Journal of Air Transportation World Wide Vol. 5, No. 2 – 2000

THE DETERMINANTS OF DOMESTIC AIR TRAVEL DEMAND IN THE KINGDOM OF SAUDI ARABIA

Dr. Abdullah O. Ba-Fail
Dr. Seraj Y. Abed
and
Mr. Sajjad M. Jasimuddin
Jeddah, Saudi Arabia

ABSTRACT

For an airline, analyzing and forecasting air travel market is a part of its corporate planning process. This paper addresses the determinants of domestic air travel demand in the Kingdom of Saudi Arabia. Here an attempt is made to develop models for domestic air travel demand in the Kingdom with different combinations of explanatory variables utilizing stepwise regression technique. The model, which has the total expenditures and population size as the explanatory variables, is the most appropriate model to represent the demand for domestic air travel in the Kingdom. The rest of the models discussed suffer from multicollinearity. The model selected may be used to identify and measure the relations between domestic air travel demand and the economic and demographic forces in the Kingdom.

INTRODUCTION

Air traffic forecast is one of the major inputs for fleet planning, route development and preparation of the annual operating plan. Analyzing and forecasting air travel demand help reduce the airlines' risk by objectively evaluating the demand side of the air transport business. Forecasting of traffic should not be considered purely as rigid lines on charts that dictate

Dr. Abdullah O. Ba-Fail is the Chairman and Associate Professor at the Industrial Engineering Department in the King Abdulaziz University. He received his Ph.D. from Arizona State University (USA) in Forecasting.

Dr. Seraj Y. Abed is Associate Professor at the Industrial Engineering Department in the King Abdulaziz University. He received his Ph.D. from Iowa State University (USA) in Simulation.

Mr. Sajjad M. Jasimuddin is a Lecturer at the Industrial Engineering Dept in the King Abdulaziz University. He received his M.Phil. from University of Cambridge (UK) in International Business.

airline's future. Instead, it should be used dynamically to help an airline to evaluate strategies (BCAC, 1993).

Several different methods are appropriate, ranging from time series techniques to econometric modeling, for analyzing and forecasting the air travel market. Time series approaches are the most common methods for forecasting the traffic demand. These methods are handicapped by their inability to identify the causes of market growth and to link the future growth with expected developments of causative factors. They cannot, for example, assess the impact of a reduction in fares, the introduction of new aircraft, an economic recession, or the uncertainties with regard to future regulatory conditions. Such questions can only be answered if the forecaster has specified and calibrated a formal model that shows the influence and interaction of all the relevant variables and not just one variable (i.e., time). The time series approach assumes that the traffic demand has behaved according to a specific pattern in the past and this pattern will continue in the future. While weekly, daily, and hourly variations can most easily be produced by using time series models, econometric models are more appropriate for long-range forecasting (Howard, 1974).

Because of the complex nature of the air transportation industry with continuous changes in the environment, the past records of air traffic forecasters (using mostly trend extrapolation) have not been impressive. In recent years, therefore, the trend has been to develop causal models that not only predict air traffic but also determine the impact of changes within the economic and operating environment on air traffic. This paper aims at developing econometric models that link future growth in domestic air travel demand in the Kingdom of Saudi Arabia with expected developments of causative factors.

The remainder of this paper reviews other studies on the air travel demand and highlights the sources of data. Domestic air travel in the Kingdom is described next followed by a discussion of the determinants of air travel demand in Saudi Arabia, the presentation of the model, and analysis of the empirical results. Some policy observations are also included in the conclusion.

LITERATURE REVIEW ON AIR TRAVEL DEMAND

During the last three decades, large scale studies have examined various aspects of analyzing and forecasting air travel demand (Alperovich and Machnes, 1994; Poore, 1993; Ghobrial, 1992; Saudi Arabian Bechtel Company, 1979; Abed, Bafail, and Jasimuddin, 1998).

The study of Alperovich, and Machnes (1994) increased the understanding of multiple dimensions of air travel. The principal findings of their analysis are that (1) air travel to all foreign destinations is highly elastic in income and inelastic in price and (2) there is no difference in demand elasticity between financial and non-financial assets and that both are inelastic.

