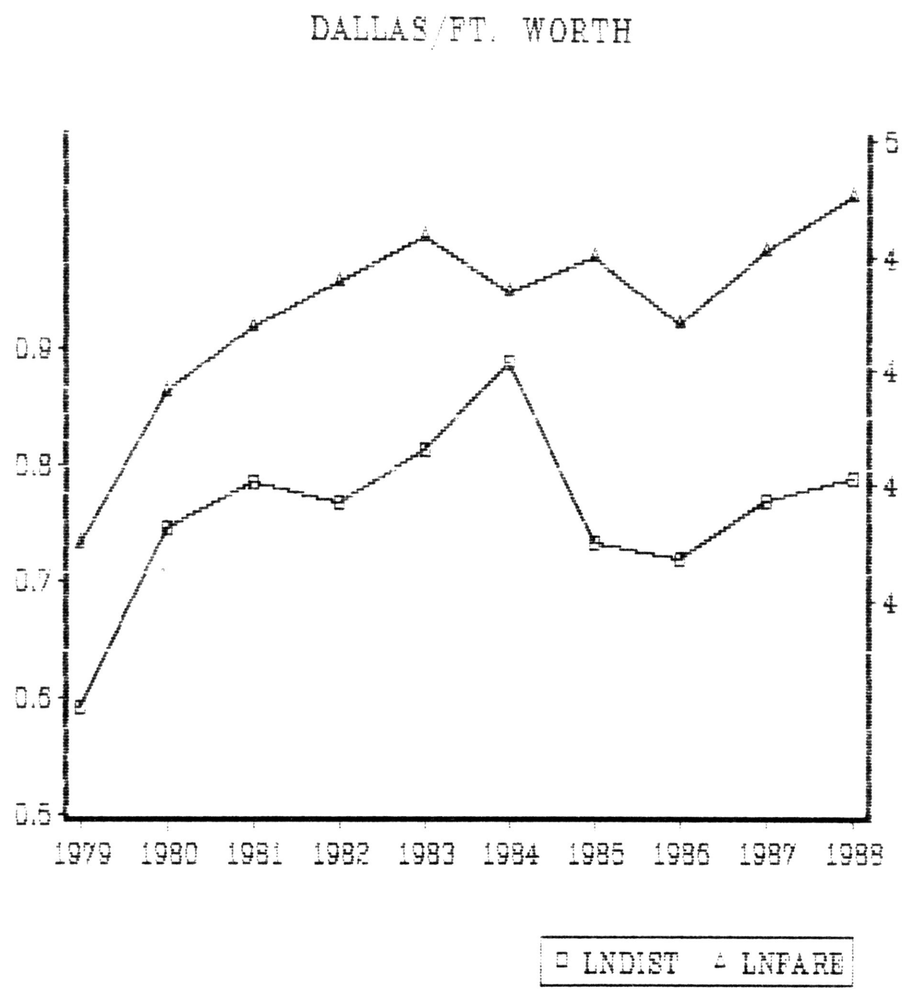
DALLAS/FT. WORTH
0.9
0.8
0.7
0.6
0.5
5.00
4.75
4.50
4.25
4.00
1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
LNDIST
LNFARE

FIGURE 2

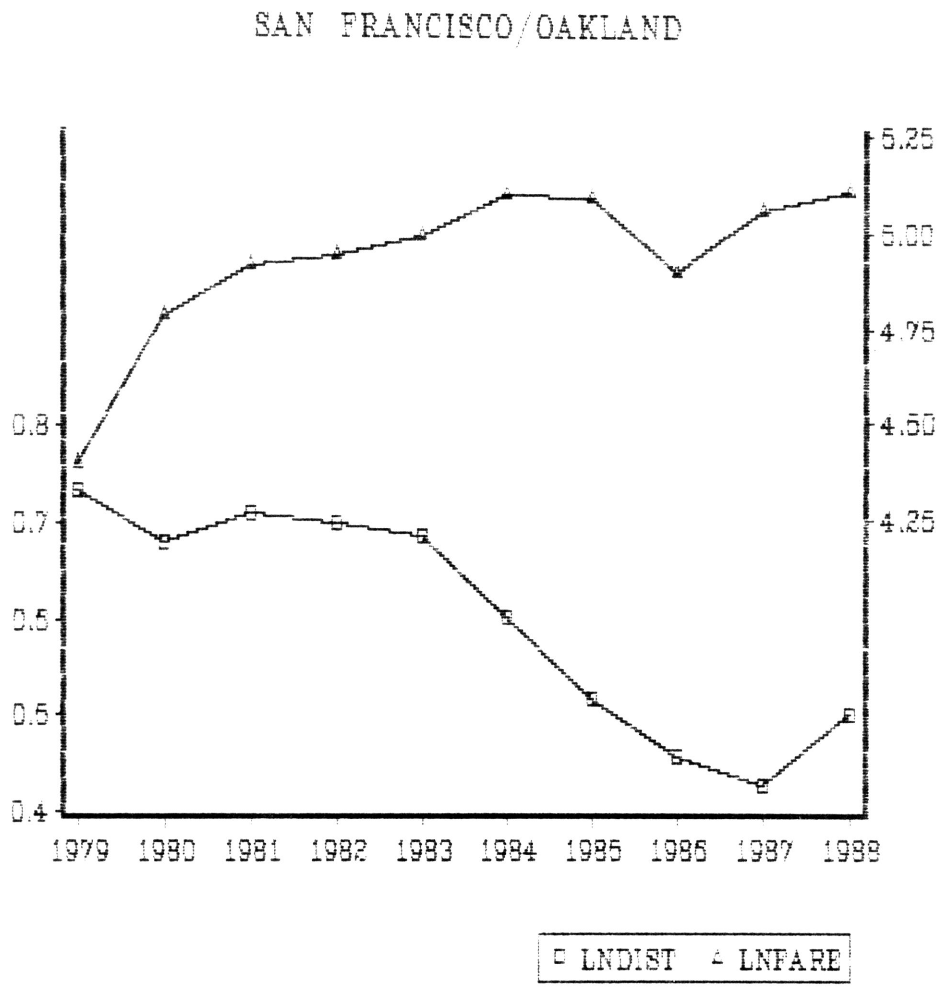
SAN FRANCISCO/OAKLAND
0.8
0.7
0.6
0.5
0.4
5.25
5.00
4.75
4.50
4.25
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
LNDIST
LNFARE

