AIR TRAVEL DEMAND MODEL FOR DOMESTIC AIR TRANSPORTATION IN BANGLADESH

Dr. Md. Jobair Bin Alam* and Dewan Masud Karim**

ABSTRACT: This paper addresses the present condition of air transportation in Bangladesh by analyzing the operation and level of service of the system, demand and supply structure and the network configuration. For the planning of infrastructure development and service improvement of domestic air transportation in Bangladesh, a couple of models have been developed in the paper. These demand model correlates socio-economic, technological and transportation system with the demand air travel. These variables include population, employment, GDP, speed of the aircraft and speed of the alternatives, distances between the airports etc. The model has been calibrated using cross-sectional as well as time series data of the variables. The models can predict the air travel demand quite satisfactorily and the variables are significant. The models are then applied to forecast the future demand for domestic air travel in Bangladesh under various scenarios. The effect of Jamuna Multipurpose Bridge on the demand of air travel has also been analyzed.

INTRODUCTION

Air travel demand has experienced very fast growth in the last two decades. The volume of air passenger and freight is expected to increase much faster in near future with increased industrialization and economic development. Congestion at airport runways, passenger, and cargo terminals, inspection and ground transport facilities is expected to increase, as will demand for additional and improved airport system. Continued traffic growth creates a need for effective longer range advance planning and requires a coordinated approach for design, development and operation of future airports. Rapid technological change, traffic expansion and environmental considerations underline the need for cooperation and coordination among aviation system planners, builders, operators and users in successfully meeting the challenges.

To adequately assess the causes of performance breakdowns in existing airport systems and to plan facilities to meet future demand needs, it is essential to predict the level and distribution of demand of the various components of airport system. Without a reliable knowledge of the nature and expected variation in the loads placed upon a component, it is impossible to realistically assess its physical and operational requirements. An understanding of future demand patterns allows the planner to assess future airport performance in light of existing and improved facilities, to evaluate the impact of various

* Assistant Professor, Dept. Of Civil Engineering, BUET, Dhaka-1000

** Undergraduate Student, Dept. Of Civil Engineering, BUET, Dhaka-1000

quality-of-service options on the airlines, travelers, shippers, and the community, to recommended development programs consistent with the overall objectives and policies of the airport operator, to estimate the costs associated with these facilities, and to project the sources and level of revenues to support the capital improvement programs.

In spite of difficulties with making forecasts of air transport demand, such estimates are necessary for the following reasons: (1) to aid in long term planning of both equipment and personal, (2) to assist central governments to facilitate the orderly development of the national and international airways system, and to aid all levels of governments in the planning of infrastructure (e.g. terminal facilities, access routes, runways, taxiways, aprons, and terminal air traffic control) and, (3) to assist manufactures as well as the airline companies in industry to anticipate levels of aircraft orders and to develop new aircraft.

By using forecasting techniques and estimates of socioeconomic parameters, a determination of the peak-period passenger volume and aircraft movements can be made. Forecasting demand in an industry as dynamic as aviation is an extremely difficult task, and is not a precise science and considerable subjective judgement must be applied to any analysis. By anticipating and planning for variations in predicted demand, the airport designer can correct projected service deficiencies before serious deficiencies in the system occur.

The primary objective of this paper is to analyze domestic air transportation in Bangladesh. This paper presents a model to forecast future demand of air transportation in the country. The impacts of the changes of different policy variables such as population, employment, GDP etc. and the effect of Jamuna bridge on the demand of domestic air transportation are also presented.

AIR TRANSPORTATION NETWORK IN BANGLADESH

The civilian domestic air transportation network in Bangladesh, as of 1997, comprised of 8 conventional (full-size) airports, 8 airports for STOL (Short-Take-Off and Landing) aircraft including two airports under construction. This study is concerned with the network consisting of 8 conventional airports only because neither Biman nor any other airline companies have any flights involving the other airports.

These 8 conventional airports exhibit widely varying traffic volumes. The largest airport is Zia International airport near Dhaka and the smallest one is Cox's Bazar airport. The most important corridors, as measured by air passenger volumes, are those between Dhaka, at one end, and Chittagong, Jessore, Sylhet at the other end. The location of the airports and the air transportation network is shown in Figure 1.

Bangladesh is a small country where the distances between the major cities are not large enough for air transportation to be very effective. But it is competitive with other modes if surface transportation time is considered. Most of this country is covered by large rivers which is a great barrier for surface transportation and, fast and continuous road or rail network does not exist in many areas of the country. In general railway is inefficient and slow and roadways are highly congested and accident-prone. Thus, a relatively low level of service for surface transportation enhances the market for domestic air travel.

This is most clearly visible in northern and southern parts of Bangladesh where air transportation competes with relatively inferior condition of road, rail and water transport modes. The per capita air travel frequency in these areas is approximately 1.5 times higher than the national average, despite the fact that income is generally lower in the northern areas.