Poore (1993) attempts to test the hypothesis that forecasts of the future demand for air transportation offered by airplane manufacturers and aviation regulators are reasonable and representative of the trends implicit in actual experience. The tests compared forecasts provided by Boeing, McDonnell Douglas, Airbus Industry and the International Civil Aviation Organization, with actual results of a baseline model of the demand for Revenue Passenger Kilometers (RPKs). The model is a combination of two equations describing RPKs demanded by the high- and the low-income groups respectively. Variations in RPKs demanded by the high-income group are related to changes in income per capita. Variations in RPKs demanded by the low-income segment are related to changes in population size. The model conforms to the assumptions and conditions for appropriate use of regression analysis.

Another study, conducted by Ghobrial (1992), presents an econometric model that estimates the aggregate demand for an airline. The demand is expressed in terms of airline network structure, operating characteristics and firm-specific variables. Model formulations with various combinations of explanatory variables are estimated using a two-stage least-square procedure. The results indicate that 'airline aggregate demand' is elastic with respect to yield, and inelastic with respect to network size and hub dominance.

Saudi Arabian Bechtel Company (1979) conducted a study to update traffic forecasts and planning assumptions for New International Airport at Riyadh. Four economic variables related to air traffic activities, namely, gross domestic product, government appropriations, project appropriations and import of goods and services were chosen for the study. Each variable was correlated with annual domestic and international passengers at the old Riyadh Airport. In case of international passengers, the correlation coefficient varies between 0.970 and 0.993 and the best results were obtained with the imports cost, insurance & freight (C.I.F). For domestic passengers, the correlation coefficient varies between 0.936 and 0.997 and the best results were obtained with government appropriations.

Abed, Bafail and Jasimuddin (1998) developed several models for analyzing and forecasting the long-term demand for international air travel demand in the Kingdom of Saudi Arabia with different combinations of explanatory variables using stepwise regression technique. They recommended a model, which has the total expenditures and population size for the explanatory variables, as the most appropriate model to represent the demand for international air travel in the Kingdom.

The literature review indicates that few studies refer to determinants of the travel demand. There is no study on the determinants of air travel demand in the Kingdom of Saudi Arabia. This paper aims at developing models to analyze and forecast the long-term demand for the air travel in the Kingdom by exploring the determinants of domestic air travel demand.

DATA SOURCES

Since the econometric model is an invaluable tool for increasing the understanding of the way an economic system works and for testing and evaluating alternative policies, it is preferred for developing macro traffic forecasts for air travel in the Kingdom. However, the most sophisticated forecasting tools are useless if they operate on poor quality historical data or faulty knowledge of the causative factors underlying traffic growth and airline market share (BCC, 1987).

The availability of a consistent data set allows the use of annual data for the period 1971 to 1994. The data used in the estimation of the model originate from a variety of sources. Economic and demographic data of the Kingdom have been taken from various issues of Achievements of the development plans published by Ministry of Planning (Kingdom of Saudi Arabia, 1992); data on GDP, GDP growth rates, real effective exchange rates, imports and interest rates are from the International Monetary Fund's International Financial Statistics Yearbook 1994; and data on Saudi air travel are from PCA Statistical Yearbooks published by Presidency of Civil Aviation, 1970 (Kingdom of Saudi Arabia, 1992). When interpreting economic data it is important to distinguish between the effects of inflation and changes in the real level of economic activity. To convert collected data from the current prices to real or constant prices, consumer price index at 1988 constant prices was used.

FACTORS THAT AFFECT DOMESTIC AIR TRAVEL MARKET IN SAUDI ARABIA

Fortunately the Kingdom of Saudi Arabia is endowed with numerous natural opportunities for air travel because of its geographical location, being the site of the two holy mosques, its vast land area spreading from Showrorah in the south to Tabuk in the north, its rapid development in all spheres of life and its friendly relations with the world community. The Kingdom has a strong base for air travel (Siddiqui, 1994). The Kingdom is among the top 10 exporting and importing countries and among the top 20 tourism business generating countries.

Air transportation in Saudi Arabia has also undergone considerable expansions and developments. There are 25 international and domestic airports in the Kingdom. The number of passengers (arriving and departing) handled by all airports in the Kingdom has increased at an average annual rate of 15 percent, rising from 1.6 million in 1970 to 33.0 million in 1994 (Ministry of Planning, 1992; 1991; 1970). Table 1 shows the total number of passenger movements on domestic flights in the Kingdom of Saudi Arabia from 1971 to 1994. The high air traffic growth rate percentage between 1971 and 1994 may reflect growth in Saudi economy in this period.