FIGURE 3

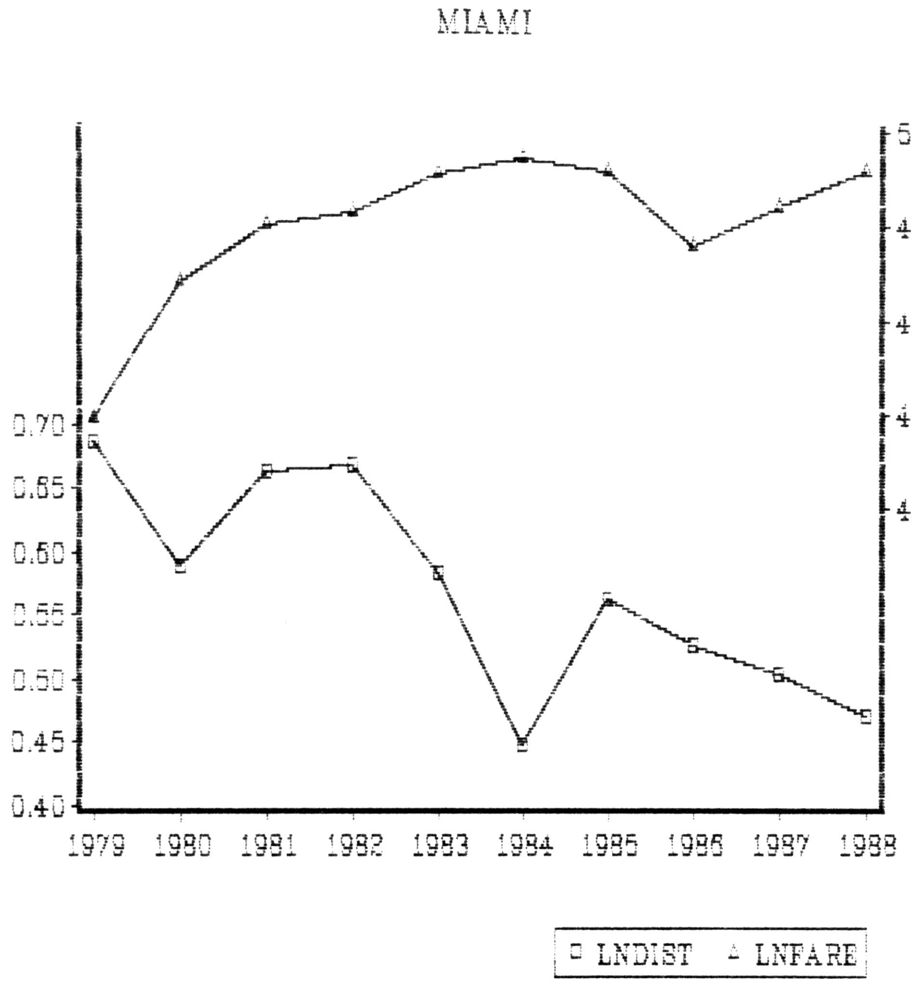
MIAMI
0.70
0.65
0.60
0.55
0.50
0.45
0.40
5.00
4.75
4.50
4.25
4.00
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
LNDIST
LNFARE

FIGURE 4

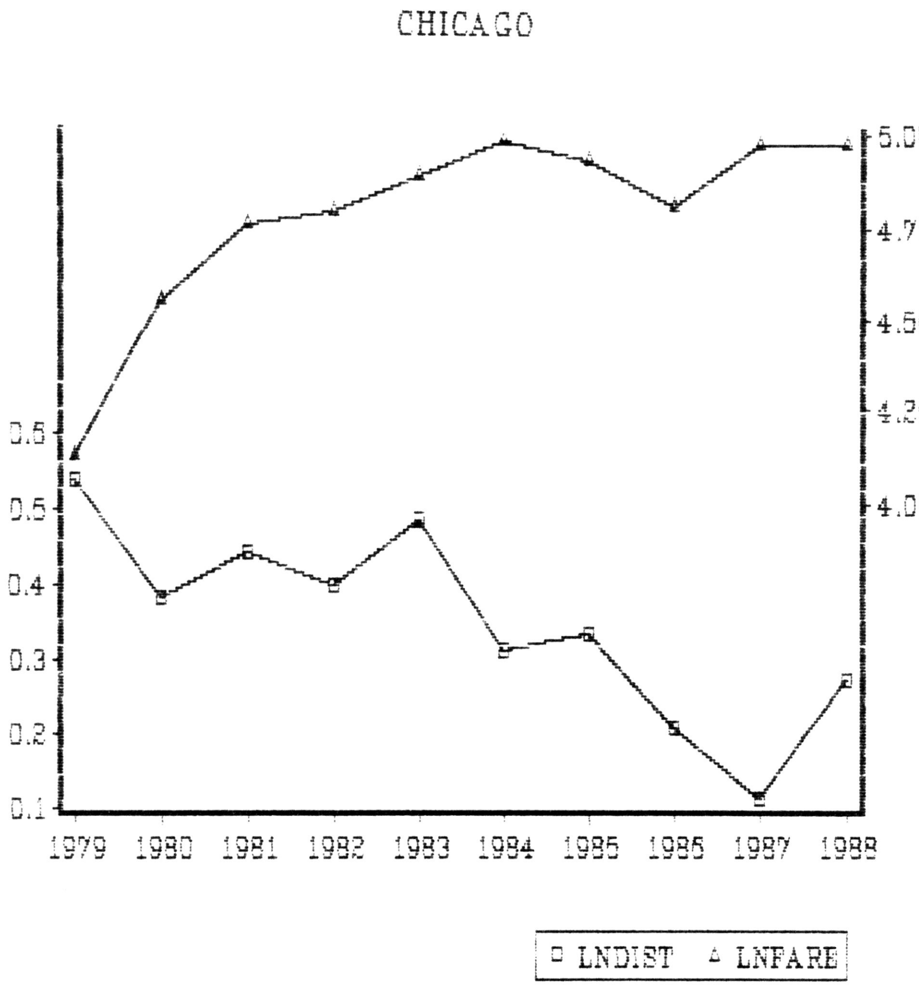
CHICAGO
0.6
0.5
0.4
0.3
0.2
0.1
5.00
4.75
4.50
4.25
4.00
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
LNDIST
LNFARE

