An Assessment of Economic Benefits From Airports:

The Building of a Model

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Abstract

Past research indicates that significant economic impacts are generated from airports. Over time several airports and statewide systems of airports have been studied and economic impacts determined. However, many airports remain unstudied and the knowledge of community economic impact is vital for airport public relations programs to demonstrate worthiness.

Using a recent airport economic impact study conducted by the Illinois Department of Transportation data were subject to multiple regression and correlation procedures in order to build an estimation equation. The results of the study indicate that a very strong relationship exists between several typical airport operational variables such as employment, total based aircraft, and annual enplanements and total economic impact. Two regression equations were developed for commercial airports and non-commercial airports. These equations were found to be statistically useful as estimating tools for determining total economic impact at a given airport.

An Assessment of Economic Benefits From Airports: The Building of a Model

Do airports contribute to the economic well-being of a community? There was once a time, not too many years ago, that this question could not be readily answered other than, it appears that airports do stimulate economic benefit. As one researcher concluded, "airports do not merely involve travel; there are implications for urban development, pollution, noise, and industrial activity," (Walters, 1978). Since 1970, there has been an alarming need for airport officials to "justify" airports on the basis of economic contribution to a community so as to prove worhtiness for continued receipt of community resources and services. The Air Transport Association of America (ATA) was instrumental in the initiation of several benchmark impact studies for major hub airports (Foster, 1972), including Los Angeles, New Orleans, Kansas City, Pittsburgh, Denver, Chicago, and San Francisco. Some of the larger airports embarked on such benefit assessments as a foundation of public relations programs to facilitate communications between airports and communities.

The need for such visibility transcends the single airport and many states have undertaken state-wide economic benefit studies that not only include the assessment of airport economic impacts but analyze the total aviation industry, i.e., government, manufacturing, business, tourism, etc. (Aviation Association of Indiana, Inc., 1984, Pennsylvania Department of Transportation, 1983, and Florida Department of Transportation, 1983).

The early efforts of the ATA to bring airport economic impacts to the forefront of community attention laid down a study framework, a pattern from which most subsequent studies based their research procedures. To the greater extent the ATA methodology was adopted as the quasi "industry standard" by other trade associations and even some Federal Aviation Administration regional offices (U. S. Department of Transportation, n.d., AAAE, 1981, and AOCI, 1979). Over time new adaptations in research methodologies have evolved but regardless of the many and varied methodologies used to assess economic impacts it can generally be stated at this time that yes, airports do have a major impact on a community in which it is located. What was eluded to over a decade ago (Jerome and Nathanson, 1971) has been tested and that direct causal links can be identified between airport development and community economic growth. In addition, (Sincoff and Dajani, 1975) concluded in their past research that airports do impact community and industrial development but not exclusively. It has also been concluded that commercial viability of an airport is not the sole criterion in airport planning; that benefit extends way beyond airport "profitability" (Rudzinski, 1971). However, airports in and to themselves are not the sole reason for growth and if not fully integrated into community planning can stimulate detrimental economic effects (Hoare, 1973).

To undertake an economic impact study of any given airport requires time, skills, and money. Most of our nation's airports cannot muster the necessary resources to accomplish such studies but could greatly benefit by having the specific information for their particular airfield. Therefore, the ability to generalize from much of the previous airport economic impact research could provide order of magnitude estimates of impact to non-studied airports. The purpose of this paper is to determine if the results of previous research can be adapted to provide airports with estimates of economic impact using generally available site specific operational data. The intent of the study is not to devise a complete solution but to test the feasibility of the hypothesis and present preliminary results. The final goal in the line of research is the development of a national formula(s) in which a local airport can enter its own operational data and arrive at order of magnitude estimates of economic impact that it has in it's community.

Method

Subjects

The subjects for this study were the 119 airports comprising the Illinois public and private airport system. Data were derived from two secondary sources as developed by the Illinois Department of Transportation, Division of Aeronautics. Economic data were obtained from The Economic Impact of Aviation in Illinois (Egeberg, 1984) summarizing a state-wide survey research project conducted for the 1982 base year. Airport operational data was derived from the Illinois Airport Inventory Report for 1982 through 1984.

