

Conceptual and Regression Models for Passenger Demand Prediction: A case study of Cairo Airport and Egyptair

By Dr. Khaled A. Abbas

1. Introduction

The main aim of this research is to develop demand models for passenger aviation from/to Cairo airport. The paper starts by forming a conceptualisation of main factors affecting passenger demand for international air transport from/to Egypt. In addition, a conceptualisation is drawn portraying factors influencing passenger selection of Egyptair, as a potential international carrier. Following this, historical data concerning aviation demand variables as well as other explanatory variables thought to affect this demand is collected and compiled from several sources.

Demand variables are historically plotted to determine the most proper and representative ones. A correlation matrix is then computed using Pearson coefficient to show extent of relation between demand variables and selected explanatory variables. Based on these analyses, it is decided to develop single and multiple variable models, using different functional forms, relating air passenger demand to population, GDP and number of foreign tourists. All calibrated models are subjected to logical and statistical tests. The paper concludes with a demonstration of usefulness of selected models in terms of ability to predict future passenger demand levels.

2. Factors Affecting Passenger Demand: A Conceptual Model

A conceptualisation of main factors affecting demand for travelling by air from/to Egypt is depicted in figure 1. Aviation demand to/from Egypt is composed of Egyptian as well as foreign passengers. It can be represented by number of international flights or number of passengers using international flights to/from Egypt. Ten factors were identified as affecting demand generated by Egyptian nationals and attracted to other countries. Three can be grouped under socio-economic factors. These include population size, GDP, and GDP/Capita in Egypt. The increase in any of these factors is expected to generate more demand for travelling by air. One factor is related to a pillar of the Islamic religion, namely performance of Haij (pilgrimage). Each year, and according to quota, Saudi Arabia grants a number of Haij visas equivalent to 0.001 of the Egyptian population. Egyptian pilgrims travel to the holy cities of Makkah and Madina in order to perform Haij once a year. In addition, Omra another Islamic ritual and a smaller version of Haij, can be

performed at any time of the year but its peak season is during Ramadan (the Muslim fasting month). Egyptians are known to frequently travel to Saudi Arabia to perform Omra. The other six factors are all related to attractions abroad, including:

- Egyptians immigrants travelling to/from countries of immigration such as USA, Australia.
- Egyptians working abroad and travelling to/from working destinations, such as Saudi Arabia and other Gulf countries.
- Egyptian tourists visiting other countries, especially in summer such as Turkey, UK and Greece.
- Egyptian businessmen travelling to countries to conduct business meetings.
- Diplomats and officials representing Egypt abroad.
- Egyptian graduate students, academics, and scholars travelling to other countries for higher education, research and exchange programs.

