PROCEEDINGS

Twenty-seventh Annual Meeting

Volume XXVII • Number 1 1986

TRANSPORTATION RESEARCH FORUM

PROCEEDINGS—

Twenty-seventh Annual Meeting

September 22-24, 1986
Seattle, Washington

Volume XXVII • Number 1 1986

TRANSPORTATION RESEARCH FORUM
In conjunction with

CANADIAN TRANSPORTATION RESEARCH FORUM

Deregulation and Concentration in Air Transportation

*By Bahram Adrangi, Richard D. Gritta and Garland Chow**

ABSTRACT

This study examines the effect of deregulation on the structure of the U.S. Airline Industry. The 4 and 8 firm concentration ratios, the Herfindhal Index and the Lorenz Curve and its companion index, the Gini Coefficient are used to examine changes in market concentration in this industry. Deregulation is found to have resulted in a decrease in the concentration of the market power of the larger carriers.

I. INTRODUCTION

The deregulation of air transportation has generated considerable controversy. The purpose of this paper is to briefly examine one aspect of this controversy. That aspect is whether the industry has become more concentrated as a result of deregulation. The methodology employed utilizes several important economic measures of industry concentration to test the hypothesis that concentration has increased. Those measures include the 4 and 8 firm concentration ratios, the Herfindal Index, the Lorenz Curve, and the Gini Coefficient.

Section II presents a brief analysis of the economics of regulation as background. In section III, several methods of measuring the impact of deregulation on the structure of the airline industry are discussed. The empirical analysis is contained in section IV. A brief summary and conclusion comprise the final section.

II. ECONOMICS OF REGULATION

Toward the end of the nineteenth century, the Interstate Commerce Commission (ICC) was established to aid the nation's struggling railroad industry. During the next century, a number of additional agencies and commissions were created to regulate other industries. In 1938, the Civil Aeronautics Board (CAB) was created to regulate the airlines. Its goal was to assure economically sound and efficient air service at reasonable charges.

In order to evaluate the subsequent impact of regulation on airline performance, the economics of regulation must first be understood.

The economic justifications for regulation fall into two general catagories; natural monopolies and partial competition. The discussion of natural monopolies is beyond the scope of this paper. The focus here is on partial competition.

In an industry such as the airlines, all firms have both monopolistic and competitive characteristics. If very few carriers serve a given route, a specific carrier can behave monopolistically. The result would be unreasonably high air fares. On the other hand, there is an incentive for self-destructive competition in certain other markets. Once an aircraft is purchased, the cost of entering a new market is a variable cost. Firms tend to compete fiercely, driving prices very close to the marginal cost of operation. These low prices directly result from the excess capacity available, especially on popular routes. Airline management may feel that any price which covers short run marginal costs is better than underutilizing the existing capacity. If low prices do not cover fixed operating costs, in the long run, bankruptcies will result. Whether a firm monopolizes the market, or goes bankrupt, society incurs a loss. Regulation has therefore been invoked to protec the firms from self-destructive competition and to protect the consumers from unreasonable prices.

Under CAB regulation, airlines wee prohibited from price competition. As a consequence, carriers engaged in other forms of non-price competition which included costly new services. The cost of these services were passed on to the consumer as CAB rates were set to cover these costs. Fares above marginal costs were the direct result of this process. Since entry into these markets was limited by CAB regulations, these prices could be sustained indefinitely.

The most injurious aspect of service competition, however, was the heavy overscheduling of services in already heavily trafficed markets.[1] In order to maintain their market share, airlines tended to schedule large numbers of daily flights between major city pairs in order to gain consumer identification. Many of these flights were duplicative and the fixed number of passengers were diverted from competing carriers. This practice led to a chronic problem of excess capacity on certain routes. During the 1970's, many analysts and regulators conceded that the industry and the public would be better served in a deregulated environment.

In 1978, Congress passed the Airline Deregulation Act. The law called for an end to all price and route controls by the year 1983. In the interim period, airlines could reduce their prices by a maximum of 50 percent. Many major carriers vehemently opposed the new legislation. While a complete discussion of the counterarguments is beyond the scope of this section, one issue is of special interest. A major concern voiced was whether deregulation would result in increased concentration in the industry. Opponents of deregulation argued that a few healthy large carriers would slash fares driving the marginal carriers out of existence, and then boost fares to recover lost profits. The industry would thus move towards greater concentration. The CAB response was that there were no economies of scale to be gained by larger airlines. Smaller airlines can

acquire larger aircraft, if necessary, and monopoly profits thus would be eroded by new entries in the markets where monopoly profits existed.

