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Econometric Modeling for International Passenger Air Travel Demand in Jordan

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ABSTRACT

The main objective of this paper is to develop an econometric passenger air travel demand model in Jordan. Two steps were employed in the model development process. In step one, the demand determinants that have high correlation with passenger air travel demand were identified using stepwise regression technique. In step two, multiple linear regression analysis was used for the econometric model development. Annual data from 2006 to 2017 and 6 explanatory variables/demand determinants were used. The output indicated that the best model which is capable of explaining the behavior of passenger air travel demand in Jordan is the one which only includes the Gross Domestic Product in USD as demand determinant. The performance of the regression model was evaluated based on the coefficient of determination (R^2), significance of each parameter and the overall significance of the regression model. Finally, the model was checked for autocollinearity and multicollinearity problems. Durbin-Watson statistics was used to check the model for autocollinearity problem. The tolerance of variables and the Variance Inflation Factor (VIF) were used to check the model for multicollinearity problem. The model was found to be statistically significant with a coefficient of determination (R^2) of 0.981, indicating that the two selected demand determinants explain 98.1% of the variability in passenger air travel demand in Jordan.

KEYWORDS: Econometric modeling, Multiple linear regression, Air travel demand, Statistical models.

INTRODUCTION

Modeling and forecasting of air travel demand plays an important role, not only for operational planning purposes, but also for providing decision makers with an objective assessment for the aviation needs in the region/country. Forecasting methods and techniques ranges from simple professional judgement to sophisticated mathematical modelling, such as time series and econometric modeling. Time series technique is the most commonly used method for forecasting air travel demand, while econometric modeling is the most sophisticated technique in air travel demand estimation. Most econometric models aim to reveal the relationship between air travel demand and selected economic or social variables. The selection of a particular methodology is a function of many factors, such as available resources, precision desired, complexity and sophistication of the technique and the time frame in which the forecast is required to be used. Factors affecting air travel demand can be categorized into two

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categories, external and internal factors (Erma et al., 2010). External factors include Gross Domestic Production (GDP), income level and demographic factors, such as population and income.

International air travel to and from Jordan has experienced significant growth over the past two decades. Civil Aviation Regulatory Commission (CARC) of Jordan reported that it increased from about 1.85 million in 1990 to 8.14 million in 2017 with an equivalent compound annual growth rate of 5.64 % (CARC, 2017). As a result, congestion at airport facilities, such as runways, terminal buildings and passenger inspection facilities tremendously increased. This rapid growth rate raised an interesting question for transportation planners in Jordan about the adequacy of the aviation infrastructure to satisfy future passenger air travel demand needs. To the best of the authors' knowledge, there has been no research conducted to predict future passenger air travel demand in Jordan. This paper aims to develop an econometric model to analyze and forecast long-term passenger air travel demand in Jordan. IBM SPSS Statistics 22 Software was used for the model development. Two steps were employed; in step one, the demand determinants that have high correlation with passenger air travel demand were identified using stepwise regression technique and in step two, multiple linear regression analysis was used for the econometric model development.