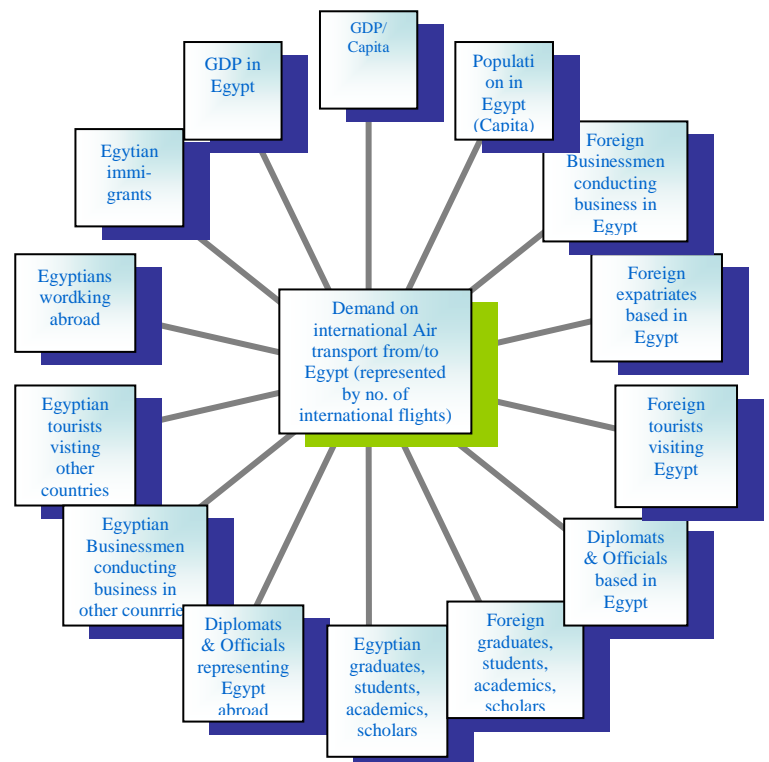


Figure 1: Conceptual Model of Factors Affecting Air Passenger Demand from/to Egypt

On the other hand, five factors were identified as affecting demand generated by foreign nationals and attracted to Egypt including:

- Foreign tourists attracted to visit historical and archaeological Egyptian heritage.
- Foreign nationals, probably expatriate, working in Egypt.
- Foreign businessmen travelling to Egypt to conduct business meetings.
- Foreign diplomats and officials representing other countries and international bodies.
- Foreign graduate students, academics, and scholars travelling to Egypt for higher education, research and exchange programs.

The most important of these five factors is number of foreign tourists visiting Egypt. Majority of foreign tourists arrives to and leaves from Egypt by air.

3. Factors Affecting Egyptair Market Share of Passenger Demand

Some generic insights on the choice of air carrier, flight and fare classes were developed by Prousaloglou and Koppelman (1999). In this section, a conceptualisation of factors affecting the modal selection by passengers travelling on international flights from/to Egypt is shown in figure 2.

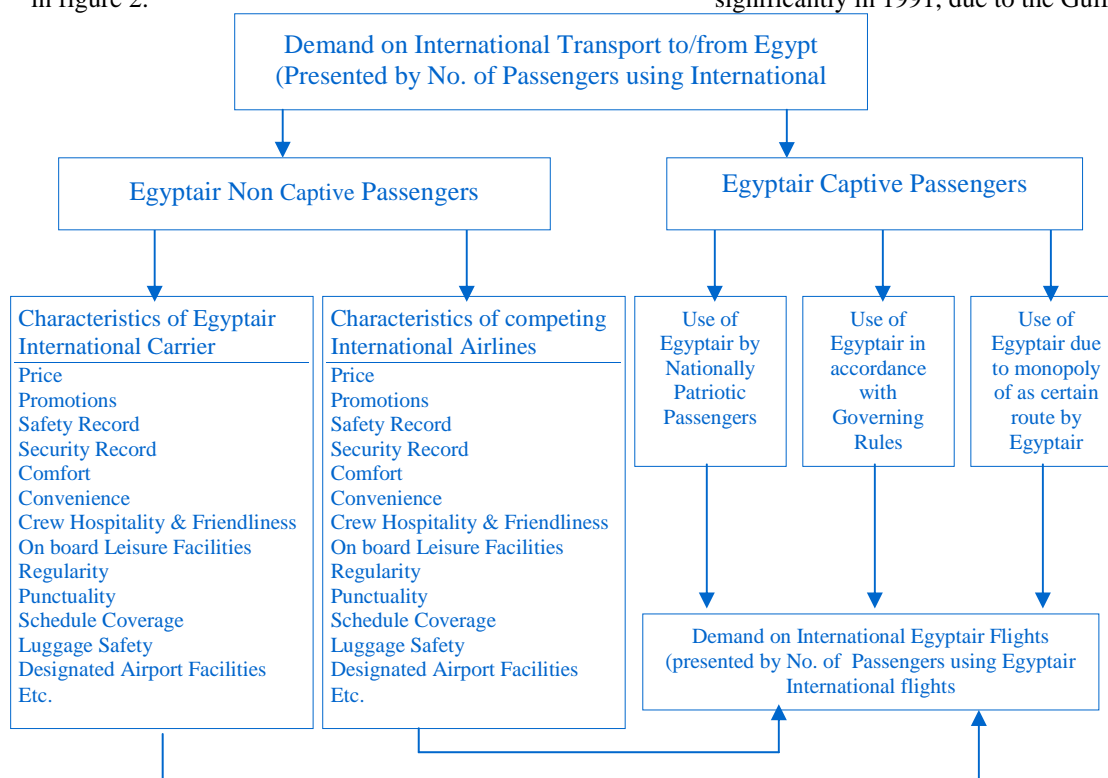


Figure 2: Conceptualisation of Factors Affecting Egyptair Market Share of Passenger Demand on International Flights from/to Egypt