The remainder of this paper deals with the issue of market concentration. The objective is to evaluate the predictions of the critics of deregulation on this specific aspect. In the next section several measures of market power are discussed and applied to airline data for the pre and post deregulation era.

III. STATISTICAL MEASURES OF CONCENTRATION

This section outlines four statistical measures of concentration. These measures are then applied to the airlines to examine the change in the concentration in the industry as a result of deregulation.

A. Concentration Ratio

The concentration ratio is the percentage of the market sales, or some other measure of size, controlled by an absolute number of firms. The most commonly used are the four or eight largest firm ratios. Concentration ratios are one of the most popular measures of structural power. It has been suggested by Scherer (1970) that four firm concentration ratios of more than 40 percent indicate oligopoly. A major advantage of these ratios is that they are easily understood. Scholars and the courts have used them widely [See Scherer (1970)]. These ratios also have the advantage of combining firm numbers anda measure of firm size rather than simply considering one or the other. There are disadvantages, however, with using concentration ratios as the only measure of market power. First, only a certain number of firms, (i.e., 4 or 8 firms), rather than all the firms are considered. This may result in distorted and ambiguious conclusions. Second, the concentration ratios for a certain group of firms do not measure the firms' power within the certain group. Researchers have tried to design indices that would alleviate these problems.

B. Herfindhal Index

The Herfindahl Index (H Index) is one such index. Although it doesn't solve all the above problems, it is popular among academicians. This summary Index is the sum of the square of the market shares of firms in a market. The mathematical formulation of the H Index is:

$$H = \sum_{i=1}^{n} (s_i^2) \quad \text{for} \quad i = 1, 2, \ldots, n$$

where s_i is the ratio of the sales of firm i to total market sales.

Under perfect competition, H = O; under monopoly, H = 1. The main advantage of the H Index is that it takes all the firms into account and assigns heavier weights to the market shares of the larger firms. It therefore captures the impact of the size inequality. The main drawback of the H Index is the detailed market share data necessary for its computation. The latter is not a constraint in this study. [See Scherer (1970) and Greer (1980) for more information on this index.]

C. Lorenz Curve

The third measure of concentration used in this paper is the Lorenz Curve and its companion summary index, the Gini Coefficient. The Lorenz Curve and Gini Coefficient reflect inequality and relative concentration. In order to construct the Lorenz Curve and compute the Gini Coefficient, the market shares for various groups of firms are computed and compared with the situation where perfect equality prevails. For instance, the total number of firms in an industry may be divided into five groups. If each one of these groups controls only 20 percent of the market, then we have a perfect equality. This would be graphically depicted by a Lorenz Curve which is a 45 degree line on a graph where the axis of the coordinates show the percentage of firms and the percentage market share, respectively.

In the next section, the measures of concentration described are applied to the airline data.

IV. EMPIRICAL RESULTS

This section applies the measures of concentration described in section III to the sales data for the U.S. carriers. The data used in the study covers the period 1967 to 1985. The time horizon is divided into two parts. The years 1967-1975 are the pre-deregulation years. The 1976-1985 period is the post-deregulation period. A list of carriers studied is presented in the Appendix.

The 4 and 8 firm concentration ratios for these years are presented in Table 1. It appears that the 4 and 8 firm concentration ratios were declining even prior to deregulation. The 4 firm concentration ratios for all the years before and after deregulation hover around 50 percent, thus indicating that the structure of the industry was oligopolistic both before and after deregulation. But the 4 and 8 firm concentration ratios for the years after deregulation tend to be generally lower than in the pre-deregulation periods. The surge in 4 firm concentration ratio in 1980, and again in 1982, appears to counter the decreasing trend of this ratio. This may be accounted for by the merger of Pan Am and National in 1980 and acquisition of Continental Airlines by the Texas Air Group. The declining trend in the 8 firm ratio is more pronounced. Compared to 1975, the 8 firm ratio has declined by four percentage points. In order to make a statistical deduction on the basis of this sample, the mean 4 and 8 concentration ratios for the pre and post deregulation years were tested for equality. Table 1 shows that, with a 99 percent confidence level, one could claim that the mean concentration ratios for both 4 and 8 firms are not equal. We can conclude therefore that, based on this sample, the concentration ratios for the years after deregulation have declined. This refutes the claims of the deregulation critics, as the market power of the largest 4 and 8 firms have declined. The industry has not become more oligopolistic in the deregulated environment.