FIGURE 5

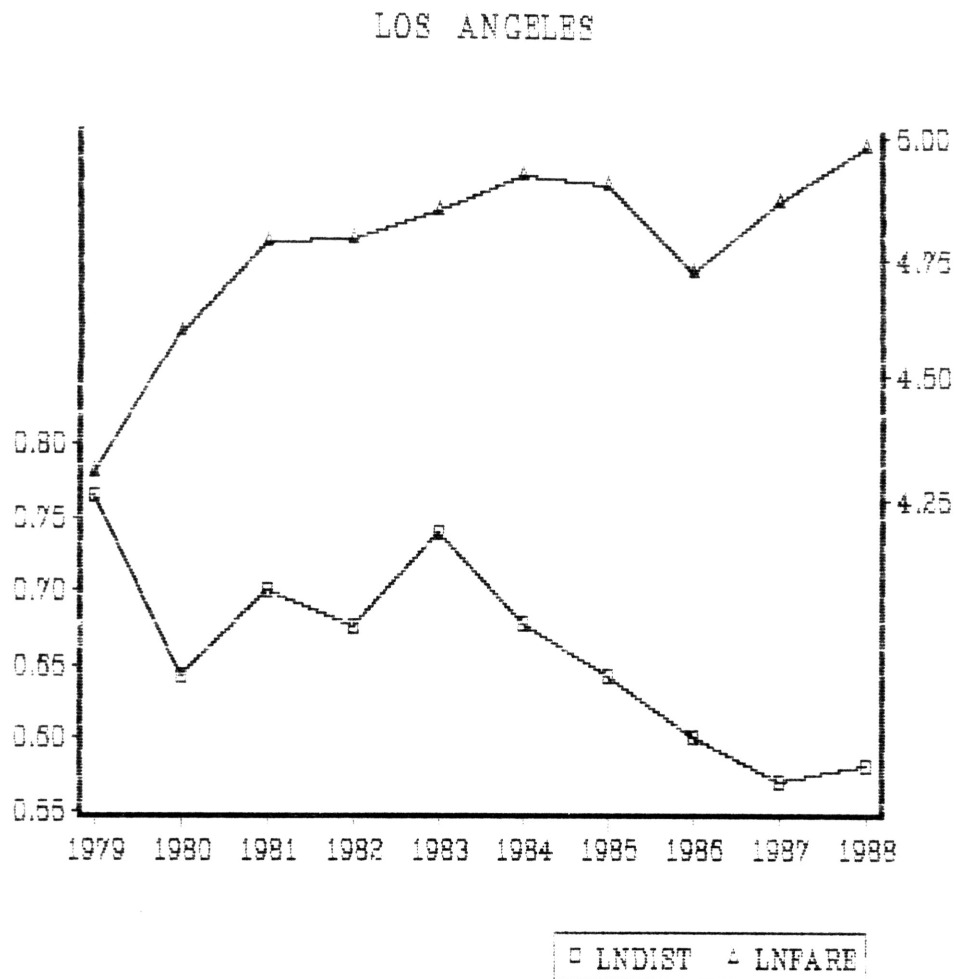
LOS ANGELES
0.80
0.75
0.70
0.65
0.60
0.55
5.00
4.75
4.50
4.25
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
LNDIST
LNFARE