The figure demonstrates the process involved in passenger selection of Egyptair versus other international carriers. Some passengers are by default Egyptair captive either due to their patriotic character, or due to Egyptian government regulations necessitating use of national carrier or due to monopoly of certain routes by Egyptair. On the other hand, the majority of passengers have the choice of selecting Egyptair versus other alternative competing airlines. In this context, price and level of service related characteristics affecting utility of competing airlines

govern passengers' mode choice. Such characteristics could include factors such as promotions, safety and security records, comfort, convenience, regularity, punctuality, schedule coverage, luggage safety, crew hospitality and friendliness, onboard entertainment facilities, designated airport facilities, etc.

4. Dependent and Explanatory Variables for Developing Demand Models for Passengers Travelling from/to Cairo Airport

Based on the conceptualisation, depicted in figure 2, of factors affecting demand, historical data, spanning over from 1990 to 2000, concerning aviation demand variables as well as variables thought to affect this demand was collected and compiled from several sources, see ECAA (2001), Egyptair (2001), NBE (2001), and IMF (2000).

Demand variables include number of international flights (scheduled or unscheduled) as well as number of passengers using international Egyptair flights (scheduled or unscheduled) originating from or attracted to Cairo airport. Demand variables were historically plotted in an effort to determine the most proper and representative ones, see figures 3 and 4. Several observations are noted, first that demand in 1990 was relatively high, being the year just before the second Gulf war. Demand dropped significantly in 1991, due to the Gulf war and its dramatic

effects on tourism and aviation sector in Egypt. In this context, it was decided to drop data points pertaining to these two years from the development of the models. The other noted observation is that generated as well as attracted demand for both scheduled and unscheduled trips are almost similar in magnitude. This demonstrates the aviation phenomenon of passengers usually using return tickets on international

flights. Based on these analyses, it was decided to add total departures and arrivals of international flights from/to Cairo airport and use the sum as the dependent variable representing passenger aviation demand from/to Cairo airport. Similarly, it was decided to use total number of passengers using Egyptair international flights from/to Cairo airport as the dependent variable representing passenger aviation demand on Egyptair.

Historical data on a number of explanatory variables thought to affect demand was also compiled, namely

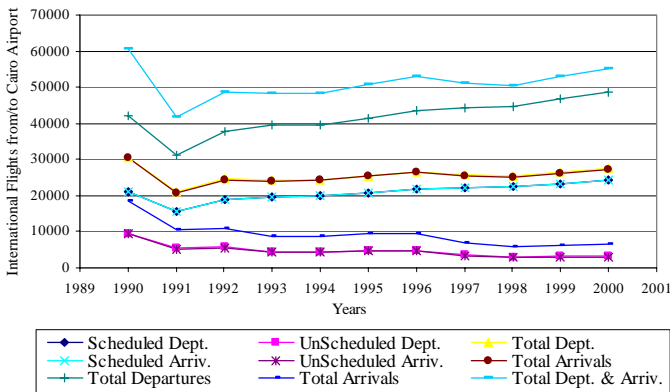


Figure 3: Pattern of Historical Demand of International Passenger Flights from/to Cairo Airport

population, GDP, GDP/Capita, number of Egyptian Hajj pilgrims, number of foreign tourists, number of Egyptians working abroad, as well as number of Egyptian immigrants. A correlation matrix was then developed containing values of Pearson coefficient and its significance in an effort to demonstrate extent of linear correlation between demand variables and selected explanatory variables, see table 1. The matrix shows the collinearity between population and Hajj pilgrims as well as between GDP and GDP/capita. This was expected as number of yearly pilgrims is determined in accordance with Saudi quota being a percentage of population of Muslim countries. In addition the matrix showed illogical negative signs of correlation coefficients between demand variables and number of Egyptian working abroad as well as Egyptian immigrants. Based on these analyses, it was decided to develop models relating demand variables to population, GDP and number of foreign tourists.

