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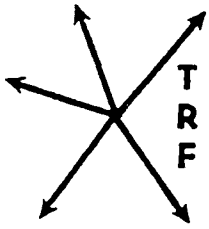

TRANSPORTATION RESEARCH FORUM
in conjunction with

Deregulation and Non-Hub Airports: Discriminant Analysis of Economic, Demographic and Geographic Factors

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The year 1978 witnessed the passage of the Airline Deregulation Act, a piece of legislation that certainly has proven to be the catalyst for major changes in the airline industry. It has also had significant implications for transportation in general. Among the major objectives of the Airline Deregulation Act was unbridling of the forces of competition, i.e., the removal of entry and exit barriers and introduction of real price competition. What then has occurred? Although a variety of factors have contributed, the major airlines have experienced the best (1978) and worst (1982) years in their history. As a general overview, Due [5] suggests that:

> There are more carriers on many routes to divide up the traffic; new firms have started up paying relatively low wages and charging low fares; extreme rate cutting has broken out on some routes . . . adequate earnings may come only afer the liquidation of a number of firms, with concentration of traffic in the hands of a smaller number of firms that will play the oligopoly game effectively.

Although the primary attention regarding deregulation has focused upon the Nation's major airlines and service to and through the major airports throughout the country, the cities and towns situated on less-dense routes and the comparatively small airlines serving those points have likewise felt the impact of deregulation. It was these smaller outlying communities that expressed considerable concern during the debate over the passage of the Act. While many of the small communities have experienced a reduction in service since 1978, numerous other communities have witnessed an increase in the level of service. This paper addresses the question of why certain small communities have seen improvements while others have experienced sharp declines in service. The methodology employed to answer this question involves the development of a model that reflects conventional wisdom ragarding the market characteristics that influence air service to small towns and a test of those characteristics structured upon the changes in air service from 1978 to 1983.

THE NON-HUB AIRPORT FOCUS

It comes as no surprise that the vast majority of the airports in this country serve small communities. While the number of these facilities is large, the number of passengers served vis-a-vis all air passengers is small; nonetheless, the vitality of a great many of these towns is linked to some degree of air service.

Over the years, the Federal Aviation Administration (FAA) has developed a system of classifying airports predicated on the volume of passenger activity at each location in relation to the total of the domestic passenger activity at each location in relation to the total of the domestic passenger activity. That system is summarized in Table 1. Table 2 shows that most of the airports serving the nation are associated with small towns, i.e., nearly 80% of the airports in the continental U.S. are non-hub facilities.

THE AFTERMATH OF DEREGULATION

Opponents of deregulation foresaw a drastic curtailment of service to the non-hub airports. They contended that frequencies would be reduced, inferior equipment would be used and overall service would deteriorate. Proponents, however, argued that "certain of the lower density routes would be served by non-subsidized commuter carriers..."[6, p. 81]. This latter view embraces a 1972 CAB Bureau of Operating Rights statement that"...operating costs could be substantially reduced if smaller aircraft were used to serve marginal stations and that the use of such aircraft should not seriously curtail traffic, even if frequencies are not increased"[2].

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TABLE 1

DEFINITION OF HUB AIRPORTS ACCORDING TO FAA CLASSIFICATION SYSTEM

HUB	DEFINITION: PERCENT OF NATION'S ENPLANEMENT	EXAMPLES
Large	1% or more	Atlanta, Dallas-Ft. Worth, Phoenix, San Francisco
Medium	.250% to .999%	Cincinnati, Kansas City, Portland, San Antonio
Small	.050% to .249%	Boise, Ft. Wayne, Lubbock, Richmond (VA)
Non-Hub	Less Than .15%	Flagstaff (AZ), Greenwood (MS) Latrobe (PA), Menominee (MI)

TABLE 2

DISTRIBUTION OF AIRPORTS BY HUB CLASSIFICATIONS

	Number of Airports Continental United States	
	Number	Percent
Large Hubs	24	3.8%
Medium Hubs	36	5.7%
Small Hubs	71	11.2%
Non-Hubs	503[1]	79.3%
	634	100.0%

SOURCE: Civil Aeronautics Board, Report on Airline Service, Fares, Traffic, Load Factors, and Market Shares, Washington, D.C., November, 1981.

1 Not all of the non-hub airports receive service at the present time.

Not long after the enactment of the 1978 Act, the popular press frequently described how individual communities had been ravished as the result of the Act. Cohen [4] noted 70 communities had lost all services from one or more carriers. *Air Transport World* [1] took the position that "Service to small communities has been slashed." Further, Kaus [10] described the airlines as playing "musical planes" resulting in substantial cutbacks.