As the next step, the H Index is computed. As noted above, the H Index will increase if the share of the larger firms increases, and it will decrease with an increasing number of firms in the industry. Table 2 presents the H Index for the years before and after deregulation. As evident in the table, the H indices for the years after deregulation have generally decreased. While some firms have filed for bankruptcy or merged with others, and new firms have taken their places, the total number of firms after deregulation has not increased drastically. Since the number of firms has not increased dramatically, the decrease in the H Index must have been due to decreases in the market shares controlled by the large firms, thus resulting in a decrease in concentration of market power in the hands of few large firms. The H Index thus coroborates the result of concentration ratios and indicates that the airline industry has not become more oligopolistic due to deregulation.

The value of the t statistic for the hypothesis that the mean of the H Index for the year of pre and post deregulation are equal statistically is reported in Table 2. The computed value of the t statistic indicates that the equality hypothesis is rejected at the 99 percent confidence level. It this indicates that the H Index has declined due to deregulation.

The above empirical tests indicate that the oligopoly power of the larger firms has declined after deregulation. To further demonstrate this directly, the Lorenz Curve and the Gini Coefficient are constructed. As noted previously, the Lorenz Curve measures the percentage of sales controlled by a certain percentage of firms. If the hypothesis advanced is true, then the market share controlled by the smallest firms should increase. To construct the Lorenz Curve, the carriers were divided into five groups in an ascending order according to market share. The market shares of each of the five groups for the pre and post deregulation years are presented in the Appendix. Table 3 shows the averages of the market shares of these firms, pre and post deregulation. Figure 1 is a graph of the Lorenz Curve. As evident from Table 3, the average market share of

TABLE 1
4 and 8 Firm Concentration Ratios For Pre and Post Deregulation Periods

Year	4 firm	8 firm
1967	0.59	0.85
1968	0.58	0.84
1969	0.57	0.83
1970	0.57	0.83
1971	0.57	0.82
1972	0.56	0.81
1973	0.53	0.81
1974	0.52	0.81
1975	0.51	0.81
Mean	0.5556	0.8233
1976	0.52	0.81
1977	0.50	0.82
1978	0.52	0.80
1979	0.49	0.78
1980	0.51	0.80
1981	0.48	0.77
1982	0.50	0.80
1983	0.51	0.80
1984	0.51	0.79
1985	0.50	0.77
Mean	0.5040	0.7940
t	(5.03)*	(4.06)*

Notes: The ratios are calculated by finding the fraction of sales controlled by 4 and 8 firms relative to the total yearly sales.

Computed from raw sales data contained in the *Value Line Investment Survey.* t values are computed for the null hypothesis that mean ratios for the pre and post deregulation years are statistically equal.

*significant at the 1% level.

TABLE 2
Herfindal Index For The Pre and Post Deregulation Years

Years	H Index
1967	.09
1968	.11
1969	.11
1970	.11
1971	.10
1972	.10
1973	.099
1974	.089
1975	.097
Mean	.101
1976	.098
1977	.086
1978	.097
1979	.088
1980	.094
1981	.087
1982	.095
1983	.095
1984	.094
1985	.086
Mean	0.092
(1967-1975)	.101
(1976-1985)	0.092
t-statistic	(3.72)*

Notes: The H Index is the Herfindhal Index or $\Sigma\ s_i^2$ for i = 1, 2 . . . , n, where, i is the number of firms. S_i is the market share of the ith firm.