5. Developing Passenger Demand Models for International Aviation from/to Egypt

Traditionally, econometric models are utilised in the forecast of air transport demand. Recently fuzzy models see Profillidis (2000) as well as models based on scenario forecasts see Cline (1998), were developed for air transport passenger demand forecasting. In this section, selected demand and explanatory variables were utilized to calibrate two types of econometric models. The first type is single variable models, where four functional relations, namely linear, logarithmic, power and exponential functions, were tested to obtain a best fit. All calibrated models were subjected to a number of statistical tests. To establish goodness of fit and statistical significance of the models, two indicators were computed, namely the R2 and the F-statistic. It became obvious that number of foreign tourists visiting Egypt represents the best fitted explanatory variable and that the power function was the best non linear function in terms of simulating the dependency of annual total international flights from/to Cairo Airport on annual number of foreign tourists. On the other hand, the logarithmic function was the best function in terms of simulating the dependency of total international passengers using Egyptair from/to Cairo Airport on annual number of foreign tourists. Such models have a significant limitation in terms of modelling demand as a function of a single explanatory variable. These variables are either representative of demand generated by Egyptian nationals such as the case of

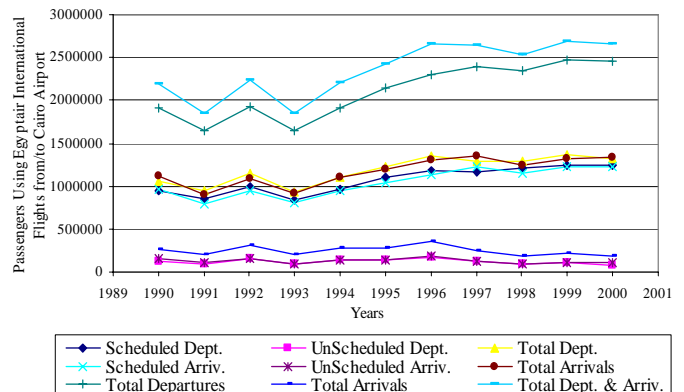


Figure 4: Pattern of Historical Demand of Passengers Using Egyptair International Flights from/to Cairo Airport

population, and GDP or alternatively representative of demand generated by foreign nationals such as the case of number of foreign tourists visiting Egypt. In this context, it was felt that a multiple regression containing at least two explanatory variables, one representing demand of Egyptian nationals and the other representing demand of foreign nationals, would be more appropriate and representative. Several trials were conducted using three selected explanatory variables as well as combination of two. The multiple regression models using three variables had less degrees of freedom and produced negative signs for some calibrated parameters. This was neither statistically nor logically accepted. On the other hand, models including population or GDP in combination with number of foreign tourists as independent variables were calibrated, see table 2. The table shows that those models with population and number of foreign tourists produced the best fit as well as proved to be the most logical and statistically significant models.

6. Applicability of Developed Models in Forecasting Future Demand

In this section, the two selected models are used to perform a short term forecasting of expected demand in terms of number of international flights as well as number of passengers using Egyptair international flights. In order to carry out such forecasts, expected future values for explanatory variables should be first obtained. In this context, two time series models were developed to simulate changes in population in Egypt as well as in number of foreign tourists visiting Egypt. The population model is based on an 11 points data set spanning from 1990 to 2000, while tourists model is based on a 9 points data set spanning from 1992 to 2000. It was assumed that the second Gulf crisis did not affect the population growth but definitely affected the pattern for number of tourists visiting Egypt and that was the reason for ignoring the 1990 and 1991 data points for the tourists model. The two models took the exponential form as follows:

$$\text{Population in Egypt} = 5E+07 * e^{0.0219(\text{Years})}$$

with 1990 as the base year

$$\text{Foreign Tourists Visiting Egypt} = 2E+06 * e^{0.0939(\text{Years})}$$

with 1992 as the base year

The above models were used to forecast expected population and number of foreign tourists in 2004 and 2005. These forecasts, shown in table 3, were then fed into the selected models displayed in table 2 and forecasts of passenger aviation demand represented by number of international flights as well as number of passengers using Egyptair were obtained. These can be averaged from annual into daily forecasts and further more into arrivals and departures.