The present condition of domestic air transport in Bangladesh is presented in Table 1. Biman Bangladesh Airlines and three private airline companies operate the conventional domestic network. The private companies have started operation very recently. For all these companies, fares are subjected to the approval of the civil aviation authorities and certain minimum standards of service are imposed on their operation. Average passenger load factors typically approach 80-85% for private companies and around 55-60% for Biman, and annual traffic volumes appear to be determined almost completely from the demand side. In flight surveys reveal that majority of the passenger trips are business trips (55%). One-fifth of the total passenger is tourist (20%) and others include government official trips (15%) and recreational trips (10%).

From the past experience of domestic air transportation of Bangladesh, it is observed that domestic section of Bangladesh Biman has always been a losing sector due to lack of appropriate size of aircraft, inefficient level of operation and inefficient management. The increase in economic activity may have marked impact on domestic air transport of Bangladesh. It can't be denied that air transportation is the major mode of transport for both passenger and cargo. Its importance increases further if the elements of time, speed and efficiency are considered for other modes of transportation of the country. Anticipating the great potential of domestic air transport business, private airline companies have now joined the fray of enticing Bangladeshi passenger and freight. This trend is expected to continue in future.

FIGURE 1
TABLE 1

METHODOLOGY OF ANALYSIS

Air traffic forecasting models usually create relationship between travel demand and a few key explanatory variables such as income, population, employment, travel time, fares etc. For the development of demand models the steps which are usually considered include observation of past and current trends of air travel demand, inventory of various economic, social, and technological factors affecting air travel demand, establishment of a relationship between travel demand and those factors found to be of significance in altering travel demand and forecasting of the values of those factors for future.

Levels of forecasting

Demand estimates are usually required for a variety of reasons in aviation. The analysis of air transportation demand usually have a structure consisting of a vector of socio-economic variables and a vector of system supply or level of service variables which are related to the demand for travel. Air transportation demand analysis can be classified into either of the following two groups:

(1) Macroanalysis : Macroanalysis is concerned with systemwide air transportation activities and deals with models that are not highly stratified. Macroanalysis of air travel demand is intended for forecasting total activity levels in air transportation and is not concerned with specific airport analysis.

(2) Microanalysis : Microanalysis is concerned with more specific origin-destination flow and with highly stratified measures of traffic activities. Microanalysis of air travel demand is performed on a finely stratified basis that is necessary as a planning and policy analysis tool.

Both macro and microanalysis are widely used in the study of aviation system. From the inception of the planning process for an airport, consideration is given to both of them. Considering the structure of data and the objectives, microanalysis using 'City Pair Model' seems to be most appropriate for this study.

City-pair Models of Air Travel Demand

In microanalysis when models are stratified by origin-destination, the resulting models are called city-pair models. An efficient way of exploiting city-pair model information is to build one mathematical model for the entire network in question and estimate the parameters of this model using data on all cities and corridors involved. In city-pair models of air travel demand, the socioeconomic characteristics of the cities of origin and destination are considered as the demand variables. It is assumed that there exists no competition among destinations and the traffic between any two cities depends only on their characteristics (Kanafani 1983). In general, the structure of most city-pair models is of the gravity or related type where the demand for travel is proportional to a product form of the demand variables for the city-pair in question and of the supply variables of the air transport system between them (Verleger 1972 and, Moore and Soliman 1981). It is important to remember while using city -pair models that the analyst should always watch for structural changes in the system which may affect the city-pair travel demand and give rise to a different choice situation.

The city-pair models can be calibrated with either cross –sectional data or time series data . In the calibration method using cross-sectional data, the same model is assumed to hold true for a number of different city pairs, and the data for these city pairs at a particular time period are used for the estimation of the coefficients in the model (Arasan and Rengaraju 1986). Different city pairs may have different demand functions and the aggregation of city pairs for cross-sectional analysis should be done very carefully.

After the calibration of the models, it is important to illustrate their validity based on statistics and logic. The statistical and logical illustrations given to prove the validity of a travel demand model depend mostly on the nature of the problem and the specific purpose for which the model is developed.

VARIABLES CONSIDERED IN THE MODEL

Air travel between 7 city pairs involving 8 cities in Bangladesh, shown in Figure 1, have been analyzed in the study. The zone of influence of each airport has been allocated very carefully. Usually the zone of influence is identified through inflight passenger survey (Stabaek 1983). It is observed that the zone of influence usually lies within 30-40 km of an airport. In this study, the maximum radius of the zone of influence is considered to be 40 km and is varied for different airports.