FIGURE 6

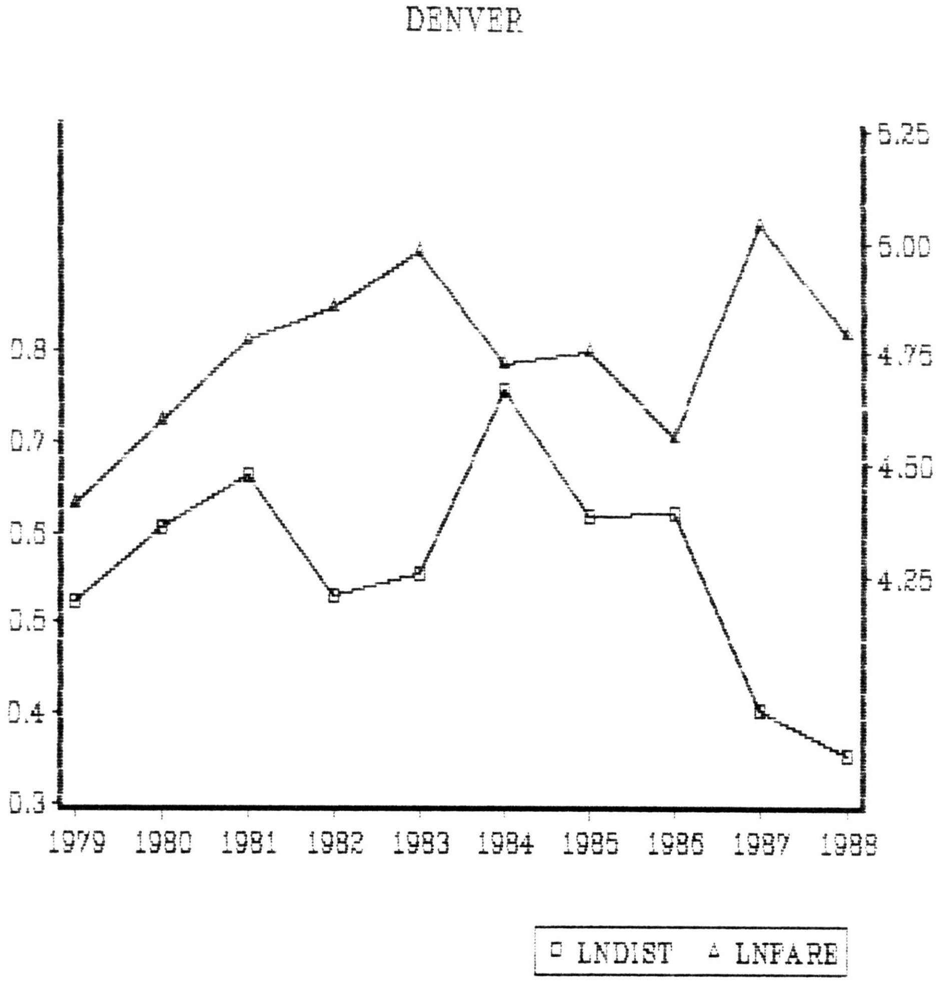
DENVER
0.8
0.7
0.6
0.5
0.4
0.3
5.25
5.00
4.75
4.50
4.25
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
LNDIST
LNFARE

FIGURE 7

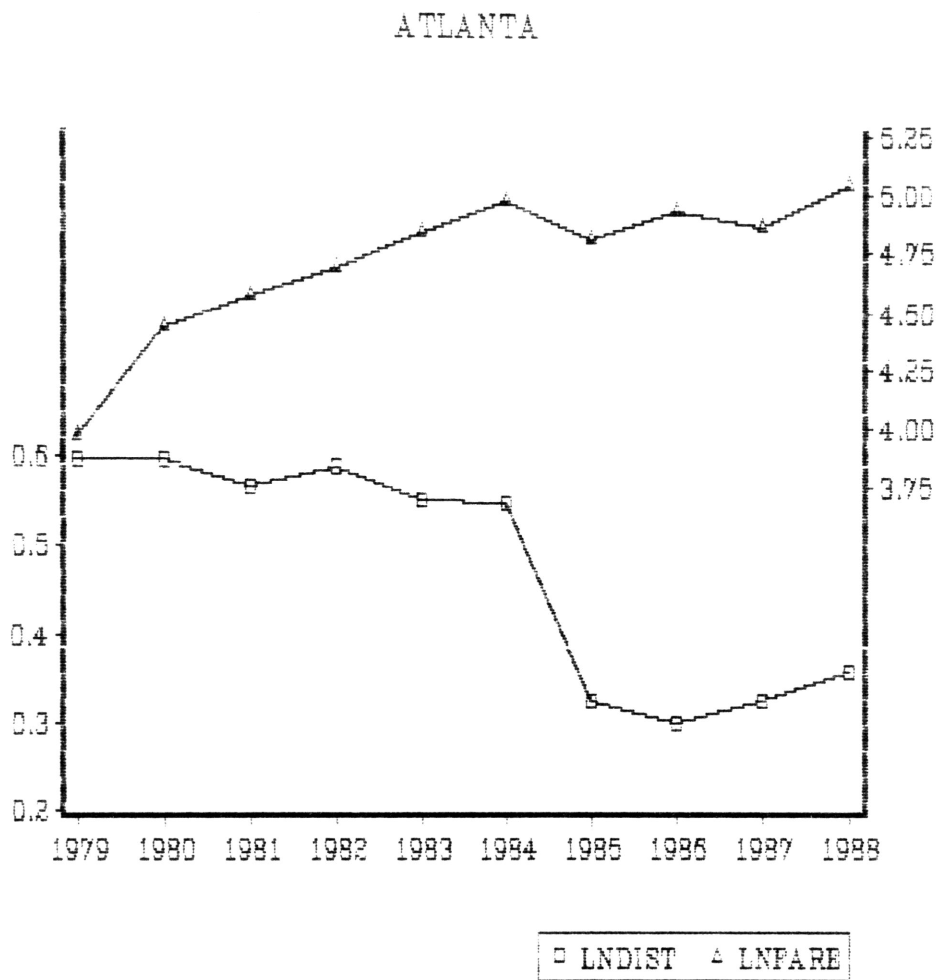
ATLANTA
5.25
5.00
4.75
4.50
4.25
4.00
3.75
0.6
0.5
0.4
0.3
0.2
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
LNDIST
LNFARE

FIGURE 8

respect to non-stop distance, we can show the trend in the effect of non-stop distance on fares over the period of airline deregulation captured by this study. This trend is also illustrated for each airport in the study in Figures 1 through 8.