LITERATURE REVIEW

During the past three decades, academics, researchers and practitioners have made many contributions to air travel demand forecasting and modeling. Abed et al. (2001) developed several econometric models for forecasting long-term international air travel demand in Saudi Arabia. These models were developed with different combinations of explanatory variables using stepwise regression technique. It was found that total expenditures and population size were the most appropriate explanatory variables in the developed models. Abbas et al. (2003) used time series technique for developing two models representing the aviation demand in Egypt based on logical acceptability, best fit and statistical significance. Wadud (2014) developed simultaneous demand models for forecasting air passenger and cargo demand at Shah Jalal International Airport at Dhaka, Bangladesh. The simulation method was based on time series data for air passenger and cargo demand using seemingly unrelated regression SUR framework which allows for more efficient and reliable results than ordinary least square method and individual co-integration. Bafail (2004) used artificial neural network techniques to forecast the number of domestic and international airline passengers in Saudi Arabia. The proposed model was developed using Model Quest Minor Package. Annual data from 1975 to 1986 and 16 explanatory variables were used. The results indicated that oil gross domestic product, population size and *per capita* income were the most contributing variables that affect passenger air travel demand. Profillidis and Botzoris (2015) developed various econometric models and analyzed whether a correlation existed between air travel demand and economic activity at world level. The developed models permitted the estimation of a reasonable evolution of air travel demand activity and its expected growth rates for the various geographical areas of the world. Profillidis (2000) employed econometric and fuzzy models to study air travel demand at Rhodes Airport. Relationships between air travel demand and economic activity were developed using market surveys. Wadud (2011) used time series technique to create a gravity model for forecasting passenger patronage in a new airport in Bangladesh using aggregated data. Bafail et al. (2000) developed several models for forecasting long-term demand for domestic air travel demand in Saudi Arabia. Several explanatory variables including population size and total expenditure were used to formulate the model. Saudi Arabian Bechtel Company (1979) conducted a study to update traffic forecasting and planning for a new international airport in Riyadh. Econometric variables used in the analysis were: Gross Domestic Product (GDP) import of goods and services.

SITE DESCRIPTION

Currently, there are three airports in operation in Jordan; two are located in the capital city, Amman and one is located in Aqaba, the only coastal city in Jordan. The first airport is Queen Alia International Airport, IATA code: AMM and ICAO code: OJAI. Queen Alia International Airport is the largest among the three airports. The second airport is the Military-Civilian Airport: Amman-Marka Airport, IATA code: ADJ and ICAO code: OJAM. The third airport is King Hussein Airport in Aqaba city, IATA code: AQJ and ICAO code: OJAQ. All three airports are managed, operated and controlled by Jordan Civil Aviation Authority.

The three airports vary in passenger and cargo handling, Queen Alia International Airport, the main airport in the country, serves only commercial international flights. Amman-Marka Airport serves domestic flights as well as regional flights. King Hussein Airport serves domestic flights as well as scheduled and non-scheduled international flights. Figure 1 shows passenger air travel demand statistics at the three airports between 2006 and 2017.

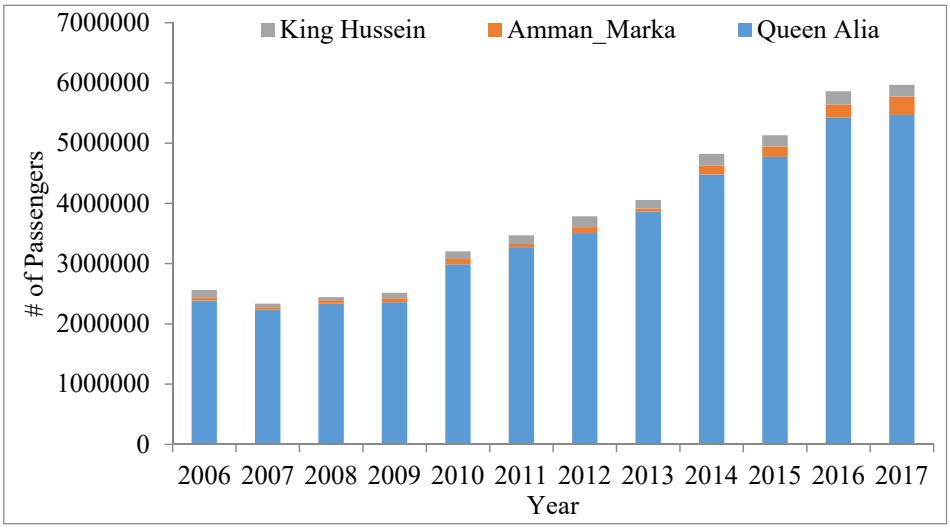

Figure (1): Passenger air travel demand between 2006 and 2017; Source: CARC Jordan

Figure 1 shows a continuous rise in passenger air travel demand for the period 2006 to 2017. Also, it can be seen that the majority of passenger air travel demand is made through Queen Ali International Airport.

METHODOLOGY

Two steps were employed in the air travel demand forecasting model development process:

- Step one: the explanatory or independent variables (demand determinants) that have high correlation with the dependent variable (passenger air travel demand) were identified using stepwise regression technique.
- Step two: multiple linear regression analysis was used for the econometric model development.