Demand Variables

Logical content and availability of reliable and predictable data are the major consideration in the selection of demand variables for the study and these considerations led to the use of socio-economic data from census (BBS, 1995) records . The reason for the inclusion socio-economic characteristics of the persons making the trips and of possible destinations is embedded in the derived demand nature of travel.

It is necessary to combine the socio-economic factors of the two cities in the city pairs to formulate the demand variables . While formulating the demand variables, it is desirable to determine the best functional form to incorporate in the model (Jason and Popper 1976). A statistical procedure to evaluate any set of functional forms is adopted. The functional forms that are most representative for city-pair travel estimation are : (1) X_i+X_j ;(2) X_iX_j ; (3) X_i/X_j; and (4) $1/x_i + 1/x_j$. Accordingly, the variables are combined in four different functional forms, and the functional form that produced maximum correlation with the dependent variable is chosen for further analysis. In the case of air transportation in Bangladesh, all the trips either emanates from or ends at Dhaka and the variables for Dhaka remains constant for all the trips which can be eliminated from the models and the socio-economic variables included in the study are the property of the destinations only.

The socioeconomic variables included in the analysis is discussed below. The values of these variables are measured on the basis of influence zone.

Population (P_j): The population of the total influence zone served by airport, rather than just the city in question should be used.

Employment (E_j): The employment in a metropolitan area is a measure of the level of economic activities that generate or attract air travel.

GDP(Gross Domestic Product,G_j: As disposable income distribution for each district is not available GDP is considered as a representative variable for level of economic activity.

Dummy Variable(X_{ij}): Dummy variable is included in a quantitative regression equation to deal with some special categories. Two special cases are considered in this model which require dummy variable, one for Cox's Bazar airport due to tourist market place and another for Sylhet airport due to special connecting international flight from Dhaka to this airport carrying a substantial amount of passenger from the United Kingdom in addition to normal demand.

Supply Variables

Since the characteristics of the air transport system connecting any two cities are well known, it is possible to specify supply variables with greater detail and thereby permit in the city-pair models to analyze of the effects of level of service characteristics on demand.

Impedance parameter: The demand for travel depends on impedance or generalized cost. In this case, travel time, cost and distance are the probable candidates for impedance parameter. But all of them should not be used directly in the same model as they are usually linearly correlated. Usually it is very difficult to obtain the actual travel time and cost data. In the study, travel time ratio has been selected as impedance parameter. It is defined as the ratio of travel time required by air and the same required by the fastest alternative mode. For Bangladesh, it is assumed that roadway is the fastest alternative.
The reason for including transportation characteristics associated with the mode for which the model predicts the demand as well as for the other possible competing modes is that the level of service characteristics of all these modes will influence the usage of the mode of interest. Usually, time is considered as the major cost element in the analysis of air transportation and impact of cost is relatively small. In the study, the travel time of the two alternatives (air and roadway) have been compared and included. The model developed in this paper, the travel time ratio has been calculated from distance and average speed as well as other factors such as waiting time, time required at ferry ghats and access time for both origin and destination of the routes.
Frequency of service is included in the model indirectly as dependent variable. Biman has supplies this data in the form of "Sector wise domestic schedule". This data is converted into the volume of air passenger as a dependent variable in the analysis. Data from other airlines has not been used because they have started operation just recently and do not have sufficient data.

MODELS TO FORECAST AIR TRAVEL DEMAND

Multiple regression analysis techniques are often applied to a great variety of forecasting problems to ascertain the relationship between the dependent variable and a set of explanatory variables which include socio-economic and demographic factors, market factors, travel impedance, and intermodal competition. The analysis is carried out by observing air trip generations from census data and recording associated levels and changes of levels of socio-economic data of the area and the physical characteristics of the all transport alternatives. For the analysis, data has been collected for five years (from '91 to '96) for the seven the routes described earlier.
For the purpose of analysis, stepwise multiple linear regression analysis have been adopted for model. Typical air trip distribution regression model established for this analysis is as follows,

$$T_{ij} = e^{a} (P_j)^{b} (E_j)^{c} (R_{ij})^{d} (X_j)^{e} (G_j)^{f}$$

where, T_{ij} = Total passenger trips per week between cities i and j;
E_j = Number of employees in j (expressed in 10000);
e = Base of natural logarithm (2.7182818);
P_j = Total population for city j (expressed in million);

R_{ij} = Travel time ratio for travel between cities i and j;
X_j = Dummy variable (1 for Sylhet and Cox's Bazar and 0 for others);
Gj = GDP per capita at current price (expressed in billion)

This is a non-linear equation and taking natural logarithm on both sides it can be transformed into linear form, which can be calibrated easily.

$$\ln (T_{ij}) = a + b \ln(P_j) + c \ln(E_j) + d \ln(R_{ij}) + e \ln(X_j) + f \ln(G_j) \qquad (1)$$