The path of change in real fares is nearly identical at each of the eight airports in the study. Generally, real fares were at their lowest levels during the fare wars of the late 1970s, were either steady or slightly rising during the early to mid 80s, fell sharply in 1986, and rose quickly to just above their 1985 levels by 1988. Fare elasticities also followed similar paths at each of the airports during the ten year sample period. Fare elasticities with respect to non-stop distance increased and decreased intermittently over the tumultuous transition years of route deregulation, 1979 to 1983.

In 1983, an unmistakable trend emerges in the elasticities of fares with respect to distance at each of the eight airports. Reaching a local maximum in 1983, fare elasticities with respect to distance then began a steady yearly decrease, reaching levels far below those levels present during route regulation. During a period of slightly increasing real fare levels, this ubiquitous trend of declining fare elasticities with respect to non-stop distance is quite telling. Simply interpreted, over the period from 1983 to 1988, fares and fare changes have less and less to do with the non-stop distance between two endpoint airports on a given route. A more intuitive interpretation of this phenomenon will require a deeper understanding of what the DISTANCE variable represents.

All things being equal, flights of longer distances last longer and involve more on-flight costs. Obviously, fuel costs and mechanical depreciation costs are higher, but personnel costs and the expense of onboard amenities also increase with the distance of a flight. Longer flights require more work time from the flight crew and flight attendants; thus, more of the salary costs of onboard airline employees should be allotted to longer flights. Similarly, longer flights have higher costs of onboard amenities such as snacks, meals, and cocktails. Lastly, longer flights require more aircraft ground service time before the planes can fly again. This ground cost, however, is largely due to refueling time and not actual mechanical servicing. Therefore, the strong downward trend in the elasticity of fares with respect to price occurring after 1983 suggests that fare levels during this period have less and less to do with on-flight costs. Furthermore, these results suggest that the source or sources of fare increases during the period from 1983 to 1988 evolve from something other than on-flight costs. Sources of fare increases over this period must be the result either of increased ground costs (e.g., slot and gate premiums, mechanical, terminal, or administrative costs) or simply of the ability of airlines to raise fares over costs.

Within the framework of the results for the DISTANCE variable, a consensus across the eight airports concerning the trend in the elasticity of fares with respect to route circuity cannot be reached. In general, the elasticity of fares with respect to route circuity became far more statistically significant after 1983. Equation [1] proved to be the more powerful of the two models in explaining fares at LaGuardia, Los Angeles, Dallas/Ft. Worth, San Francisco, and Chicago O'Hare airports. Miami airport was also well described by equation [2], whereas equation [1] was unable to capture the functional form of Miami fare levels over the entire ten year period. Only at Dallas/Ft. Worth and Miami airports did equation [2] produce strong statistically significant results for the route circuity variable over the entire ten year sample period. For the five year period after route deregulation, the results indicated that fares at San Francisco, Chicago, Miami, and Los Angeles were elastic with respect to route circuity. Though fares at these airports were elastic with respect to route circuity over the entire sample period, fares became even more elastic after 1983. At Dallas/Ft. Worth and LaGuardia airports, fares were found to be inelastic with respect to route circuity over the entire sample period and slightly more inelastic after 1983. The results for the route circuity variable at the Denver and Atlanta airports were statistically significant in less than four of the ten years of the sample period.

During the period of generally increasing fares, 1983 to 1988, the increasing elasticity of fares with respect to route circuity at San Francisco, Chicago, Miami, and Los Angeles airports indicates that fares are impacted upon more and more by the presence on a flight of passengers originating at interim endpoint airports. Following route regulation, airlines quickly formed mammoth hub and spoke routing systems and, consequently, the number of non-stop routes skyrocketed. As a result, routes that included one or more stops were viewed by passengers as inferior routes, so those (through) passengers on the flight who were inconvenienced by the stop paid a lower fare than they would have if the flight had been non-stop.[6] However, those passengers whose tickets originated or terminated at the interim endpoint airport were charged a higher fare per mile. It may be the case that the higher fare per mile paid by these interim-endpoint passengers offsets the lower fare per mile paid by through passengers inconvenienced by the stops and the average fare on the flight may increase as a result of the stop. Since it is unlikely that passengers inconvenienced by the stop would pay more as the number of stops or the deviation from the non-stop distance increased, it seems logical that positive values of the route circuity variable indicate a higher fare per mile charged to those passengers serviced by the interim endpoint airport stop. Therefore, the emergence of higher fare elasticities with respect to route circuity probably indicates higher fare per mile charges to passengers serviced by the stops as a result of the growing inferiority of one-stop and multiple-stop flights amidst the popularity of non-stop flights.

The remainder of this section presents a summary of the results of models [1] and [2] at each of the eight airports in the study.

LaGUARDIA (LGA)

FARES Real average one-way fares at LGA airport ranged from a low of $63.43 in 1979 to a high of $120.30 in 1988. As was the case for the other seven airports, fares at LaGuardia increased significantly from 1979 to 1981. During the first half of the 1980s, fares at LGA were more stable than at any other airport in the study. As was expected, fares fell in 1986, by 11.31%, returned to their 1985 levels by 1987, and reached their peak of $120.30 in 1980.