Demand Determinants

Demand is an economic principle which refers to a consumer's need and willingness to pay a price for a specific good or service, which is, in this case, air travel. Air travel demand determinants are factors that make it

possible for people to travel. These are usually related to econometric or socio-economic factors. Based on previous research, it was found that the following demand determinants are the most commonly used demand determinants for air travel demand modeling:

- Population (Abed et al., 2001; Bafail, 2004). Population is the total number of persons inhabiting a country, city or any district or area.
- Gross Domestic Product GDP (Bafail, 2004). GDP is the monetary value of all the finished goods and services produced inside a country's borders in a specified period of time.
- Consumer Price Index CPI (Gang, 2012). CPI is a measure of the average change over time in prices paid by urban consumers for a market basket of consumer goods and services; it is used as an economic indicator.
- *Per Capita* Income PCI (Bafail, 2004). PCI is the mean income per person in a city, region or country for a specified period of time.
- Imports and Exports of Goods and Services (Bafail, 2004). This factor reflects the economic status of the country.
- Final Consumption Expenditure FCE (Bafail, 2004). FCE is a measure of the domestic costs (by residents and non-residents) for individual needs. Among other things, it includes expenditure on goods and services.
- Exchange Rate (Bafail et al., 2000). Exchange Rate is considered as one of the short–term conditions which may have strong effect on the growth potential of both individual airlines and total aviation industry.
- Number of tourists (Devoto et al., 2002). Tourism has become an important sector that affects the economical development of a country.

Data Sources

The primary data needed for development of air travel demand model was obtained from the Department of Statistics (DOS, 2017), Civil Aviation Regulatory Commission of Jordan (CARC, 2017) and the World Bank Group (WBG, 2017) for the years 2006-2017. Multiple linear regression analysis was used to estimate the econometric demand model; the dependent variable is annual passenger air travel demand in Jordan. The independent variables are the most commonly used demand determinants in econometric demand modeling. The selection of demand determinants was based on the availability of data. The following demand determinants were selected and tested:

X_1: Gross Domestic Products (GDP) in USD (WBG, 2017).

X_2: *Per Capita* Income (PCI) in USD (WBG, 2017).

X_3: Imports of Goods and Services (WBG, 2017).

X_4: Exports of Goods and Services (WBG, 2017).

X_5: Total Population (DOS, 2017).

X_6: International Tourism expressed in numbers of arrivals (CARC, 2017).

Figure 2 shows the evolution of the selected demand determinants between 2006 and 2017.

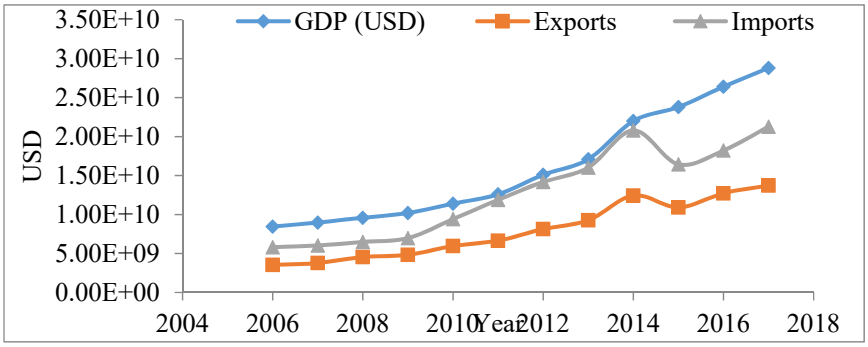

Figure 2 (a): Evolution of GDP and export/import of goods and services (2006-2017)