The regression analysis is performed in two sets of variables, one set contains population, GDP, distance ratio and dummy variable and another set contains employment instead of GDP. This is because GDP and employment are highly correlated. The resulting models are,

Model 1(Employment Model): $\ln (T_{ij}) = a + b \ln(P_j) + c \ln(E_j) + d \ln(R_{ij}) + e \ln(X_j)$

Model 2 (GDP Model): $\ln (T_{ij}) = a + b \ln(P_j) + c \ln(G_j) + d \ln(R_{ij}) + e \ln(X_j)$

From these models the elasticity can also be calculated. The elasticity of demand with respect to population can be calculated as :

$$\text{Elasticity, } e_p = (\partial T/T)/(\partial P/P) = (P/T)(\partial T/\partial P) \qquad (2)$$

Differentiating equation (1)

$$(1/T)(\partial T/\partial P) = b.(1/P)$$

$$\text{or,} \quad (\partial T/\partial P) = b.(T/P)$$

Substituting this is equation (2), one obtains

$$e_p = b$$

Other elasticities can also be calculated similarly.

Calibration

Tables in this section present the results obtained from estimating the demand equations. For estimation purpose 'Least Square Method' is used. Table 2 and Table 3 presents the estimated coefficients of Model 1 and Model 2 respectively. All the coefficients have signs consistent with expectation. Model 1 includes employment variable which is substituted by GDP in Model 2. These two variables are collinear, accounting for similar effects. In both the models, population is the most dominant variable , which is also highly significant. The variables, employment and GDP, are also significant at 95% and 90% confidence level respectively. The dummy variable accounting for Sylhet and Cox's-Bazar is highly significant in both the models. This justifies the inclusion of this variable in the model. The distance ratio variable is not very significant (significant only at 65% confidence level). This implies that as an impedance factor in addition to time, other factors such as cost, safety, comfort etc. should be included. Cost factor was not included in the present study due to unavailability of data. Both the model show very high value of the coefficient of determination.

The validity of the calibrated model is examined by comparing the forecasted demand with the observed demand. The results are shown in Figure 2 and Table 4.

It is observed that the results of the model are consistent with the observation and the maximum percentage of error is less than 20% for most of the cases. From the estimated results the demand elasticities are calculated as 2.09% (average), 1.25% and 0.98% with respect to population, employment and GDP.

TABLE 2,TABLE 3,TABLE 4,FIGURE 2

APPLICATION OF THE MODEL

In this section, the applications of the models are presented to analyze the future air travel demand in various scenarios. The performance indicator of any model is its ability to forecast the inter-city air-travel demands to assist in public policy formulation and implementation. The following sections will present some aspects in this regard.

Effect of Change in Variable

In this section, the effects of possible changes in explanatory variables are estimated.

(1) Effect of change in population: As shown in Figure 3, the air travel demand will increase 20% in Model 1 and 25% in Model 2 for 10% increase in population which imply that airline companies will have to accommodate this demand by readjusting their flight schedules, introducing high-capacity aircraft or increasing frequency of service.

(2) Effect of change in GDP and employment: Figure 4 and Figure 5 summarize the growth of air travel demand due to increase in these variables. From the estimation result it is clear that GDP and employment have smaller effect on demand than population. Travel demand will increase 12.5% and 9.5% for 10% increase of GDP and employment respectively.

(3) Effect of change in distance ratio: Figure 6 shows that for 12% increase in the speed of alternate mode produce 2.1% decrease in air travel demand whereas for 12% decrease in the road speed, travel demand will increase 2.6%. It is observed that the distance ratio has a little effect the demand.

FIGURE 3,FIGURE 4,FIGURE 5,FIGURE 6

Effect of Jamuna Bridge on Air Travel Demand

Jamuna Bridge has an important impact on air travel demand along the two corridors of Dhaka-Saidpur and Dhaka-Rajshahi route. These effects can be evaluated in two ways:

(1) Short-term effect: For Jamuna Bridge total travel time by road to reach this two cities will be reduced, decreasing the distance ratio as a whole. This change in the ratio will update the existing air travel demand. From Table 5 it is evident that travel demand in this corridor will drop around 8% to 10% although the total demand will not be affected greatly because these corridors contribute only 13-14% (avg.) travel demand to the total.

(2) Long-term effect: The introduction of Jamuna Bridge will compensate the initial loss in demand in another way. For Jamuna Bridge economic activity of that region will increase tremendously which will offset the reduced demand and even this will raise the demand more than the business as usual situation. Travel demand will increase by about 13% for 10% increase in GDP of these areas.

CONCLUSIONS

The study shows that demand for air travel can be modeled with reasonable accuracy using generalized nonlinear models and they are very simple to use for planning purpose. In the paper, two models have been developed. Results indicate that both models are statistically valid.