EQUATION[1] This model yielded very high explanatory power for LGA--adjusted Rsquared = 0.965. All variables were significant at the 1% level and there was no presence of first-order autocorrelation as evidenced by a sufficiently high Durbin-Watson statistic, DW = 1.93. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARE,DISTANCE)}$ = 0.69, and inelastic with respect to route circuity, $\eta_{(FARE,RATIO)}$ = 0.64. All three dummy variables were negative and significant.

EQUATION[2] This model demonstrated a poor explanation of functional form for 1979 and 1980 as evidenced by a Durbin-Watson statistic below the lower bound for a sample of thirty-

-DW = 1.35 and 1.53, respectively. Thereafter, this model exhibited very high explanatory power, with an adjusted Rsquared = 0.95 or higher. Fares were found to be inelastic with respect to non-stop distance in each year of the sample period, while becoming slightly more inelastic after 1983. The effects of route circuity fluctuated widely over the sample period, reaching a maximum in 1984, $\eta_{(FARES,RATIO)}$ = 2.1, and falling thereafter to a minimum in 1988, $\eta_{(FARE,RATIO)}$ = 0.83.

DALLAS/FT. WORTH (DFW)

FARES Real average one-way fares at DFW ranged from a low of $61.56 in 1979 to a high of $131.63 in 1988. Fares at DFW fell rather steadily from 1979 to 1983, fell 11.31% in 1984, returned to 1983 levels in 1985, fell 13.93% in 1986, and then rose steadily to a high mark of $131.63 in 1988.

EQUATION[1] The results showed very high explanatory power for DFW airport--adjusted Rsquared = 0.86. All variables were statistically significant at the 1% level and there was no presence of first-order autocorrelation as evidenced by a sufficiently high Durbin-Watson statistic, DW = 1.96. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARES,DISTANCE)}$ = 0.76, and inelastic with respect to route circuity, $\eta_{(FARES,RATIO)}$ = 0.68. All three dummy variables were negative and statistically significant.

EQUATION[2] This model also wielded very high explanatory power and accurate functional form for each year of the sample period--adjusted Rsquared = 0.85 or greater, DW = 2.1. Fares were found to be inelastic with respect to non-stop distance throughout the entire sample period, reaching a high mark in 1984 and falling thereafter. Similarly, fares were found to be inelastic with respect to route circuity throughout the sample period, becoming more inelastic after 1984.

SAN FRANCISCO/OAKLAND (SFO)

FARES Real average one-way fares at SFO ranged from a low of $80.64 in 1979 to a high of $165.67 in 1988. Fares at SFO rose steadily from 1979 to 1983, increased sharply in 1984, fell 17.31% in 1986, and then rose steadily to their high mark of $165.67 in 1988.

EQUATION[1] There was very high explanatory power in this model for SFO airport--adjusted Rsquared = 0.84. All variables were statistically significant at the 1% level and there was no presence of first-order autocorrelation as evidenced by a sufficiently high Durbin-Watson statistic, DW = 1.86. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARE,DISTANCE)}$ = 0.61, and elastic with respect to route circuity, $\eta_{(FARES,RATIO)}$ = 1.80. All three dummy variables were negative and statistically significant.

EQUATION[2] Model [2] was a poor representation of functional form for 1979, 1980, 1986, and 1987, since the Durbin-Watson statistics were below the lower bounds for a sample of thirty in each of these years. In addition, the variable for route circuity, RATIO, was not significant in those four years, nor in 1984 and 1985. The adjusted Rsquared = 0.92 or higher, however, for all ten years. Fares were found to be inelastic with respect to non-stop distance throughout the sample period, decreasing steadily after 1982. For the other five years fares were found to be inelastic with respect to route circuity, reaching a high mark of only .70 in 1982.

<u>**MIAMI (MIA)**</u>

FARES Real average one-way fares at MIA ranged from a low of $68.71 to a high of $130.37 in 1984. Fares at MIA rose steadily from 1979 to 1984, remained stable through 1985, fell by 18.12% in 1984, and then rose steadily to $134.28 in 1988.

EQUATION[1] The model demonstrated very high explanatory power for MIA--adjusted Rsquared = 0.88. All variables were statistically significant at the 1% level; however, this equation is not a wholly accurate description of functional form as evidenced by a low Durbin-Watson statistic, DW = 1.55. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARES,DISTANCE)}$ = 0.56, and elastic with respect to route circuity, $\eta_{(FARES,RATIO)}$ = 2.91. All three dummy variables were negative and statistically significant.

EQUATION[2] The model provided a sound description of functional form for all years of the sample period--DW 1.72 or higher, and wielded strong explanatory power--adjusted

Rsquared = 0.94 or higher. Fares were found to be inelastic with respect to non-stop distance, becoming more inelastic after 1982. Fare elasticities with respect to route circuity were found to be elastic over the entire sample period, reaching a high mark in 1984 and becoming less elastic thereafter.

CHICAGO O'HARE (ORD)

FARES Real average one-way fares at ORD ranged from a low of $61.56 in 1979 to a high of $145.47 in 1984. Fares at ORD rose steadily from 1979 to 1984, remained stable through 1985, fell by 11.31% in 1986, rose sharply back to 1984 levels in 1987, and remained stable through 1988.

EQUATION[1] There was strong explanatory power for ORD--adjusted Rsquared = 0.69. All variables but EIGHTDUM were statistically significant at the 1% level, and EIGHTDUM was significant at the 5% level. There was no indication of the presence of first-order autocorrelation, DW = 1.87. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARES,DISTANCE)}$ = 0.35, and elastic with respect to route circuity, $\eta_{(FARES,RATIO)}$ = 3.2. All three dummy variables had the expected sign.