Table 1. Year-wise Passengers Movements on Domestic Flights in Saudi Arabia (in million)

Year	*Number of Passengers*
1971	0.402
1972	0.526
1973	0.614
1974	0.756
1975	0.999
1976	1.959
1977	3.347
1978	4.444
1979	5.534
1980	6.828
1981	6.625
1982	7.270
1983	7.986
1984	7.940
1985	7.357
1986	6.861
1987	6.896
1988	6.717
1989	6.383
1990	6.803
1991	6.439
1992	7.625
1993	8.145
1994	8.009

Source: PCA statistical yearbook Presidency of Civil Aviation at the Kingdom of Saudi Arabia, (various issues).

Saudi Arabian Airlines (Saudia) has a monopoly in the domestic air transportation market of the Kingdom. Over the past years Saudia has coped with the needs of air travel and played a vital role in the development of the Kingdom. This process has resulted in formation of a huge base of operations, including facilities, ground and flight equipment, and trained personnel. Saudia currently has an active fleet of 52 aircrafts for scheduled operations. Saudia has made a vital contribution to the development of the country by linking the widely-separated centers of population in a country which is as large as Western Europe and thus facilitating social and economic cooperation between the various regions. Moreover, its industrialization has benefited greatly by the speedy transportation of foreign and Saudi workers on both Saudia's international and domestic routes. The current Saudia network consists of 63 stations (of which 25 are domestic and 38 international stations). Average flights segments per day are 265 with an average of 33 departures per day from international stations and 232 departures per day from domestic stations. Saudia has to have knowledge about the impacts of changes in economic forces on domestic air travel demand in the Kingdom.

There are many factors affecting the air travel demand; each factor is composed of elements that can stimulate or constrain air travel growth. For air travel demand forecasting purpose, these factors are more conveniently classified into two broad groups, those external to the airline industry and those within the industry itself. The external environment includes those factors that are outside the control of the individual airline and even the entire airline industry. These basically include long-range economic, social, demographic, and political trends. For example, the historical development of a country, the age and income distribution of its population, its ethnic and cultural ties to other nations, and its international business linkage are all powerful influences on airline growth (BCAC, 1993). Similarly, short-term conditions such as inflation, interest rate and currency exchange rates can have a strong effect on the growth potential of both individual airlines and the total industry. The major task is to predict the future development of the first group (the external forces) so that the airline can make the most intelligent decision on the second group.

The first task of this study is to determine the explanatory variables of the econometric model for domestic air travel demand in the Kingdom of Saudi Arabia. Reviewing and gathering information relevant to the characteristics of the relationship as well as the studies already published on the subject by other researchers has helped to make the following list of the economic and demographic factors.

1. Oil Gross Domestic Product
2. Private Non-Oil Gross Domestic Product
3. Government Non-Oil Gross Domestic Product
4. Total Non-Oil Gross Domestic Product
5. Total Gross Domestic Product
6. Consumer Price Index
7. Per Capita Income

8. Import of Goods and Services
9. Exchange Rate (Saudi Riyals/Special Drawing Rights—SDR)
10. Exchange Rate (Saudi Riyals/US$)
11. Population Size
12. Total Expenditures
13. Private Consumption Expenditures
14. Government Consumption Expenditures
15. Total Consumption Expenditures
16. Yield

DISCUSSION

The most important step in attempting to study the relationship between variables is to express this relationship in mathematical form, that is, to formulate or specify the model with which the economic phenomenon may be explored empirically. Since the correlation matrix (Tables 2) shows a high correlation between private non-oil GDP (0.93), government non-oil GDP (0.93) and their total (0.93), the components of the non-oil GDP are excluded and only the total was taken into consideration.

It is also observed from the correlation matrix that there is a low correlation between the demand for domestic air travel and the oil GDP (0.21). This can be explained from the findings of El-Masri (1982) in which he pointed out that in the Kingdom the oil revenue accrues directly to the government and the non-oil GDP is indirectly influenced by the government oil revenue through mainly government expenditure. Khalid Abdelrahman (1987) also state that the oil sector's contribution to the labor force is very low since the oil revenue goes directly to the government. Moreover, the oil sector's income has been fluctuating sharply during the last years. Therefore, it is logical to disregard the oil sector from the model for the demand for domestic air travel in the Kingdom.

The correlation matrix (Table 2) shows a high correlation between private consumption expenditures (0.96), government consumption expenditures (0.94) and their total (0.96). It is also found that there is comparatively low correlation (-0.33) between the domestic air travel demand and the yield that represents the cost of air travel. So yield variable was also excluded from the model. From the above analysis, the following list of variables relevant to the demand for the domestic air travel in the Kingdom are considered.