In all the cases, models cannot be expected to estimate with 100% accuracy due to uncertainty of input data and generally inherent uncertainty of random variables. The success of the model is crucially dependent on the quality and quantity of data available. Nevertheless, statistical models are helpful in obtaining the estimates that are perhaps more valid than nonstatistical approaches because the level of accuracy can be scientifically tested and also subsequent fine tuning of the estimated parameters can be done.

This paper has provided a short overview of the domestic air-travel demand market in Bangladesh. City-pair air travel demand models show a very general association with the changes in demographic and economic variables. This study will provide a tool for short-run strategic planning for the related organizations. The trends in domestic air travel demand in Bangladesh suggest that in near future private airline companies will dominate the domestic market with the introduction of proper level of activity, optimization of their capacity and improvement of service and operation. The results of this study will help these airlines greatly. The research can further be extended to include supply side variables such as operations, management and cost. Further research is also required to incorporate international air transportation especially in the light of 'Hub-Spoke' network system, which is becoming very popular in aviation industry.

APPENDIX 1. REFERENCES

Ashford, N., and Wrigh, P. H. (1979), Airport *Engineering*, A Wiley-Interscience Publication, a division of John Wiley and Sons, New York.

BBS. (1995), Bangladesh Statistical Yearbook, Bangladesh Bureau of Statistics, 1995.

David M. A. and Foster B. C. (1982), *Analyzing Experimental Data By Regression*, Lifetime Learning Publications, A division of wodsworth,Inc. Belmont, California.

Fridstrom L., and Thune-Larsen H. (1989), *An econometric air travel demand* Res. B. Vol.23B. No.3. Pp213-223.

Horonjeff R., and McKelvey F.X. (1994), *Planning and design of airports*. Fourth Edition, McGraw-Hill, New York, N.Y.

Hutchinson, G (1993), Analysis of Canadian Air Travel Demands, Vol. 119, No. 2,ASCE Paper No. 1766, Pp 301.

Jason, C.Y., and Popper, R.J. (1976), "Processing variable forms for travel estimation". Journal of Transportation Engineering, ASCE, 102(1).

John, A. (1981), *Transportation Planning*, Routledge and Kegan Paul Ltd., London.

Kanafani. A. (1983), *Transportation demand analysis*, McGraw-Hill, New York, N.Y.

Meyer D. Micheal and Miller J. Eric (1984), *Urban Transportation Planning, A decision-oriented Approach*, McGraw-Hill Book Company, New York 10020.

Moore, O. E., and Soliman, A.H. (1981), "Airport catchment areas and air passenger demand". Journal of Transportation Engineering, ASCE, 107(5).

Morlok, E.K. (1978), *Introduction to Transportation Engineering and Planning*, McGraw-Hill Kogakusha, Ltd.Japan.

Myers H. Raymond (1986), *Classical and Modern Regression with Applications*, PWS Publishers, Boston, Massachusetts 02116.

Nakamura, Dr Fumihiko (1994), *Multivariate Analysis for Human Settlements Planning*,Volume II, HSD Reference Materials.

Rengaraju V.R., and Arasan T. V. (1992), *Modeling for air travel demand*, Journal of Transportation Engineering, Vol 118, No. 3,ASCE Paper No. 26613.

Stabaek, K. (1983), *Passajertrefikken ainflyruter i, Norge* 1972-1982.Institute of Transport Economics, Oslo.

Arasan, T.V. and Rengaraju, V. R. (1986), *A methodology of approach for intercity travel demands modeling.* Indian Highway, 14(12).

Verleger, P.K. (1972), *Models of the demand for air transportation*. Bell j. Econ. Mgmt. Sci., 3(2).

Name of The airlines	No of Air craft*	Type of Aircraft*	No. of seats	Total no. of flights(One wayperweek)	Avg. Passenger Load factor	Avg. passenger Carried(per week)
Biman Bangladesh Airlines	4	2 F-28 2 ATP	85 70	68	55-60% (approx.)	5134
Aero Bengal Ailines	3	1 AN-24 2 Y-12**	48 17	18	75-80% (approx.)	1016
Air Parabat Limited	1	2LET-410 UVPE.	19	56	80-85% (approx.)	1294
GMG Airlines	2	CANADA -08	37	35	80-85% (approx.)	1520
Note: * For Biman data shown upto Winter schedule'97-98. ** At the moment Aero Bengal does not operate two Y-12 aircraft.						