EQUATION[2] There was strong explanatory power and proper functional form in Model [2] for ORD in all years but 1979--DW = 1.41. Fares were found to be inelastic with respect to non-stop distance throughout the ten year sample period, reaching a high mark in 1984, and becoming steadily more inelastic thereafter. Fare elasticities with respect to route circuity fluctuated widely over the first three years of the sample period, then steadily became more elastic over the last seven years.

<u>**LOS ANGELES INTERNATIONAL (LAX)**</u>

FARES Real average one-way fares at LAX ranged from a low of $73.70 in 1979 to a high of $140.03 in 1988. Fares at LAX increased steadily from 1979 to 1984, remained stable through 1985, fell 16.47% in 1986 and then rose steadily to their high mark of $144.03 in 1988.

EQUATION[1] This model exhibited strong explanatory power for LAX--adjusted Rsquared = 0.89. All variables were statistically significant and no presence of first-order autocorrelation was detected, as evidenced by a sufficiently high Durbin-Watson statistic, DW = 1.77. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARE,DISTANCE)}$ = 0.67, and inelastic with respect to route circuity, $\eta_{(FARE,RATIO)}$ = 0.69. All three dummy variables had negative signs.

EQUATION[2] The model presented a generally poor description of functional form over most of the sample period due to very low significance of the constant term. The adjusted Rsquared = 0.85 or higher. Fares were found to be inelastic with respect to non-stop distance over the entire sample period, becoming steadily more inelastic after 1983.

Fare elasticities with respect to route circuity fluctuated widely over the first six years of the sample period and then became more elastic after 1984, reaching a high mark in 1988.

DENVER (DEN)

FARES Real average one-way fares at DEN ranged from a low of $82.26 in 1979 to a high of $154.47 in 1988. Fares at DEN increased steadily from 1979 to 1983, decreased by 22.89% in 1984, remained stable through 1985, fell 17.3% in 1986, rose sharply to 1985 levels in 1987, and remained stable through 1988.

EQUATION[1] This model presented a poor description of functional form for DEN as evidenced by a low Durbin-Watson statistic DW = 1.35, adjusted Rsquared = 0.71. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARES,DISTANCE)} = 0.55$ and elastic with respect to route circuity, $\eta_{(FARES,RATIO)} = 4.08$. All three dummy variables were negative and statistically significant.

EQUATION[2] Model [2] also presented a generally poor description of functional form for DEN throughout the ten year sample period, adjusted Rsquared = 0.46 or higher, DW = 1.46 or higher. The coefficient for the RATIO variable was of questionable significance throughout the sample period. Fares were found to be inelastic with respect to non-stop distance over the entire sample period, becoming more inelastic after 1984. Fare elasticities with respect to route circuity fluctuated widely and were of low statistical significance throughout the sample period.

ATLANTA (ATL)

FARES Real average one-way fares ranged from a low of \$52.45 in 1979 to a high of \$154.47 in 1988. Fares at ATL increased steadily from 1979 to 1984, remained stable through 1985, fell 12.19% in 1986, and rose steadily to a high mark of \$154.47 in 1988.

EQUATION[1] The model provided a poor description of functional form for ATL, as evidenced by a low Durbin-Watson statistic DW = 0.83, adjusted Rsquared = 0.84. Fares were found to be inelastic with respect to non-stop distance, $\eta_{(FARES,DISTANCE)}$ = 0.48, and inelastic with respect to route circuity, $\eta_{(FARES,RATIO)}$ = 0.44. ONEDUMB and TWODUMB were negative and statistically significant; EIGHTDUM, however, produced a two-tailed significance of only 0.376.

EQUATION[2] This model wielded strong explanatory results for ATL--adjusted Rsquared = 0.88 or higher throughout the sample period. Fares were found to be inelastic with respect to non-stop distance throughout the sample period, becoming steadily more inelastic after 1982. Fare elasticities with respect to route circuity fluctuated widely and were of little statistical significance throughout the sample period.

VI. Conclusions

Since the last of the Civil Aeronautics Board's regulatory restrictions were lifted in 1983, the effects of non-stop distance and on-flight costs on fares have steadily decreased. In this period of stable if slightly rising real fare levels, the impact of route circuity on fares has grown slightly larger. Particularly for the last two years of this study, 1987 and 1988, fare increases are less and less impacted upon by the effects of on-flight costs, and partially explained by the increasing impact of route circuity.

Concerning research on the contestability of the travel market, this study suggests that gate, slot, terminal, and other ground costs have grown more important in the determination of fares and thus may be evolving into barriers to entry into air travel markets. Alternatively, if ground costs and on-flight costs have <u>both</u> become less important in the determination of fares, then rising fare levels may be reflecting the growing ability of airlines to increase fares over costs. That is, airlines' monopoly power may be increasing. This would support the findings of Morrison and Winston as well as those of Moore, while the previous scenario would support the findings of Bailey, Graham, and Kaplan. In either case, this study lends indirect support to the notion that the market for air travel is not contestable.

Along similar lines, the increasing impact of route circuity and decreasing impact of non-stop distance on fares supports the notion that route deregulation would allow airlines to improve operational and service efficiency. The steady decrease in the impact of non-stop distance on fares reveals a more efficient use of labor and fuel following full deregulation in 1983. Furthermore, the increase in fare elasticity with respect to route circuity after 1983 serves as evidence of the growing inferiority of one-stop or multiple-stop routes. These findings reveal the success of airline deregulation in providing a more efficient system of routing for airlines and passengers.

Whereas the profitability and economic welfare of airlines under deregulation cannot be directly measured by this study, the results of this study suggest that profitability has not suffered as a result of increasing fare sensitivity with respect to on-flight costs. The decreasing impact of on-flight costs on fares reveals the increased efficiency of airlines under the hub and spoke system and the lower on-flight costs associated with this new system of routing.