The Egeberg study developed estimates of airport economic impact for each of Illinois' airports using previously developed methodologies from many of the past studies. Similar studies have been undertaken for Arizona, New Jersey, Florida, South Carolina and

Iowa. The Illinois study reviewed four major components of the state's aviation industry, 1) airports, 2) federal government airports and facilities, 3) aviation related manufacturing, and 4) aviation education. This analysis will only focus upon the airport component of the industry.

Procedure

A data set was created which captured economic and operational information for each Illinois airport. The elements included:

- airport name
- airport type
- direct economic impact
- indirect economic impact
- induced economic impact
- total economic impact
- employment[1]
- annual operations
- based aircraft - helicopter
- based aircraft - glider
- based aircraft - single-engine
- based aircraft - multi-engine
- based aircraft - jet
- based aircraft - military
- based aircraft - total
- annual enplanements

The data set was segregated into to basic categories by airport type, airports with commercial enplanements (n = 17) and those without (n = 101). Thus the two categories of airports were defined as commercial and non-commercial airports. One airport was eliminated from study

[1] Employment considers both fulltime and part-time individuals. Employment includes direct airport employees as well as employees from fixed based operations and tenants (airlines, restaurants, business parks, National Guard, FAA towers, Flight Service Station, GADO, etc.).

due to inconsistent data. See Exhibit 1 for a profile of Illinois airports under study.

Insert Exhibit 1 about here.

The data were analyzed using multiple correlation and regression statistical techniques. The SAS (SAS Institute, Inc., 1982) computer system software was used to conduct the analysis. The STEPWISE procedure was used to determine from the many independent variables (X_i) which should be included in a regression model that accounts for the variability in the dependent variable (Y_i), an airport's total economic impact. The basic multiple regression model is described as:

$$Y_i = B_1 X_{i,1} + B_2 X_{i,2} + \ldots + B_k X_{i,k} + E_i , \quad i = 1, 2, \ldots, N$$

where:

Y_i = ith dependent random variable corresponding to $X_{i,1}$, ... $X_{i,k}$
B_0 , B_1 , B_2 , ... B_k are (k + 1) parameters in the model
$X_{i,j}$ = ith level of the jth independent variable, j = 1, 2, ... k
E_i = random error term.

Results

Several exploratory regression models were developed to acquire a "feel" for the interactions of the independent variables. The main emphasis was to determine the level of detail within the independent variables that could be used. For example, should the detailed description of based aircraft by type be used as six independent variables or is the single variable, total based aircraft, sufficient. It was found that the detailed scenario produced some misleading results caused from the development of several negative regression coefficients. A negative coefficient implied, for example, that for each additional helicopter based at an airport negative economic impact was generated. Reality suggests that this is not a true happenstance. Reality suggests that all coefficients should be positive. As a result, a less detailed approach was taken in describing airport operations.

The basic models that were tested consisted of the following components:

<u>Non-Commercial Airports</u>

Y = Total Economic Impact

X_1 = Employment

X_2 = Total Based Aircraft

X_3 = Annual Operations

<u>Commercial Airports</u>

Y = Total Economic Impact

X_1 = Employment

X_2 = Total Based Aircraft

X_3 = Annual Operations

X_4 = Annual Enplanements

The results indicate that the best single variable that explains the variability in total economic impact is employment for non-commercial airports and annual enplanements for commercial airports. There is a strong relationship between dependent and independent variables.

Correlation coefficients are 0.924 between total impact and employment for non-commercial airports and 0.999 between total impact and enplanements for commercial airports. For commercial airports there is also a strong relationship between total impact and employment (*r* = 0.998) and total impact and annual operations (*r* = 0.947). The magnitude of the coefficients describe nearly a direct relationship between variables. The results of the single variable models are shown in Exhibit 2.

Insert Exhibit 2 about here.