Following these initial reactions, a variety of broader-based analyses surfaced. As Oster [11, p. 120] suggested: "Obviously, to determine the impact of deregulation on air service to small communities, the *system-wide* patterns of service changes to small communities must be assessed rather than merely examining the isolated experiences of only a few communities." Meyer and Oster [11, p. 259] within a year of the passage of the Act, concluded that "small communities have not fared badly under the deregulation." Using a similar timeframe, Vellenga and Allen [16] concluded that, "For the most part, airline service to small and medium-size cities in six midwestern states has been good to adequate." Finally, upon reviewing several of the early studies related to deregulation, Due [5, p. 20] commented: "that on the whole, smaller cities have not experienced a reduction in the number of flights, although the quality and reliability of service may have suffered."

In an effort to provide a broader-based systematic study of service changes at smaller communities, Jones and Cocke [9] compiled data which indicated that over a five-year span (1978-1983) service to non-hubs had declined, whether measured by number of flights or the number of seats offered. Their data represented all flights associated with the non-hub airports served exclusively by commuter airlines and showed that flights and seats had decreased by 25.4% and 33.4% respectively from 1978 to 1983.

RESEARCH DESIGN

As the important question being addressed in this paper concerns the factors which tend to explain why service at some small communities has improved while declining at others, a service measurement must first be established for each location. Two of the most frequently employed measures of performance related to the airline/community linkage are the number of flights and the number of seats per week. At one time the CAB gathered and disseminated a series of reports containing data on both of these measures. Given the budget cutbacks associated with the "sunset" provision of the 1978 Act, the CAB has discontinued the collection of these data. Thus, while 1978 data are available via the CAB reports, subsequent data must be generated by the researcher. To capture data depicting flights and seats associated with non-hub airports, all commuter airline flights with one leg of the flight (non-stop) to a non-hub were analyzed. Jones and Cocke [9] had earlier shown that nearly three-quarters of the non-hub airports that received service in 1983 were served exclusively by commuters.

For 1983, a scheduled flight figure was computed for each non-hub airport, i.e., 19,002 flights shown in the January 1, 1983 *Official Airline Guide* were analyzed. To ascertain the number of seats that left (or arrived at) a given non-hub airport each week, the frequency of the flight (e.g., daily, all but Saturday, etc.) was established along with the type of aircraft used for the flight. The configuration of the aircraft (e.g., deHavilland Dash 7 = 50 seats, Swearingen Metro = 19 seats, Beechcraft L99—15 seats), was then multiplied by the frequency of the flights to compute the number of seats per week! Inasmuch as the number of the flights can belie the fact that, for example, one Dash 7 flight can supply more capacity than 5 Cessna 402 flights, seats per week was selected as the performance measure.

Using the procedure outlined above, October 1, 1978 and January 1, 1983 data for non-hub airports were made comparable. Thus, for each non-hub airport served exclusively by commuter airlines in 1983, the service pattern following deregulation (1978-1983) could be established.

From Table 3 it can be discerned that of the 360 non-hubs involved in the study, 25.83% experienced an increase in service, while 73.89% had a decrease and .28% had absolutely no change over the five years. Table 3 also shows that 75 non-hubs (or 20.83% of the total) had all service withdrawn by 1983 (i.e., 100% reduction), thus leaving 285 non-hubs with commuter airline service on an exclusive basis.[2]

The Question. As stated previously, the focus here concerns the factors that result in added service to one community and service cutbacks in another. For example, what factor(s) explains why Rocky Mount, North Carolina (pop. 41,283) experienced a 59.8% loss in service from 1978 to 1983 while Elkhart, Indiana (pop. 41,305) had a 54.3% increase in seating capacity during the same period? Further, what accounts for the similar cutbacks of—42.6% at Clovis, New Mexico (pop. 31,194) and—42.9% at Manistee, Michigan (pop. 7,566)?

Conventional Wisdom. Although different airlines may function under different operating strategies, generally speaking one would expect that service standards should differ only as a matter of degree whether the city being served is Milwaukee, Meridian or Moab. That is, service should be a function of spatial alignments, numbers of travelers, and the economy in the vicinity of the airport.

Conventional wisdom suggests that the further one is from an alternative airport, the more likely that community is to have service. Conversely, the closer a community is to a small, medium, or large hub, the more likely the prospective passenger will be "asked" to drive to that facility.

It seems somewhat tautological that the level of service extended is related to the number of passengers desiring the service. Nonetheless, the population of the community should be expected to have some impact on service decisions.

Population alone, as students of marketing are wont to suggest, does not constitute a market. To be a market, the population must have some buying power. Thus, service may be related to the economic well-being of the community since, for example, a locale with a poor economic base may not excite an airline contemplating route-structure changes.