- Total Non-Oil Gross Domestic Product (X_4).
- Consumer Price Index (X_6)
- Import of Goods and Services (X_8)

Table 2. Correlation Matrix for All Candidate Explanatory Variables and Domestic Air Travel

	Y	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*	*X7*	*X8*	*X9*	*X10*	*X11*	*X12*	*X13*	*X14*	*X15*	*X16*
Y	1	0.21	0.93	0.93	0.93	0.8	0.9	0.89	0.96	0.09	-0.27	0.81	0.92	0.94	0.96	0.96	-0.33
X1		1	-0.01	0.13	0.05	0.71	0.32	0.33	0.24	-0.34	-0.72	-0.14	0.48	0.18	0.06	0.12	-0.32
X2			1	0.98	1	0.7	0.82	0.7	0.88	0.36	-0.02	0.96	0.76	0.96	0.99	0.98	-0.22
X3				1	0.99	0.79	0.85	0.71	0.88	0.36	-0.1	0.94	0.8	0.99	0.98	0.99	-0.28
X4					1	0.74	0.84	0.71	0.88	0.36	-0.05	0.96	0.78	0.97	0.99	0.99	-0.24
X5						1	0.8	0.72	0.79	0.02	-0.52	0.58	0.87	0.81	0.74	0.78	-0.39
X6							1	0.81	0.86	0.05	-0.46	0.71	0.91	0.86	0.83	0.85	-0.67
X7								1	0.93	-0.34	-0.44	0.49	0.93	0.76	0.77	0.78	-0.31
X8									1	-0.1	-0.26	0.73	0.91	0.91	0.93	0.93	-0.26
X9										1	0.47	0.57	-0.2	0.25	0.26	0.25	0.04
X10											1	0.13	-0.5	-0.16	-0.1	-0.1	0.7
X11												1	0.57	0.89	0.92	0.91	-0.16
X12													1	0.97	0.81	0.83	-0.44
X13														1	0.97	0.99	-0.29
X14															1	0.99	-0.21
X15																1	-0.24
X16																	1

Where

Y = Demand for domestic air travel

X1 = Oil-GDP

X2 = Private Non-oil GDP
X3 = Government Non-oil GDP
X4 = Total Non-oil GDP
X5 = Total GDP
X6 = Cost of Price Index
X7 = Per Capita Income
X8 = Import of Goods and Services
X9 = (Riyals/SDR)
X10= (Riyals/US Dollar)

- Per Capita Income (X_7)
- Population Size (X_{11}).
- Total Expenditures (X_{12}).
- Total Consumption Expenditures (X_{15}).

Per Capita Income is the gross domestic product divided by the population size. Because of their direct relation, gross domestic product and per capita income may not exist together as explanatory variables of the same model. The same thing can be said about population size and per capita income. Total expenditures, total consumption expenditures and gross domestic product have strong relations between them. Total consumption expenditures is the total expenditures excluding investment expenditures. Also, gross domestic product provides detailed analysis of total spending. It measures, according to category of spending, consumption, investment and net export. Based on the above discussion, the model that represents the demand for domestic air travel may consist of a subset of one of the following groups of variables.

Group I: (X_4, X_6, X8 , X_{11})
Group II:(X_7, X_6, X_8)
Group III:(X_{12} , X_6, X_{11})
Group IV:(X_{15} , X_6, X_{11})

In the previous section, a long list of economic and demographic factors, which may influence domestic air travel demand in the Kingdom has been drawn up. At this step, from each group of the explanatory variables, a subset of the group's variables that appear most relevant to the demand for domestic air travel are determined. A sequence of regression equations is computed by using different combinations of the group's variables through stepwise regression procedure for selecting independent variables. At each step, an independent variable is either added or deleted until the prediction of the dependent variable Y does not significantly improve. There are several methods available for adding and deleting variables. The criteria for entering or removing an independent variable can be stated in terms of reduction of the error sum of squares, partial correlation coefficient, or the *F* statistics. These models or regression equations were developed using SPSS. The SPSS output shows the relevant variables in every group that best specify the model as follows.