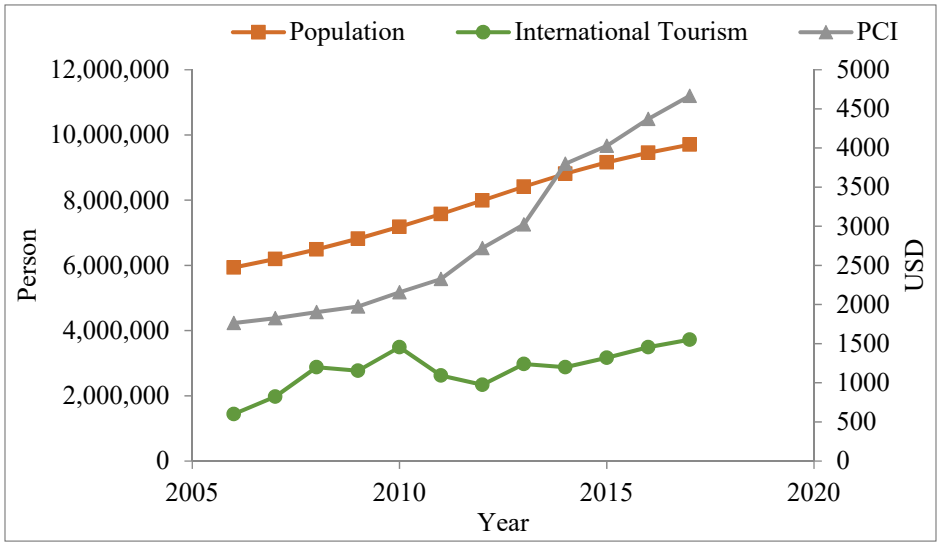

Figure 2 (b): Evolution of population, international tourism and PCI (2006-2017)

Model Development

In order to develop a logical econometric model, Pearson correlation coefficient was used to study the relationship between various variables. Pearson correlation coefficient is a measure of linear correlation between two variables. It has a value between +1 and −1, where 1 indicates total positive linear correlation, 0 indicates no linear correlation and −1 indicates total negative linear correlation. Table 1 shows the correlation matrix for all candidate demand determinants with air passenger travel demand as dependent variable for the years 2006-2017.

Table 1. Correlation matrix for all candidate demand determinants and air travel demand

	Y	X_1	X_2	X_3	X_4	X_5	X_6
Y	1.000	0.990	0.990	0. 945	0.979	0.976	0.677
X_1		1.000	1.000	0.937	0.980	0.971	0.684
X_2			1.000	0.940	0.982	0.970	0.673
X_3				1.000	0.984	0.968	0.620
X_4					1.000	0.982	0.685
X_5						1.000	0.729
X_6							1.000
Y (passenger air travel demand) X_1, X_2, X_3, X_4, X5 and X_6: demand determinants							

It can be seen that high correlation existed between passenger air travel demand and all independent variables, X_1: GDP (0.990), X_2: PCI (0.990), X_3: imports of goods and services (0.945), X_4: exports of goods and services (0.979), X_5: total population (0.976) and X_6: international tourism (0.677). In order to avoid multicollinearity problem, X_1: GDP and X_2: PCI may not exist together as demand determinants in the same model, because PCI is calculated as GDP divided by the total population. The same thing applies to X_5: total

population and X_2: PCI. Based on that, PCI will be excluded from the model and the passenger air travel model may consist of one or more of the following variables: X_1, X_3, X_4, X_5 and X_6. Stepwise multiple regression technique was used to select the significant independent variables / demand determinants in the model. IBM SPSS statistics, version 22.0 was used for this purpose. At each step, the independent variable (demand determinant) was either added or removed until the dependent variable (passenger air travel demand) does not significantly improve.

The SPSS output indicated that the best model which is capable of explaining the behavior of passenger air travel demand in Jordan is the one which only includes X_1: GDP in USD. The final econometric model for predicting passenger air travel demand in Jordan can be expressed as follows:

$$y' = 918236 + 0.000180X_1 + \varepsilon$$

where

Y': predicted passenger air travel demand.

X_1: GDP (in USD).

ε: error term.

Econometric Model Evaluation

The performance of the econometric model was evaluated based on the coefficient of determination (R^2), significance of each parameter and the overall significance of the regression model. The results of the statistical analysis performed are given in Tables 2-4.

