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THE DEMAND FOR AVIATION ACTIVITIES AT GENERAL AVIATION AIRPORTS: AN EMPIRICAL STUDY

Atef Ghobrial and Don Ramdass

ABSTRACT

This paper develops two models that relate the number of aircraft operations and number of based aircraft at general aviation airports to certain socioeconomic variables and characteristics of the counties where the airports exist. The results of the first model indicate that the demand for aircraft operations is inelastic with respect to population of the county and is elastic with respect to per capita income. The results also indicate that runway length, location of the county as a vacation destination, and presence of military and/or industrial bases have significant impact on airport demand. The results of estimating the number of based aircraft at general aviation airports suggest that the demand is inelastic with respect to both population and per capita income. The demand is also responsive to the location of the county as a vacation destination.

INTRODUCTION

Most of the empirical research in the study of air travel demand has focused on developing models to estimate passenger volumes and aircraft operations between city pairs or at air carrier airports. Examples of these studies include Verleger (1972); Ippolito (1981); Anderson and Kraus (1981); Abrahams (1983); and Talley and Eckroade (1985). One largely unexplored area is demand analysis for general aviation airports. Specifically what are the determinants of demand for general aviation airports? And what is the relative importance of these factors in estimating the demand?

This paper fills a gap in the literature of modeling demand for aviation activities at general aviation airports. In particular, it attempts to assess the effects of some socioeconomic and supply variables on the number of aircraft operations and the number of based aircraft at general aviation airports. The problem is approached from a regional perspective in order to keep the data requirements manageable and to demonstrate the applicability of the approach. The paper consists of two parts. The first part presents a model to estimate the number of aircraft operations at general aviation airports. The second part develops a model to estimate the number of based aircraft at these airports. Both empirical models were estimated using data from twenty general aviation airports in the state of Florida in 1990.

ECONOMIC IMPACTS OF GENERAL AVIATION AIRPORTS

Benefits derived from the development of general aviation airports accrue to both the users and the local community. New jobs are created initially, by construction activities at the airport and later by the increase in airport improvement activities. Jobs are also created by fixed base operators (FBO) as more services are needed. General aviation airports can be of vital importance to many industries such as agriculture, recreation and tourism, flying instruction, corporate flying, etc. Many less tangible benefits can also accrue to the community. An airport can provide access from other regions to the community's recreation facilities. It can provide a site for airshows and a base for low cost vacation charter flights. The airport is also valuable in times of emergency to evacuate seriously ill patients, to bring urgently needed medical supplies, and to evacuate the area in case of natural emergencies. Aerial fire fighting and airborne search and rescue can be of vital help to the community during times of trouble. Airports and firms which do business through the airport generate the aviation economic impacts in much the same way people transact business--they spend money. This money is then re-spent in other areas, creating a rippling effect of economic benefits. While some of the above economic benefits could be quantified, many other economic impacts are unquantifiable.

Despite the many advantages of a general aviation airport to a community, before an airport is built, a financial feasibility analysis of constructing and operating the airport should be conducted. In other words, one has to develop a demand profile for operations in the short, medium, and long-run. This demand is then translated into a revenue stream and evaluated against the cost of operating and maintaining the airport.

AN EMPIRICAL MODEL FOR ESTIMATING AIRCRAFT OPERATIONS

The future demand for general aviation airports has traditionally been estimated using historical trend analysis or using ratios between aviation activities and population and/or income. Both techniques assume a linear relationship either over time (trend analysis) or between aviation activities and population or income (ratio analysis). One cannot, however, use these techniques to assess the combined effects of two variables such as population and income on future demand. For example, two communities with the same population but with different income levels should produce different aviation activities. In addition, these techniques do not take into account the impact of improved levels of service at the airport (such as runway length) on potential aviation activities.

This section presents a more comprehensive approach to estimate future aircraft operations at general aviation airports. Specifically, the econometric model presented relates the number of aircraft operations at general aviation airports to some socioeconomic characteristics and supply variables. This relationship can be extrapolated into the future, based on assumptions of likely explanatory variables, to forecast aircraft operations. The results from this analysis should prove useful in projecting the needed improvements in general aviation airports, and in assisting city, county, and state officials in planning and allocating resources for constructing and upgrading aviation facilities. The general structure of the empirical model takes the following form:

Equation 1

$$Q = f\ (SE, S, C)$$

where Q is the number of annual aircraft operations at a given general aviation airport. Aircraft operations include both local and itinerant operations. The former is defined as operations in the local traffic pattern or in the local practice area within a 20 mile radius of the control tower, or executing of simulated instrument approaches. Itinerant operations include all aircraft arrivals and departures other than local operations (e.g.; enroute flights). SE

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in **Equation 1** is a vector of the socioeconomic characteristics in the county where the airport exists; S is a vector of some supply variables at the airport; and C is a vector of county-specific variables which affect the demand for aviation activities.