Table 1: Comparison of Various Companies in Domestic Air Transportation

Model 1 (Employment Model)		
Parameter	Value	t-value
Y-Intercept	-0.410	-0.46
Popualtion	1.866	3.09
Employment	1.247	2.27
Distance Ratio	0.246	0.93
Dummy	2.634	10.56
R-Square 0.88		
Adj. R-Square 0.86		
Sample Size 31		

TABLE 2: Statistical Results of Multiple Regression Analysis of MODEL 1

Model 2 (GDP Model)		
Parameter	Value	t-value
Y-Intercept	-0.403	-0.39
Popualtion	2.319	4.53
GDP	0.981	1.81
Distance Ratio	0.342	1.03
Dummy	2.691	9.19
R-Square 0.86		
Adj. R-Square 0.85		
Sample Size 31		

TABLE 3: Statistical Results of Multiple Regression Analysis of MODEL 2

City-pair	One Way Weekly Travel Demand			Percentage error	
	Actual	Predicted			
		Model 1	Model 2	Model 1	Model 2
Dhaka-Chittagong	1370	1542	1632	12.5	19.0
Dhaka-Sylhet	1103	1172	1112	8.7	5.4
Dhaka-Jessore	843	931	967	10.4	14.7
Dhaka-Saidpur	298	333	328	11.7	10.0
Dhaka-Rajshahi	328	313	312	4.6	4.88
Dhaka-Cox's Bazar	101	67	72	33.6	28.7
Dhaka-Barisal	54	55	46	1.85	14.8

Table 4: Actual and Predicted Air Travel Demand (1996)

City-pair	Percent decrease in total time of alternate mode	Travel demand Before Jamuna Bridge	Travel demand After Jamuna Bridge	Change in air travel demand
Dhaka-Saidpur	25	Model 1: 333	310	- 9
		Model 2: 328	298	- 7
Dhaka-Rajshshi	23	Model 1: 314	295	- 8.3
		Model 2: 312	286	- 6
Total	----	Model 1: 4415	4374	- 1.28
		Model 2: 4469	4412	- 1.0

Table 5: Effect of Jamuna Multipurpose Bridge on Air Travel Demand.