The coefficient of determination (R^2) is a measure of certainty one can have in making prediction using the developed model. It measures the proportion of variability in the dependent variable (Y) that is explained by the model through the independent variables (X_i). Its value lies between 0 and 1. The higher the R^2 value, the better the performance of the regression model. Table 2 shows the model summary. It includes the correlation coefficient (R) which indicates the linear correlation between the observed and predicted values of the dependent variable. Its large value of 0.990 indicates a strong relationship of how well passenger air travel demand can be predicted from the selected demand determinants. The coefficient of determination (R^2) can be obtained by squaring the value of the correlation coefficient (R). Each variable doesn't explain much if it was taken by itself; adding a large number of variables can result in very high R^2 values. This is why some packages provide "adjusted R^2," which allows comparing regressions with different numbers of variables. The high values of R^2 and adjusted R^2 shown in Table 2 indicate that a strong relationship exists between the dependent and the independent variables and 98.1% of passenger air travel demand can be explained by the developed model using the two selected demand determinants. Also, Table 2 shows the standard error of the regression (S) which provides the absolute measure of the typical distance that the data points fall from the regression line. It measures the precision of the model's predictions. The low value of the standard error indicates high precision of the model's predictions.

The significance of the regression model coefficients can be evaluated using t-test. Table 3 presents a list of the regression model coefficients and their statistics. It can be seen that the p-values are less than the significance level α (0.05), which means that there is sufficient evidence to conclude that the regression model coefficients are statistically significant.

The overall significance of the regression model can be tested using the analysis of variance (ANOVA) method. ANOVA is evaluated by observing the power function of the F-test. It indicates whether the linear regression model provides a better fit to the data than a model that contains no independent variables. Table 4 shows the ANOVA results. It can be seen that the p-value is less than the significance level α (0.05). So, there is sufficient evidence to conclude that the regression model fits the data better than the model with no independent variables.

Finally, the model was checked for autocollinearity and multicollinearity problems. Table 5 shows Durbin-Watson value d, which is a measure of autocollinearity

between the demand determinants. If the d value is closer to zero, there is evidence of positive autocorrelation. If it is closer to 4, there is evidence of negative autocorrelation. It can be seen that the computed Durbin-Watson value is closer to 2 which indicates that the model does not suffer from autocollinearity problem. Also, Table 5 shows the tolerance of variables and the variance inflation factor (VIF) values, which provide an index that measures how much the variance of an estimated regression coefficient is increased because of multicollinearity. If the tolerance values are small and VIF value is closer to 1, there is evidence of no multicollinearity problem. It can be seen that the model does not suffer from multicollinearity problem, because the variance inflation factor (VIF) values are around 1.0.

Table 2. The model summary

R	R^2	Adjusted R^2	Standard Error of Regression (S)
0.990	0.981	0.979	192.23

Table 3. Coefficients of the regression model

Demand Determinant	Coefficient	t	p-Value
Constant	918236	6.526	0.000
GDP (in USD)	0.000180	22.645	0.000

Table 4. The results of ANOVA analysis

	Sum of Squares	df	Mean Square	F	p-Value
Regression	1.906E13	1	1.906E13	513.783	0.000
Residual	3.718E11	10	3.718E10		
Total	1.943E13	11			

Table 5. Autocollinearity and multicollinearity results

	Multicollinearity		Autocollinearity
Demand Determinant	Tolerance	VIF	Durbin-Watson
GDP	1.000	1.000	1.862

CONCLUSION

The main objective of this paper is to develop an econometric passenger air travel demand model to analyze and forecast long-term air travel demand in Jordan. Currently, there are three airports in operation in Jordan, two are located in the capital city, Amman and one is located in Aqaba, the only coastal city in Jordan. The three airports vary in passenger and cargo handling. Queen Alia International Airport, the main airport in the country, serves only commercial international flights. Amman-Marka Airport serves domestic flights as well as regional flights. King Hussein Airport serves domestic flights as well as scheduled and non-scheduled international flights. The primary data needed for the model development was obtained from the Central