TABLE 3

FREQUENCY DISTRIBUTION OF PERCENTAGE CHANGE IN LEVEL OF SERVICE 1978-1983 BY NON-HUB AIRPORT

% CHANGE 1978-1983	NUMBER	% OF TOTAL
+ 100% & over	32	8.89
+ 90 - 99.9	2	.56
+ 80 - 89.9	5	1.39
+ 70 - 79.9	1	.28
+ 60 - 69.9	5	1.39
+ 50 - 59.9	3	.83
+ 40 - 49.9	3	.83
+ 30 - 39.9	3	.83
+ 20 - 29.9	7	1.94
+ 10 - 19.9	15	4.17
+ 1 - 9.9	17	4.72
0	1	.28
- .1 - 9.9	18	5.00
- 10 - 19.9	10	2.78
- 20.- 29.9	25	6.94
- 30 - 39.9	19	5.28
- 40 - 49.9	25	6.94
- 50 - 59.9	29	8.06
- 60 - 69.9	29	8.06
- 70 - 79.9	16	4.44
- 80 - 89.9	16	4.44
- 90 - 99.9	4	1.11
- 100%	75	20.83
Total	360[1]	100.00

1. Note: 33 non-hubs not in this total but included in the FAA list of non-hubs were not receiving service in 1978 and were not likewise in 1983.

In addition, the structure of the economy may influence mobility requirements. Two communities may be similar in terms of economic strength, yet one may be agricultural and the other dominated by a more mobile industrial base. Previous research [8] suggests that the vast majority of commuter airline travelers are on business-related trips.

The Model. With the passage of the Airline Deregulation Act, airline executives have discovered the relative ease with which one can enter a market, withdraw from a market, and augment or reduce service to a market. The kind and degree of the action, according to the conventional wisdom, should be a function of distance to alternative air service, population, buying power, and business activity.

The market characteristics comprising the variables above are made operational by means of the following measures:

1. *DISTANCE TO NEAREST SMALL HUB:* Direct nautical miles from the non-hub airport to the nearest small hub airport. The mileages were computed through reference to the *Jeppeson Low Altitude Flight Planning Chart.* This measure of mileage is included to account for the proximity of alternative locations for flight service. One might theorize that, *ceterus peribus,* the farther from an alternative hub the more likely service will be available at the non-hub. Thus, while one is unable to affect a change in a community's location, one might certainly explain the service given that community by viewing its proximity to an alternative hub of any size.
2. *DISTANCE TO THE NEAREST MEDIUM HUB:* Direct nautical miles from the non-hub airport to the nearest medium hub airport. The mileages were established in a manner identical to the first measure.
3. *DISTANCE TO THE NEAREST LARGE HUB:* Direct nautical miles from the non-hub airport to the closest large hub airport. Again, these figures were computed in a manner identical to the first measure.
4. *POPULATION:* The number of residents in the county where the non-hub airport is situated as expressed as a percentage of the U.S. population. The figures taken from *Sales Management* [14] portray the foundation of the individual airport's market.
5. *BUYING POWER:* The buying power associated with the county where the airport is located. This variable, developed by *Sales Management* [14], is expressed as a percentage of the U.S. total and permits the input of dollars as a measure of influence rather than just people. Inasmuch as one of the components of the Buying Power Index (BPI) is retail sales, a factor reflecting a tourist area is introduced.
6. *VALUE ADDED BY MANUFACTURING:* Dollars added by manufacturing in the county where the airport is located. This measure represents a surrogate for business activity and thus travel. One might expect that as business activity in an area increases, air travel may as well. These data were gathered from the *Census of Manufacturers* [15].

The Analytical Approach. Once the market characteristics were defined, data pertaining to each were collected for each non-hub airport. The analytical technique employed in this study was a discriminant analysis. Discriminant analysis revolves around the derivation of a linear combination of the six independent variables that will statistically distinguish (discriminate) between two *a priori* defined groups, i.e., those non-hubs experiencing an increase in service (1978-1983) and those where service diminished. Since the non-hubs are categorized strictly on a percentage basis and since it is somewhat difficult to rationalize the difference between a small increase and small decrease, a decision rule for inclusion into the analysis was introduced. That decision rule held that any non-hub with an increase or decrease of less than 10% would be deemed "too close to call" and excluded from the analysis. Thus, as can be deduced from Table 3, the number of non-hub locations included in the analytical phase of the study is 324.