Group I (X_4, X_6, X_8, X_{11}): the subset of the group's variables which appear most relevant and best specify the model is (X_4, X_6, X_8)

Group II (X_7, X_6, X_8): the subset of the group's variables which appear most relevant and best specify the model is (X_6, X_8)

Group III (X_{12}, X_6 X_{11}): the subset of the group's variables, which appear most relevant and best specify the model is (X_{12}, X_{11})

Group IV (X_{15}, X_6, X_{11}): the subset of the group's variables which appear most relevant and best specify the model is (X_{15}, X_6, X_{11})

From the SPSS output, the least-squares lines of these models are as follows (the estimated t-values are in parentheses).

(1) Demand for domestic travel = Y = f(X_4, X_6, X_8)

$$Y = - l.29982l + 0.011111\ X_4 + 0.023004\ X_6 + 0.025649\ X_8$$
$$(3.343) \qquad (2.463) \qquad (5.295)$$

(2) Demand for domestic travel = Y= f(X_6, X_8)

$$Y = - 1.6082 + 0.033608\ X_6 + 0.035039\ X_8$$
$$(3.087) \qquad (7.164)$$

(3) Demand for domestic travel = Y= f(X_{12}, X_{11})

$$Y = - 2.961205 + 0.027701\ X_{12} + 0.368102\ X_{11}$$
$$(12.067) \qquad (7.436)$$

(4) Demand for domestic travel = Y = f(X_{15}, X_6, X_{11})

$$Y = 0.0398 + 0.029538\ X_{15} + 0.028203\ X_6 - 0.273172\ X_{11}$$
$$(2.771) \qquad (2.595) \qquad (6.429)$$

where

Y : Number of Passengers in Millions.

X_4 :Total Non-Oil Gross Domestic Product in billion SR.

X_6 : Consumer Price Index

X_8 : Import of Goods and Services in billion SR.

X_{11}: Population Size in Millions.

X_{12}: Total Expenditures in billion SR.

X_{15}: Total Consumption Expenditures in billion SR.

Testing Hypotheses. A frequently tested hypothesis is that there is no linear relationship between X and Y that the slope of the population regression line is zero. The statistic used to test this hypothesis is *t* statistics. The *t* statistics and their two-tailed observed significance levels are displayed. If a is set at 0.05 or 5 percent level, the two-tailed critical *t* value is about 2.093 for 19 degrees of freedom (*d.f.*) If a is fixed at 0.01 or 1 percent level, the critical *t* value for 19 *d.f.* is 2.861 (two-tailed). The output indicates significant linear relationship between the dependent and independent variables in all the models since calculated *t* values exceed critical *t* values.

The R-squared Coefficient. The coefficient of determination, R^2, tells the proportion of variance in the dependent variable that can be explained by the independent variables. As shown in Table 3, R^2 and adjusted R^2 indicate that, for all the models, most of the observations fall on the regression line. This means that a strong linear relationship exists between the dependent variable and independent variables.

Table 3. R^2 and Adjusted R^2 for Domestic Air Travel Demand Model

Models	R^2	*Adjusted* R^2
$F(X_4, X_6, X_8)$	0.969	0.964
$F(X_7, X_6, X_8)$	0.9508	0.954
$F(X_{12}, X_{11})$	0.96	0.955
$F(X_{15}, X_6)$	0.961	0.955

The F-test for Overall Significance. The *F*-test allows us to test the significance of the overall regression model to be able to answer the statistical question. Is there a significant relationship between the dependent variable and the independent variables? Table 4 shows that *F* values are high for all the models and the observed significance level is less than 0.0005. The findings indicate that there is a significant relationship between the dependent variable and the independent variables.

Table 4. F-values for Domestic Air Travel Demand Model

Models	*F-value*
$f(X_4, X_6, X_8)$	F = 192
$f(X_6, X_8)$	F = 184
$f(X_{12}, X_{11})$	F = 226
$f(X_{15}, X_6, X_{11})$	F = 150

Measures of Autocorrelation. The Durbin-Watson *d* statistics is used to detect autocorrelation, i.e., to indicate whether there is any no correlation between members of observations ordered in time. If computed *d* value is closer to zero, there is evidence of positive autocorrelation, but if it is closer to 4, there is evidience of negative autocorrelation. And the closer the *d* value is to 2, the more the evidence is in favor of no autocorrelation. The

Table 5. Computed *d* values for Domestic Air Travel Demand Model

Models	*d-value*
$f(X_4, X_6, X_8)$	1.02
$f({}_6X, X_8)$	.80
$f(X_{12}, X_{11})$	1.31
$f(X_{15}, X_6, X_{11})$	1.43

computed *d* values for domestic air travel demand models are shown in Table 5.