The results of this study suggest that it would be unwise and probably futile for the government to try to increase public welfare by returning in any degree to route or pricing regulation. Furthermore, the results suggest that efforts to increase public welfare through changes in the air travel market should be directed at a more equitable and efficient use of existing ground facilities. One suggestion for further research involves calculating the effects of nonstop distance and route circuity on fares in a study which includes data on flight connections into large airports from small airports and feeder airports. Additionally, improvements over this current study could be achieved by adding carrier-specific and flight-specific information such as size of aircraft, load factors and presence of regional carriers in the market. These data are available from The Official Airline Guide, but their use would require many manhours of manually inputting data since the data set is massive and is not available in any computer-usable form. Still, in spite of the difficulties involved, researchers of airline deregulation should make use of all sources of data and proxy variables in order to study the U.S. air travel market in the period following the end of regulation and the cessation of data publication by the Civil Aeronautics Board. Finally, in an era of broad uncertainty concerning the ability of the existing deregulated air travel market to adequately and efficiently serve the public interest, much more research is required before government intervention or reregulation is duly conceded.

FOOTNOTES

[1]U.S. Congress, Senate, Committee on Commerce, Science, and Transportation (1988).

[2]Jonathan Allen (1989, p. 1).

[3]Air Transport Association (1978-1988).

[4]The Department of Transportation sells raw, unprocessed data tapes containing Disk Bank 1A for $1500 per quarter. At this price, the costs of this sample would have been too exhorbitant for the present study. Needless to say, other means of acquiring the data were sought. A smaller version of Data Bank 1A was generously provided for the entire sample period at a pauper/student rate of $100 by Richard Fletcher at Data Base Products, an industrial research firm located in Dallas, Texas. The author wishes to extend special thanks to Mr. Fletcher, whose commitment to academic research made this study possible.

[5]R.S. Pindyck and D.L. Rubinfeld (1976, pp. 202-211).

[6]Database Products, (1989).

REFERENCES

Air Transport Association of America. 1989. The Annual Report of the U.S. Scheduled Airline Industry. Washington, D.C.

Allen, J. 1988. Republicans are Joining a Chorus of Airline Critics Seeking Reregulation to Spur Competition. Wall Street Journal, October 27: 1.

Bailey, E.E., Graham D.R., and Kaplan D.R. 1985. Deregulating the Airlines. Cambridge, Mass.: MIT Press.

Bailey, E.E., and Panzar, J.C. 1981. The Contestability of Airline Markets During the Transition to Deregulation. Law and Contemporary Problems, 44, 1: 125-145.

Bain, J.S. 1949. A Note on Pricing in Monopoly and Oligopoly. American Economic Review, 39, 3: 448-464.

Bain, J.S. 1959. Industrial Organization. New York: Wiley.

Baumol, W.J., Panzar, J.C., and Willig, R.D. 1982. Contestable Markets and the Theory of Industry Structure. New York: Harcourt, Brace, Jovanovich, Inc.

Carleton, D.W., Landes, W.M., and Posner, R.A. 1980. Benefits and Costs of Airline Mergers: A Case Study. Bell Journal of Economics, 11, 1: 65-83.

Caves, D.W., Laurits, C.R., and Tretheway, M.W. 1983. Productivity Performance of U.S. Trunk and Local Service Airlines in the Era of Deregulation. Economic Inquiry, 21, 2: 55-71.

Douglas, G.W., and Miller, J.C. 1974. Economic Regulation of Domestic Air Transport: Theory and Policy. Washington, D.C.: The Brookings Institution.

Database Products. 1989. Partial Data Set of Data Bank 1A, Dallas, Texas: Database Products.

Graham, D.R., Kaplan D.P., and Sibley, D. 1983. Efficiency and Competition in the Airline Industry. Bell Journal of Economics, 4, 1: 118-138.

Keeler, T.E. 1978. Domestic Trunk Airline Regulation: An Economic Approach. Washington, D.C.: Study on Federal Regulation. U.S. Government Printing Office, S. Doc. 96-14, Congress 1, Session.

Moore, T.G. 1986. U.S. Airline Deregulation: Its Effects on Passengers, Capital, and Labor. Journal of Law and Economics, 24, 1: 1-28.

Morrison, S., and Winston, C. 1986. The Economic Effects of Airline Deregulation. Washington, D.C.: The Brookings Institution.

Peltzman, J.B. 1976. The Composition of Fares in the U.S. Domestic Air Transport Industry. Logistics and Transportation Review, 21, 1: 3-26.

Pyndyck, R.S., and Rubinfield, D.L. 1976. Econometric Models and Economic Forecasts. New York: McGraw-Hill Book Co.

Small, K.A., and Rosen, H.S. 1981. Applied Welfare Economics with Discrete Choice Models. Econometrica, 49, 1: 105-130.

U.S. Department of Labor. Bureau of Labor Statistics. 1989. Historical Consumer Price Index for All Urban Consumers (CPI-U) and Urban Wage Earners and Clerical Workers (CPI-W): U.S. City Average, Major Groups. Washington D.C.: U.S. Government Printing Office.

U.S. Congress, Senate Hearing 100-959. 1988. Hearing Before the Senate Committee on Commerce, Science, and Transportation. Airline Concentration at Hub Airports. Second Session. Washington D.C.: U.S. Government Printing Office.

Van Scyoc, L.J. 1988. Effects of Airline Deregulation on Profitability. Journal of Law and Economics, 24, 4: 12-31.