The vector SE consists of a set of descriptors of the nature and level of the socioeconomic activities that are likely to generate the demand for air travel from a given county. Population and per capita income are commonly used as representative of the socioeconomic characteristics of residents. The vector S includes the supply variables which affect the levels of service at a given general aviation airport. These variables include runway length and the conditions of runway surface (i.e.; grass or paved strip). For instance, a 5000 foot runway was considered as the threshold for the levels of service at a general aviation facility according to the types of aircraft that can be accommodated by that facility. Finally, the vector C captures those county-specific variables that can affect the demand for general aviation airports. These variables include presence of military and industrial bases, location of the county as a vacation destination, and location of the airport as a primarily local or local/itinerant operations facility.

Based upon the above discussion a demand model takes the following form:

Equation 2

$$Q = \alpha I^{\beta} P^{\theta} \exp\left(\sum \varphi TR + \eta RW + \lambda IT + \omega MI\right)\varepsilon$$

where:

Q = The number of annual aircraft operations at a given general aviation airport.

I = The per capita income in dollars of residents in the county.

P = The population of the county where the airport exists.

TR = A dummy variable for tourism which takes on the value one if the county is a vacation destination, and zero otherwise. In Florida, counties located on the Gulf of Mexico or the Atlantic Ocean are assumed to be vacation destinations.

RW = A dummy variable which takes on the value one if the airport has a runway longer than 5000 feet, and zero otherwise.

IT = A dummy variable which takes on the value one if the airport is a local/itinerant facility, and zero otherwise.

MI = A dummy variable which takes on the value one if the county where the airport exists has military bases or significant service and/or manufacturing industries.

α, β, θ, φ, η, λ and ω are the coefficients to be estimated and ε is the error term of estimation. From the above definition of explanatory variables, one would expect the signs of coefficients β, θ, φ, η, λ and ω to be positive.

RESULTS

To estimate the model in **Equation 1**, data was obtained for twenty general aviation airports in the state of Florida in 1990. The counties are served by general aviation airports only. These counties also differ in their characteristics; a few have military bases; a few are located on the Gulf of Mexico or the Atlantic Ocean (i.e.; vacation destinations); and a few are primarily local/itinerant facil-ities.Data on

Table 1
Independent and Explanatory Variables for Selected Counties in Florida in 1990

COUNTY	Number of Aircraft Operations	Number of Based Aircraft	Population	Income per capita	Runway Length (feet)	Location as a Vacation Destination	Military-Industrial Bases	Local-Itinerant Airport
Citrus	36,191	81	94,200	14,174	4,300	yes	no	no
Clay	19,102	74	105,986	13,945	5,025	no	no	no
Columbia	23,683	22	42,800	12,609	8,000	no	no	no
Dixie	6,676	9	10,585	8,527	5,000	yes	no	no
Gadsden	14,400	23	41,105	8,597	2,982	no	no	no
Hardee	8,948	38	14,202	10,858	4,000	no	no	no
Hendry	15,500	31	25,800	14,354	3,810	no	no	no
Holmes	8,143	11	15,800	11,668	3,700	no	yes	yes
Levy	23,397	42	25,923	9,386	5,000	yes	no	no
Marion	49,691	170	196,300	13,839	5,000	no	no	no
Okaloosa	63,000	59	143,800	15,760	5,000	no	yes	yes
Putnam	26,436	44	65,070	10,079	5,013	no	no	no
Suwannee	12,660	28	26,900	12,221	3,000	no	no	no
Taylor	7,018	13	17,111	10,331	5,013	no	no	no
Okeechobee	40,107	37	29,800	12,070	5,000	yes	no	no
Santa Rosa	15,600	39	81,600	14,084	3,700	no	yes	yes
Jackson	18,000	50	41,400	12,343	4,997	no	no	no
DeSoto	18,400	35	23,900	12,264	3,700	no	no	no
Walton	3,200	20	27,800	11,852	3,200	no	no	no
Flagler	155,000	48	28,700	13,331	5,000	yes	no	yes

the number of aircraft operations were obtained from the Florida Avia-tion SystemPlan, 1992-2010 (Florida Depart-ment of Transportation [DOT], 1992). Data on county population and per capita income were obtained from the Florida Long-term Forecast, Counties, 1991 (Florida DOT, 1992). Data on the physical characteristics of individual airports were obtained from the Florida Airport Directory (Florida DOT, 1991). **Table 1** includes the explanatory and dependent variables for the selected counties. The model in **Equation 2** was transformed to log-linear form and was estimated following the ordinary least square procedure (OLS). The results of estimation along with t-statistics are depicted in **Table 2**.