FINDINGS

To determine if the discriminating variables would distinguish beween those non-hubs that had improved service (1978-1983) and those experiencing reduced service levels for the same period,and to ascertain the relative importance of the variables, the data were analyzed by means of SPSS Discriminant Analysis, Direct Method. Discriminant analysis can be utilized as a descriptive tool or as a predictive or inferential technique [13]. The intent here is to profile the extent to which the discriminating variables explain the variance in the change in airport activity.

The results of the analysis are shown in Tables 4 and 5. Table 4 depicts both the standardized and unstandardized discriminant functions while Table 5 percents the test statistics related to the discriminant model.

Table 4 establishes the relative contributions of the variables by viewing the standardized discriminant coefficient and ignoring its sign. Clearly the greatest contributions to the function are made by the non-geographic or spatial factors, i.e., the economic and demographic factors of population, buying power, and value-added contribute most.

If one contemplates the results of the analysis as shown in Table 5, one must seriously doubt the conventional wisdom. The figures suggest little success in discriminating between the successful (more service) and the unsuccessful (less service). Three measures depict the discriminant function as not separating the non-hub groups well. First, by squaring the canonical correlation, the proportion of the variance in the discriminant function explained by the groups can be determined. Second, the Wilks' Lambda is inverse measure of the discriminating power and as such the larger the lambda, the greater the amount of information yet to be explained. Third, by converting the lambda to a chi-square score the statistical significance of the differences can be shown, i.e., a measure of chance variation can be determined. Each of these three statistics introduce doubt as to whether the variables suggested by the

TABLE 4

STANDARDIZED AND UNSTANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

Variable	Standardized Coefficient	Unstandardized Coefficient
Distance - Small Hub	.22793	.0043
Distance - Medium Hub	.09684	.0013
Distance - Large Hub	- .20683	- .0027
Population	12.77950	48.4183
Buying Power	- 7.84910	- 27.0113
Value Added	- 5.03751	- .0026
(Constant)		- .5535

TABLE 5

TEST STATISTICS FOR DISCRIMINANT FUNCTION

Statistic	Value
Eigenvalue	.05742
Percent of Variance	100.00
Canonical Correlation	.2330
Wilks - Lambda	.9457
Chi-square	9.8829
d.f.	6
significance	.1297

conventional wisdom do indeed account for the differences in service levels experienced by the non-hub airports subsequent to deregulation. Based on the results of the discrimination process one can only conclude that the two groups are more similar than different.

Since it seemed obvious that only a limited amount of group separation is present, one additional measure, an unbiased classification matrix was produced in an effort to further confirm the results of the statistical results. A classification hit-ratio [7] of 63.74 on the hold-out sample so nearly mirrors Morrison's proportional chance criterion [12] of 63.54 that the conclusion is reached that the discriminant model provides minimal accuracy over chance.

CONCLUSIONS

This study was undertaken to assess factors that have influenced airport activity at non-hub airports served exclusively by commuter airlines following the deregulation of the airline industry. To date, there have been few, if any, models developed to account for such impacts. This is not to suggest that some airlines have not formulated models for decision-making purposes. If these models exist, however, they are proprietary.

The model developed here utilized the conventional wisdom which counsels that the success of obtaining air service a small community (non-hub) has experienced since the passage of the deregulation act in 1978 is a function of geographic factors (distance from alternative airports) and demographic and economic factors (population, buying power, and value-added-by-manufacturing). The considered judgment that these variables would input significantly to an explanation of the variation in airport activity was, to say the least, a considerable overstatement.

The model developed for this study was exploratory and consequently has served a useful purpose. What seems clear is that underlying reasons related to increased or reduced airline service are more complex than many realized and/or are such that they are difficult to measure. In searching for other explanations, attention should be directed to the role of the subsidy paid to Essential Air Service (EAS) locations under Section 419 of the Act. The subtleties of politics (state, local or national) may also enter into the equation.

Surely, Chambers of Commerce in various communities could profit from an understanding of the data contained in this study. These groups are often the most vocal in their demands for air service to their community and usually attempt to support their case with the quantification of conventional wisdom. This study suggests we need to devote more thought to defining conventional wisdom.

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NOTES

1. The seating capacity for many of the aircraft used in deriving aggregate seats are average figures which may not represent the actual capacity scheduled. In many cases the carriers report average available seats by aircraft type to the *Official Airline Guide.* If seats have not been reported, a "default" table was used which includes a single average figure for each aircraft type. This results in seating capacity figures that may differ from what is actually scheduled by particular carriers. Also, if a carrier has several seating configurations for a basic aircraft type, its single average seating figure will only be approximately correct when used to compute total seats.

2. Any non-hub served by a carrier other than a commuter airline (whether exclusively or in addition to the commuter airline) is not included in the data.