Measure of Collinearity Collinearity refers to the situation in which there is a high multiple correlation when one of the independent variables is regressed on the others, that is, there is a high correlation between independent variables. The tolerance of a variable is commonly used to measure collinearity. The tolerance of a variable is defined as $1- R^2$, R_i is the multiple correlation coefficient when the ith independent variable is predicted from the other independent variables. If the tolerance of variable is small, it is almost a linear combination of the other independent variables. The variance inflation factor (VIF) is closely related to the tolerance. As the Variance inflation factor increases, so does the variance of regression coefficients. The SPSS output shows that high correlation exists between the independent variables of the domestic air travel models:

$f(X_6, X_8)$, $f(X_{15}, X_6, X_{11})$ and $f(X_4, X_6, X_8)$ model. The model

$f(X_{12}, X_{11})$ does not suffer from multicollenerity. However, multicollinearity may arise because there is a tendency of economic variables to move together over time.

RESULTS

There are various ways of reporting the results of regression analysis, but here the following format is used. The first fact to note about the regression results is that all the coefficients have the signs that are expected by economic theory. For instance, the population size has a positive effect on domestic air travel demand—holding other things the same, as the population size goes up by 1.000 percentage point, on the average demand for domestic air travel goes up by 0.368 percentage points. Likewise, if the total expenditure goes up by 1.000 percentage point, on the average demand for domestic air travel goes up by 0.027 percentage points, holding the other things same.

In Table 6, the figures in the first set of parentheses are the estimated standard errors of the regression coefficients and those in the second set of parentheses are the estimated *t*-values computed from the expression under the null hypothesis that the true population value of each regression coefficient individually is zero. Hence, the two-tailed *t*-test can be used to test whether such a null hypothesis stands up against the (two-sided) alternative hypothesis that each true population coefficient is different from zero. The degrees of freedom are 19, which are obtained by subtracting the number of parameters estimated, which are 3 in the present instance from *n* (=22). If a is set at 0.05, the two-tailed critical *t* value is about 2.093 for 19 d.f. If a is fixed at 0.01 or 1 percent level, the critical *t* value for 19 d.f. is

Table 6. The Determinants of Air Travel Demand in the Kingdom of Saudi Arabia (Least square coefficients with standard errors and absolute t-values in parentheses)

Independent Variables	*Domestic Air Travel Demand Model*	*International Air Travel Demand Model**
X_{11}: Population Size in million	0.368102	0.39522 0
Se	(.049504)	(.041881)
T	(7.436)	(9.437)
X_{12}: Total Expenditures in billion	0.027701	0.021314
Se	(.002296)	(.001942)
T	(12.067)	(10.975)
Constant	-2.961205	-2.2566
Adj- R^2	0.955	0.959
N	22	22
F	226	244
DW	1.309	2.016

*Study results of Abed, el. al. (1998), An econometric Analysis of International Air Travel Demand in the Kingdom of Saudi Arabia.

2.861 (two-tailed). Looking at the *t*-values presented in Table 6, partial regression coefficient is statistically significantly different from zero at the 1 percent level of significance.

What about the overall significance of the estimated regression line? That is, can the null hypothesis that the partial slope is simultaneously equal to zero or, equivalently $R^2 = 0$ be accepted? This hypothesis was tested with the help of an *F*-test. The *F* value has an *F* distribution with 2 and 19 d.f. If a is set at 0.05, the *F* table shows the critical *F* value of 4.38. The corresponding value at a = 0.01 is 8.18. The computed *F* of 226 far exceeds either of these critical *F* values. Therefore, the null hypothesis that the partial slope is simultaneously equal to zero or, alternatively $R^2 = 0$ is rejected. Collectively and individually the two explanatory variables influence the dependent variable (domestic air travel demand). Since the computed *d* value in the model is closer to 2, the evidence is in favor of no autocorrelation as shown in Table 6.

The previous analysis shows that all the developed models for domestic travel demand are well fitting. However, these models, except the f(X_{12}, X_{11}) model, suffer from the existence of multicollenerity. This is clear because most of the independent variables have small tolerance and high variance inflation factor (VIF). This means that they are almost linear combinations of the other independent variables and indicate high variance of the regression coefficients. The correlation matrix shown in Table 2 also support this evidence.