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Table 2
Results of Estimating the Number of Aircraft Operations at General Aviation Airports

Variable	Estimated Coefficient	t-Statistics
Constant (α)	0.0003	0.69
County Population (P)	0.4718	1.88
Per capita income (I)	1.3114	0.96
Tourism dummy variable (TR)	0.8579	2.04
Runway length dummy variable (RW)	0.4182	1.11
Itinerant operations dummy variable (IT)	0.6538	1.80
Military-industrial base dummy variable (MI)	0.4992	0.98
R-Squared	0.66	

From **Table 2**, one can see that the signs of estimated coefficients in the model agree with their *a priori* signs. Despite their correct signs, the coefficients of the variables per capita income, runway length, and military/industrial bases have relatively weak statistical significance. Because the model was transformed to log-linear form, the coefficients of the variables population and per capita income are interpreted as elasticities of demand. Elasticity is a measure of the relative change in demand due to a relative change in a given explanatory variable. The results show that the number of aircraft operations at a given general aviation airport is inelastic with respect to the population in the county; a ten percent increase in the county population will likely result in a 4.7 percent increase in the demand for aircraft operations. On the other hand, the number of aircraft operations seems to be elastic with respect to the levels of income in the county; a ten percent increase in the real per capita income will likely be associated with a 13.1 percent increase in aircraft operations. The results of estimating income and population elasticities seem to be quite interesting when compared with literature on passenger demand analysis in air travel. Previous studies show that passenger travel demand is inelastic with respect to population and relatively elastic with respect to the levels of income (Kanafani, 1979, and Abrahams, 1983).

The estimated coefficient of the dummy variable for vacation destinations indicates that, other things being equal, the number of aircraft operations at general aviation airports in counties located on the Gulf of Mexico or the Atlantic Ocean is likely to increase by about 135 percent. Likewise, the number of aircraft operations at general aviation airports with runways longer than 5000 feet is about 52 percent higher than at airports with, for example, grass or unpaved runway. Finally, the number of aircraft operations from counties with military bases and/or service and manufacturing industries is likely to be 65 percent higher than from other counties.

A simple example illustrates how the

model can be used. Assume that a new industrial park is planned in a given county which currently has a grass strip and that both population and per capita income (expressed in 1990 dollars) are expected to increase by 10 percent for the period 1991-1995. Given the elasticity estimates of population and per capita income and assuming the presence of an industrial base, the number of aircraft operations will likely increase by 95.4 percent. Now assume that as a result of the new business development a general airport facility will be constructed with a 5000 foot runway. The number of aircraft operations will now increase by 197 percent.

Table 3
Results of Estimating the Number of Based Aircraft at General Aviation Airports

Variable	Estimated Coefficient	t-Statistics
Constant (α)	0.000012	1.62
County Population (P)	0.7263	5.47
Per capita Income (I)	0.7493	0.95
Tourism dummy variable (TR)	0.3673	1.76
R-Squared	0.74	

AN EMPIRICAL MODEL FOR ESTIMATING BASED AIRCRAFT

This section presents a demand model to estimate the number of based aircraft at general aviation airports. Based aircraft is defined as an aircraft that is permanently stationed at an airport, usually by some form of agreement between the aircraft owner and the airport management. From this definition it appears that the factors which influence the number of based aircraft are population, per capita income, and location of the county as a vacation destination. The demand model now takes the following form:

Equation 3

$$Q = \alpha I^{\beta} P^{\theta} e^{\varphi^{TR}} \varepsilon$$

where Q is the number of based aircraft at a given general aviation airport. I, P and TR are defined earlier in model 2. α, β, θ and φ are the coefficients to be estimated and ε is the error term of estimation. From earlier definitions of explanatory variables, one would expect the signs of coefficients β, θ and φ to be positive. Note that because TR is a dummy variable which may take either the value zero or one, it is specified in an exponential form. Using the same data in **Table 1**, the model in **Equation 3** was estimated following the ordinary least square procedure (OLS). The results of estimation along with t-statistics are depicted in **Table 3.**

From **Table 3**, we can see that the signs of estimated coefficients in the model agree with their *a priori* signs. The results show that the number of based aircraft is inelastic with respect to both population of the county and per capita income. For example, a ten percent increase in the population of the county will likely result in a 7.26 percent increase in the number of based aircraft. The estimated coefficient of the dummy variable for vacation destinations indicates that, other things being equal, the number of based aircraft

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at general aviation airports in counties located on the Gulf of Mexico or the Atlantic Ocean is likely to increase by about 44.38 percent. Given the assumptions in the example cited at the end of the previous section, one can expect the number of based aircraft to increase by about 15.3 percent as a result of a ten percent increase in both population and real per capita income.

SUMMARY AND LIMITATIONS OF THE STUDY

This paper presented two models for estimating aviation activities at general aviation airports. The models were estimated using cross-sectional data from twenty general aviation airports in Florida in 1990. The results show positive relationships between the number of aircraft operations and population, per capita income, runway length, location of the county as a vacation destination, and presence of military and industrial bases.

The number of based aircraft is responsive to population, to per capita income, and to location of the county as a vacation destination.

Despite the meaningful results of estimating the two models, it is but a first step toward modeling aviation activities at general aviation airports. Data limitations (only twenty observations) and sensitivity of the model specifications are drawbacks to this particular empirical analysis. In addition, more explanatory variables could be included in the model such as presence of navigation aids and amenities at the airport (e.g. hangers, fueling facilities, etc.) A more robust specification of the model together with a comprehensive data collection would certainly yield more useful results.□

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