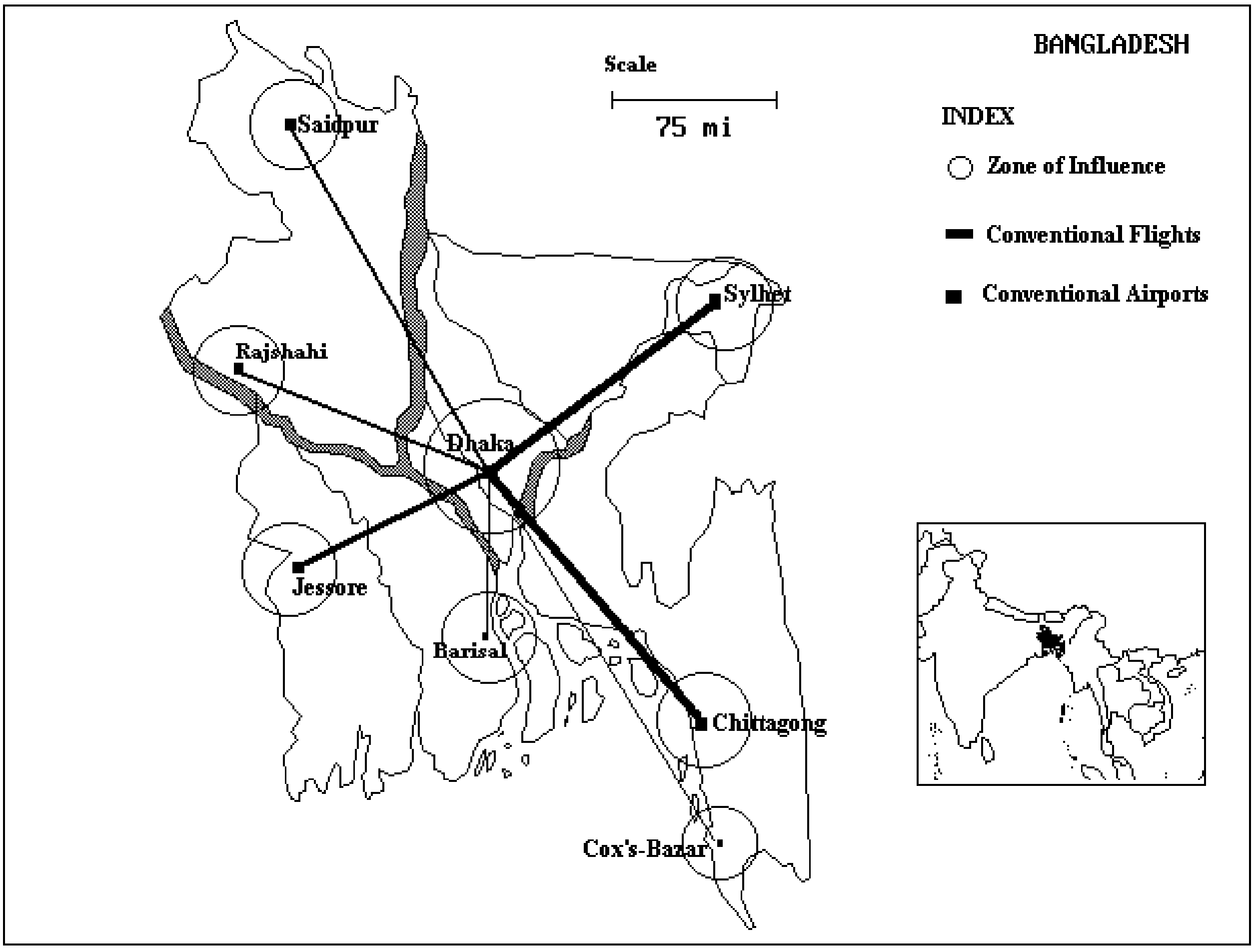

Figure 1: Selected city studies. Widths of column are proportional to passenger volumes.