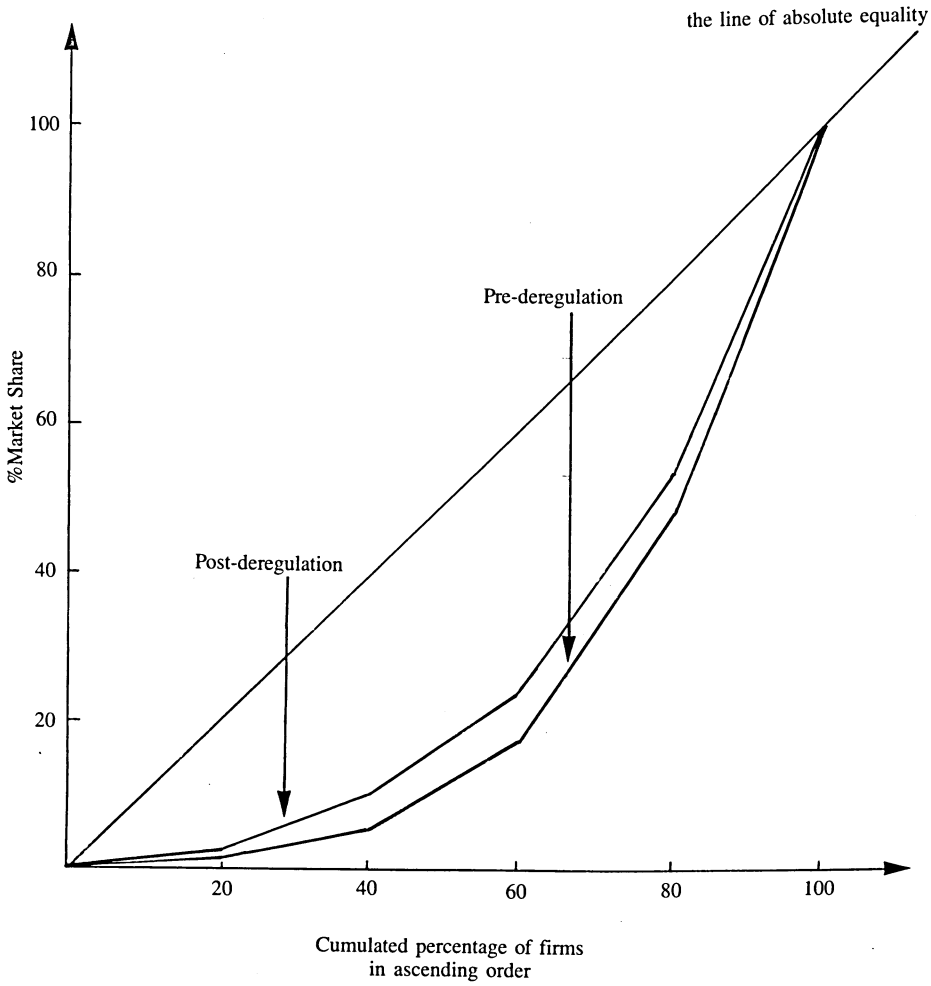
The t-statistic is computed for the null hypothesis that the pre and post deregulation means of the H Index are statistically equal.

*significant at 1 percent level.

TABLE 3
Average Market Shares of 5 Groups Of Firms In Ascending Order

Firms (5)	1st 20	2nd 20	3rd 20	4th 20	5th 20
Pre-deregulation market share (1967-1975)	2.5	4.3	12.6	30.9	49.6
Post-deregulation market share (1976-1985)	3.4	8.0	14.1	29.0	46.1

Figure 1
Lorenz Curve



the bottom 20 percent of the firms has increased from 2.5 to 3.4 percent, a 36 percent increase. The increase in the market shre of the second 20 percent of the firms is even more impressive. These firms have increased their market share from 4.25 to 8.0 percent, a whopping 88 percent increase. The 3rd 20 percent of the firms have also increased their market share from 12.6 percent, the average for the pre-deregulation years, to a 14.4 percent, the average for the post-deregulation years. This translates into a 12 percent increase. On the other hand, the market shares of first and second 20 percent of the firms at the top have both declined. This evidence clearly indicates that due to deregulation, the firms with smaller market shares have benefitted by being able to increase their market share. The larger firms have lost some of their market power.