Bank, Department of Statistics, Civil Aviation Regulatory Commission (CARC) of Jordan and the World Bank Group, for the years 2006-2017.Two steps were employed in the air travel demand forecasting model development process. Step one: the demand determinants that have high correlation with passenger air travel demand were identified. Pearson correlation coefficient was used to study the relationship between various variables. It was found that high correlation existed between passenger air travel demand and Gross Domestic Product (GDP) in USD, *Per Capita* Income (PCI) in USD, imports and exports of goods and services in USD, total population and international tourism. To avoid multicollinearity problem, GDP and PCI may not exist together as demand determinants in the same model, because PCI is calculated as GDP divided by the total population. The same thing applies to total population *Per Capita* Income. Based on that, the passenger air travel model may consist of one or more of the following variables / demand determinants: GDP in USD, imports of goods and services, exports of goods and services, total population and international tourism. Stepwise multiple regression technique was used to select the significant demand determinants in the model. At each step, the independent variable (demand determinant) was either added or removed until the dependent variable (passenger air travel demand) does not significantly improve. Step two: multiple linear regression analysis was used for the econometric model development using IBM SPSS Statistics 22 software. The SPSS output indicated that the best model which is capable of explaining the behavior of passenger air travel demand in Jordan is the one which only includes Gross Domestic Product in USD as demand determinant. The performance of the regression model was evaluated based on the coefficient of determination (R^2), significance of each parameter and the overall significance of the regression model. The model was found to be statistically significant with a coefficient of determination (R^2) of 0.981, indicating that the two selected demand determinants explain 98.1% of the variability in air travel demand. Finally, the model was checked for autocollinearity and multicollinearity problems. Durbin-Watson value was calculated to check the model for autocorrelation problem. The tolerance of variables and the variance inflation factor (VIF) values were used to check the model for multicollinearity problem.

REFERENCES

Abbas, K.A., Fattah, N.A., and Reda, H.R. (2003). "Developing passenger demand models for international aviation from/to Egypt: a case of Cairo Airport and Egypt Air". In: Proceedings of Air Transport Research Society, Toulouse, France, 1-14

Abed, S.Y., Bafail, A.O., and Jasimuddin, S.M. (2001). "An econometric analysis of international air travel demand in Saudi Arabia". Journal of Air Transport Management, 7, 143-148.

Bafail, A. (2004). "Applying data mining techniques to forecast the number of airline passengers in Saudi Arabia (domestic and international travels)". Journal of Air Transport, 9 (1), 100-115.

Bafail, A.O., Abed, S.Y., and Jasimuddin, S.M. (2000). "The determinants of domestic air travel demand in the Kingdom of Saudi Arabia". Journal of Air Transportation Worldwide, 5 (2), 72-86.

Civil Aviation Regulatory Commission CARC of Jordan. (2017). "Report". http://www.carc.jo/en/annual-report/118-annual-carc-reports

Department of Statistics. (2017). Available at: http://www.dos.gov.jo/dos_home_a/main/index.htm

Devote, R., Farci, C., and Lilliu, F. (2002). "Analysis and forecast of air transport demand in Sardinia's Airports as a function of tourism variables". Urban Transport, VIII, ISBN 1-85312-905-4.

Erma, S., Chou, Sh-Yan, and Chen, Ch-H. (2010). "Air passenger demand forecasting and passenger terminal capacity expansion: a system dynamics framework".

Profillidis, V., and Botzoris, George. (2015). "Air passenger transport and economic activity". Journal of Air Transport Management, 49, 23-27.

Profillidis, V.A. (2000). "Econometric and fuzzy models for the forecast of demand in the airport of Rhodes". Journal of Air Transport Management, 6, 95-100.

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

Wadud, Z. (2011). "Modeling and forecasting passenger demand for a new domestic airport with limited data". Transportation Research Record: Journal of the Transportation Research Board, (2214), 59-68.

Wadud, Z. (2014). "Simultaneous modeling of passenger and cargo demand at an airport". Transportation Research Record: Journal of Transportation Research Board, (2336), 63-74.

World Bank. (2017). "World development indicators". http://data.worldbank.org/data-catalog/world-development-indicators

Yu, Gang (ed.). (2012). "Operations' research in the airline industry". Vol. 9. Springer Science and Business Media.