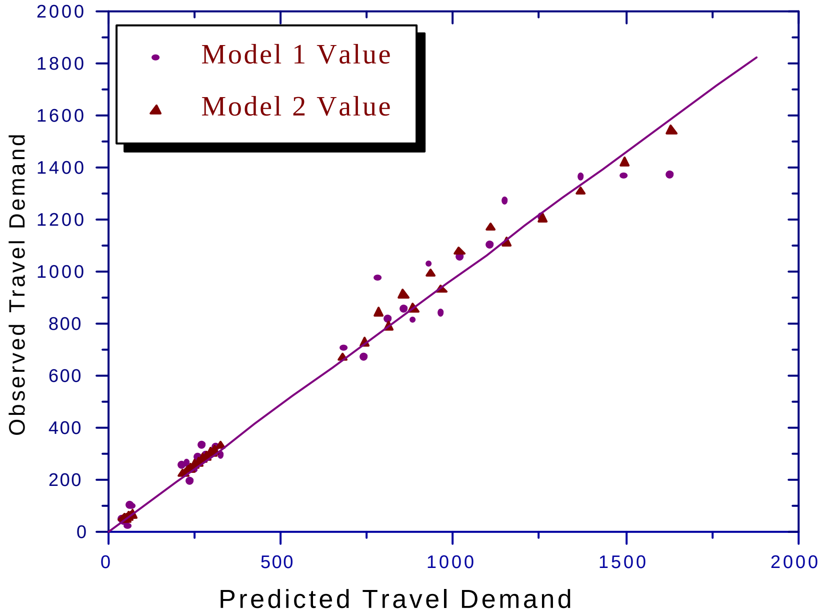

Figure 2: Predicted Vs. Observed Travel Demand

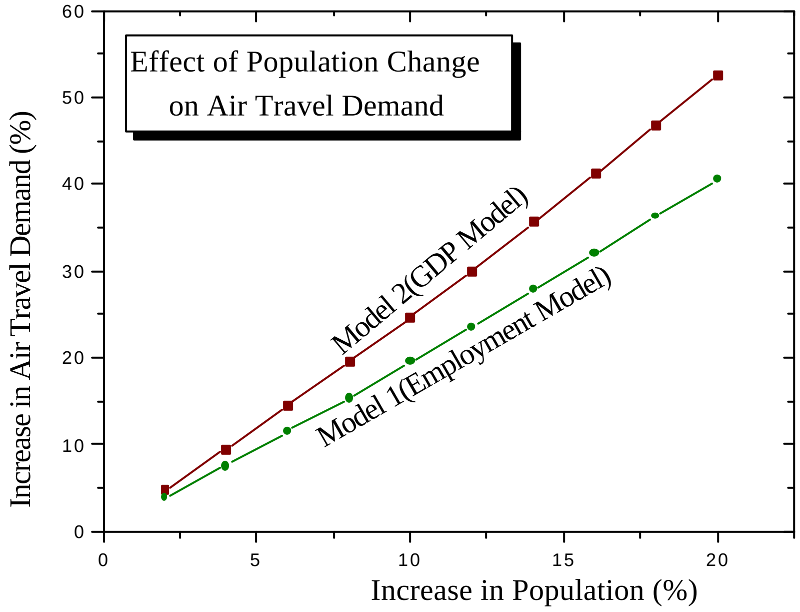

Figure 3: Effect of Change in Population on Air Travel Demand

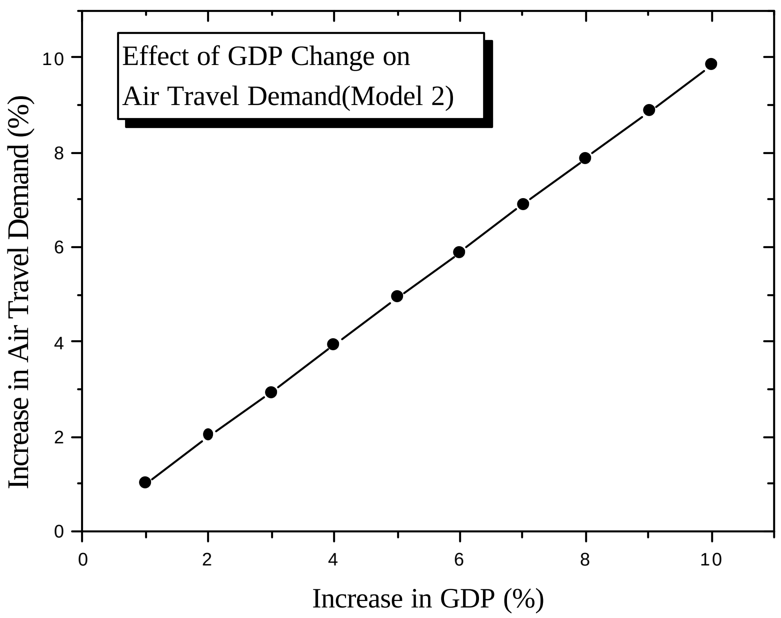

Figure 4: Effect of Change of GDP on Air Travel Demand

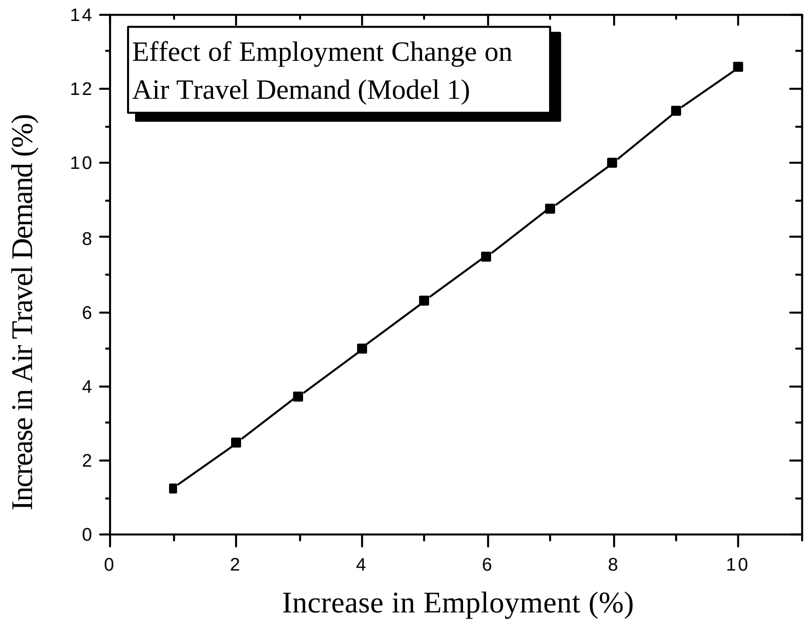

Figure 5: Effect of Change of Employment on Air Travel Demand

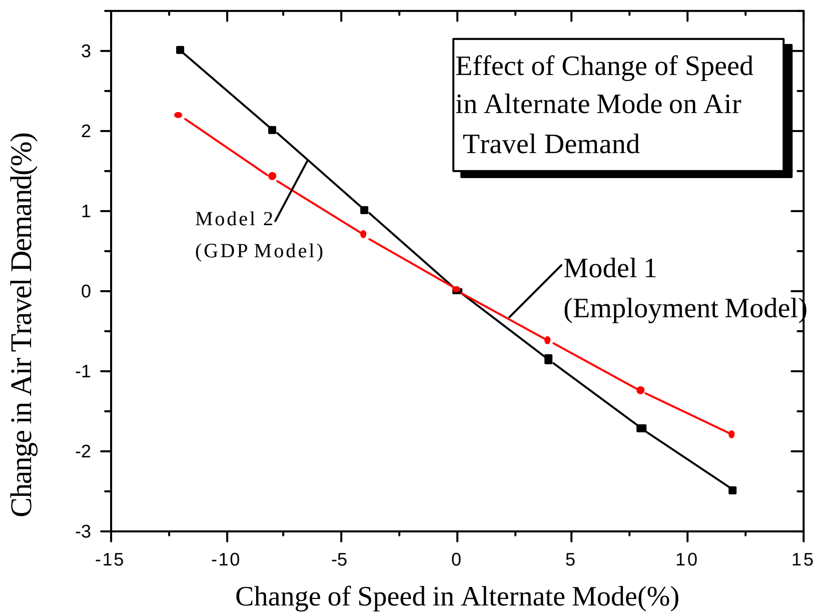

Figure 6: Effect of Change of Speed in Alternate Mode on Air Travel Demand