CONCLUSION

Here domestic air travel demand in the Kingdom of Saudi Arabia through identifying its determinants have been analyzed. Air transportation in the Kingdom of Saudi Arabia has undergone considerable expansions and developments during the past years. There was a high air traffic growth rate percentage between 1971 and 1992, which reflects the growth in the Saudi economy during this period.

The statistical analysis of the past travel trends and the variables that may have an impact on it has also been undertaken. The analysis indicates the existence of high correlation between the economic variables. This might arise because there is a tendency of economic variables to move together over time. The statistical analysis shows a strong relationship between the air travel demand and the economic activity in the Kingdom.

An empirical examination of the determinants of domestic air travel demand in the Kingdom of Saudi Arabia has been presented in the paper. Econometric models were attempted to forecast domestic air travel demand in the Kingdom of Saudi Arabia in the previous sections. Through the models the statistical relationship between selected demand-influencing factors and the corresponding level of traffic is developed. From the statistical measures for evaluating the models as discussed earlier, the following model is found to be the most appropriate model to represent domestic air travel demand in the Kingdom of Saudi Arabia.

$$\text{Domestic air travel demand } (Y) = -2.961205 + 0.027701\,X_{12} + 0.368102\,X_{11}$$

where

Y : Number of passengers in millions
X_{11}: Population Size in millions.
X_{12}: Total Expenditures in billion SR.

This model is very good in terms of *Goodness of Fit* measures and does not suffer from multicollinearity. The rest of the developed models suffered from severe multicollinearity which reduce the forecaster's ability to draw inferences about the significance of individual variables and cause the estimators to have large variances. However, since the goal of the study is to use the model to predict the future data of the dependent variable (i.e., the number of passengers in million), collinearity per se may not be bad.

This proposed model may help determine future demand for domestic air travel in the Kingdom. The study may also provide a policy guideline to civil aviation authority in studying the proper sizing of airports facilities such as gate requirements, apron size, terminal capacity, etc., through coordination with airport consultants. The airlines could utilize the model for long term forecasting of the demand for domestic air travel in the Kingdom. Based on the air traffic forecasts determined through the model, they can develop a corporate plan that may reflect the present situation, capacity utilization, manpower requirements and training plans, financial projections for the operating capital projects, and other projects.

REFERENCES

Alperovich, G. & Machnes, Y. (1994). The role of wealth in the demand for international air travel, *Journal of Transport Economics and Policy, 28* (2).

Abdulrahman, K. (1990, February). Money demand & money supply in Saudi Arabia an empirical study, Unpublished Ph.d. dissertation, UK.

Abed, S. Y., Bafial, A. O. & Jasimuddin, S. M. (1998). An econometric analysis of international air travel demand in the Kingdom of Saudi Arabia, mimeo, King Abdulaziz University, Jeddah.

Boeing Commercial Airplane Company (BCAC). (1993). Airline Evaluation Seminar.

Boeing Commercial Company (BCC). (1987). Air Freight, Air Travel, and Strategic Planning, UK.

El-Masri. (1982). Passenger profiles surveys. Economic Research Department in Saudi Arabian Airlines, Saudi Arabia.

Ghobrial, A. (1992). Aggregate demand model For domestic airlines. *Journal of Advanced Transportation*. Canada.

Howard, G P. (1974). Airport economic planning. The Massachusetts Institute of Technology. U.S.A.

IMF. (1994). Statistics Department, International Financial Statistics Yearbook. vol. Xlvii, the USA.

Kingdom of Saudi Arabia. (1992). Achievements of the development plans. Ministry of Planning.

Microsoft Corporation. (1994). Building Application Using Microsoft Access.

Ministry of Planning. (1992).

Poore, J. W. (1993, September). Forecasting the demand for air transportation services. *Journal of Transportation Engineering*. USA.

Presidency of Civil Aviation at the Kingdom of Saudi Arabia. (1991). PCA statistical yearbooks, Ministry of Planning. Kingdom of Saudi Arabia.

Presidency of Civil Aviation at the Kingdom of Saudi Arabia. (1970). PCA statistical yearbooks, Ministry of Planning. Kingdom of Saudi Arabia.

Saudi Arabian Bechtel Company. (1979, July). Update forecast and planning assumptions. New Riyadh International Airport.

Siddiqui, A. (1994, July). Operating levels and airline economics. *Saudia World*.

SPSS Inc. (1993, June). SPSS User Manual, Release 6. U. S. A.