The SAS STEPWISE procedure produced the best multiple regression models for estimating total economic impact. For commercial airports a trivariate model produced an R^2 of 0.9999 and a C(p) of 3.25. The equation is shown below:

Total Impact (\$) = 10,524,580 + 65,177(Employment) + 121,722(Total Based Aircraft) + 182(Annual Enplanements)

This equation accounts for over 99.99% of the variability in total economic impact. There appears to be a very strong relative linear relationship between total economic impact and employment, total based aircraft, and annual enplanements in these sample data. A bivariate regression was developed for non-commercial airports. This equation produced an R^2 of 0.8577 and a C(p) of 4.00. The equation is shown below:

Total Impact ($) = 1,068,779 + 326,968(Employment) + 37(Annual Operations)

This model is not as "strong" of a predictor as the equation accounts for 85.77% of the variability in total economic impact. Yet the R^2 value is relatively high in statistical terms. F-tests indicate that both equations are significant at the 0.0001 level. As a result the regression equations developed are deemed useful for estimating total impact for the range of variables examined.

Discussion

The results that have been developed are two mathematical equations that can be used to predict order of magnitude total economic impact for an airport given the specific airport operational data. Airport officials can now mathematically see the relationship between economic impact and their day-to-day environment of employees, based aircraft, enplanements, and operations. The results can also be used to generate growth strategies for airports and communities. For example, in a non-commercial, general aviation setting, the equation indicates that the addition of one airport related job is the same as attracting an additional 8,837 annual operations, they both produce the same effect in the community as a change in total economic impact; all other things remaining equal. Similar trade-offs exist between the variables within the commercial airport regression equation.

One also could conclude that if a community did not have a small general aviation airport and desired such a facility that the expected annual total minimum impact would be approximately $1,000,000. This assumption is arrived at by observing the constant term within the non-commercial airport regression equation and assuming the hypothetical situation of an airport with no employment and no annual operations. Although the scenario is unreal, the constant describes a base situation. In addition, some 76% of the impact is felt within a 10-mile radius of the airport (Economic Research Associates, 1982).

The findings from this study are promising but have limited usefullness until the research is taken some steps farther. The models need to be verified using other studies' findings. The models are however valid for the state of Illinois and could be used today to estimate impact in 1982 dollars. The results would just have to be indexed to current dollars. In addition, the data set should be expanded to include as many data points as possible from which to generate new regression coefficients. The dependent variable might be changed to direct economic impact or the combination of direct and indirect instead of total. This would neutralize the regional economic multiplier differentials that occur in the different parts of our country.

The broad definition of employment used in the Egeberg study should possibly be adjusted to a narrower definition of direct employment (on-field employment) that only includes employees directly related to the operation and maintenance of aviation on the airfield.

The presence of Chicago - O'Hare International Airport as a data point within the commercial airport data set may have caused some unusual results. As O'Hare is the busiest airport in the world it is an outlier point in the data. O'Hare's impact and operational statistics are much greater than the other 16 commercial airports by many orders of magnitude. In Exhibit 2 the data point for enplanements is highlighted. To illustrate the difference all remaining data points are contained within the small black rectangle located near the origin of the equation line.

Finally, confidence intervals should be developed to show the range of the estimates derived from the equations. This would provide a range of impacts that would be more credible than one specific point estimate.

The research does indicate that there are some extremely strong relationships between economic impact and ordinary airport operational data. The models developed are statistically correct and prove useful although further development may be required. The goal of the phase of research has been achieved and there is no apparent reason to conclude that a national model could not ultimately be constructed.

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EXHIBIT 1

Profile of Illinois Airports 1/

Commercial Airports (n = 17)

Variable	Mean	Standard Deviation	Minimum	Maximum
Total Economic Impact ($)	$378,689,365	1,267,401,888	6,359,864	5,290,334,162
Employmemt (FTE)	1,699	5,056	12	21,222
Total Based Aircraft	99	69	2	269
Annual Operations	107,176	137,661	18,000	605,000
Enplanements	1,348,348	5,170,113	2,173	21,400,000

Non-Commercial Airports (n = 101)

Variable	Mean	Standard Deviation	Minimum	Maximum
Total Economic Impact ($)	$ 8,701,352	22,561,757	0	190,097,764
Employment (FTE)	20	61	1	446
Total Based Aircraft	53	83	0	534
Annual Operations	25,139	34,875	1,000	166,000

1/ Does not include military or government facilities.

Source: Illinois Department of Transportation, Division of Aeronautics, The Economic Impact of Aviation in Illinois, 1984 and Illinois Airport Inventory Report(s), 1981 - 1984.

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EXHIBIT 2

Simple Linear Regression Model