The two Lorenz Curves in Figure 1 show the same result. On the graph, the 45 degree line is the line of perfect equality. The area between the Lorenz Curve and the line of perfect equality indicates the degree of inequality in the industry. The smaller that area, the closer the industry is to perfect equality. The ratio of this area to the area under the line of eprfect equality is defined as the Gini Coefficient. As market shares approach equality, the Gini Coefficient approaches zero. A Gini coefficient approaching one indicates increasing inequality in the market shares and thus, a higher concentration in the market.

It is obvious from Figure 1 that the inequality of the market shares has declined after deregulation. The Lorenz Curve for the post deregulation years has less concavity and therefore is closer to the line of absolute equality. It is evident that the Gini Coefficient for the post-deregulation years is smaller. The value of the Gini Coefficients for the average market share, pre and post deregulation, are 0.6998 and 0.6893, respectively. Although both these ratios indicate that the industry had been, and still is oligopoistic, the Gini Coefficient has declined somewhat due to deregulation. One can safely conclude therefore that, not only has concentration not increased due to deregulation, it has actually decreased.

V. SUMMARY AND CONCLUSION

This paper has examined the impact of deregulation on market concentration in the airline industry. Critics of airline deregulation have charged that deregulation would result in increased concentration in this industry. Several measures of concentration were used to test this hypothesis. The 4 and 8 concentration ratios, the Herfindahl Index, and the Gini Coefficient and Lorenz Curve, all widely accepted by scholars and the courts, evidenced a decrease in market power, post-deregulation. The time period of the study covered the 19 years from 1967 to 1985. This period was divided in the pre-deregulation (1967-1975) and post-deregulation era (1976-1985). It was concluded that the increased competition has eroded the market power of the largest firms. These findings corroborate those of Gritta And Adrangi (1985), who found that deregulation caused an icnrease in both price competition and financial risk. it is noteworthy that although price competition has been fierce, market concentration has not increased. Evidently, bankrupt carriers have been replaced by more efficient and profitable carriers. Free market forces are working.

APPENDIX

Data for the following carriers were used in the study.

Pre-deregulation (1967-1975)	Post-deregulation (1976-1985)
Allegheny	American
North Central	Alaska
American	Braniff
Braniff	Continental
Continental	Delta
Delta	Eastern
Eastern	National
National	Frontier
Northwest	Northwest
PSA	Ozark
Pan AM	PSA
TWA	Pan Am
United	People's Express
Western	Piedmont
World Air	Republic
Ozark	Southwest
Frontier	Texas Air (Acquired Continental)
Piedmont	TWA
Southwest	United
Texas Air	US Air (Includes Allegheny)
	Western
	World

REFERENCES

Carson, Robert B. *Economic Issues Today.* Third Edition. St. Martin's Press. 1983.

Cavara, L., R. Stover, and B. Allen. The Capital Market Effects of Airline Deregulation. *Transportation Journal.* Volume XX. Spring 1981.

Greer, Douglas F. *Industrial Organization and Public Policy.* Second Edition. McMillan Publishing Company. 1980.

Gritta, Richard D. and Adrangi, Bahram. Risk in the Airline Industry: Pre and Post Deregulation. *Proceedings of the Twehty-sixth Annual Meeting of the Transportation Research Forum.* 1985.

Hailstone, Thomas J., and Frank V. Mastrianna. *Contemporary Economic Problem and Issues.* 7th Edition. 1982.

Scherer, F.M. *Industrial Market Structure and Economic Performance.* Rand McNally & Company.

ENDNOTES

* Bahram Adrangi and Richard Gritta are Assistant Professor of Business Economics and Professor of Finance, School of Business Administration, University of Portland, respectively; Garland Chow is Assistant Professor of Transportation, School of Business Administration, University of British Columbia. During the past year, Garland Chow was Visiting Assistant Professor at Arizona State University.

1. For a complete discussion, see Wesley G. Kaldhal; "The Direct Testimony of Wesley G. Kaldhal". *Domestic Passenger Fare Investigation*, (Washington, D.C.: Civil Aeronautics Board, August 1970), Docket 21866-Phase 7, EA-T-1, 7-18.
2. Although the Deregulation Act was passed in 1978, many researchers have treated 1976 as the beginning of defacto deregulation. For example, see Cavarra et el., "The Capital Market Effects of Airline Deregulation", *Transportation Journal.* 1980.