The usefulness of such forecasts lies in their potential utilisation in resource planning in terms of airport capacity and sufficiency of resources as well as in terms of fleet purchase by Egyptair. Such demand forecasts can be also used as input into Cairo airport and Egyptair cost and revenue models.

7. Conclusions

The main aim of this research was to develop demand models for passenger aviation from/to Cairo airport. In pursuing this objective the research developed two

conceptual models, the first pertaining to factors affecting the passenger aviation demand to/from Egypt, while the second depicted factors influencing the selection of Egyptair as a potential international carrier by passengers. Two demand variables were selected, namely total international flights from/to Cairo airport as well as total number of passengers using Egyptair international flights from/to Cairo airport. In addition, two explanatory variables were also selected to represent demand of Egyptian nationals i.e. population and GDP as well as one variable selected to represent demand of foreign nationals i.e. number of foreign tourists visiting Egypt. These variables were then used to develop several single and multiple variable models with different functional forms. Finally two models were selected based on their logical acceptability, best fit and statistical significance. In an effort to demonstrate the applicability and practicality of the developed models, these were utilised to forecast future expected passenger aviation demand from/to Cairo airport.

Table 1: Pearson Correlation Coefficients Between Variables Representing International Passenger Demand from/to Cairo Airport (CA) and Explanatory Variables

Explanatory Variables	Population (Capita)	GDP*	GDP/ Capita	Egyptian Pilgrims (Haij)	Foreign Tourists	Egyptian Working Abroad	Egyptian Immigrants
Air Passenger Demand							
Total International Flights from/to CA	0.85 (0.004) Sig.	0.861 (0.003) Sig.	0.86 (0.003) Sig.	0.85 (0.004) Sig.	0.903 (0.001) Sig.	-0.855 (0.003) Not Logical	-0.494 (0.176) Not Logical
Total International Passengers Using Egyptair from/to CA	0.82 (0.007) Sig.	0.804 (0.009) Sig.	0.81 (0.008) Sig.	0.82 (0.007) Sig.	0.822 (0.007) Sig.	-0.922 (0.00) Not Logical	-0.651 (0.057) Not Logical

GDP in Current Prices Using Local Currency i.e. Egyptian Pound (L.E.) Currently 1US\$ \cong 6.13 L.E.
Sig.= Significant i.e. the hypothesis H0 stating that the two variables are independent is rejected.

Table 2: Multiple Regression Models Relating Air Passenger Demand Variables to Selected Explanatory Variables

Forecasting Years	2004	2005
Forecasts		
Population in Egypt	69444162	70981764
Foreign Tourists Visiting Egypt	6779119	7446523
Total International Flights from/to Cairo Airport (Annually)	56752	58040
Passengers Using Egyptair International Flights from/to Cairo Airport (Annual Departures or Arrivals)	3071693	3201854

Table 3: Applicability of Developed Models in Forecasting Future Passenger Aviation Demand from/to Cairo Airport

Explanatory Variables	Population (X1) & Foreign Tourists (X2)	GDP (X1) & Foreign Tourists (X2)
Air Passenger Demand		
Total International Flights from/to Cairo Airport (Y)	Y=1.0E-04(X1)+1.7E-03(X2)+38283 R2 =0.82, F = 13.7, Significant d.f. = 6 (SELECTED MODEL)	Y=6.8E-09(X1)+1.6E-03(X2)+43227 R2 =0.82, F = 13.8, Significant d.f. = 6
Total International Passengers Using Egyptair from/to Cairo Airport (Y)	Y=3.3E-02(X1)+0.119(X2)-26680 R2 =0.71, F = 7.2, Significant d.f. = 6 (SELECTED MODEL)	Y=1.32E-06(X1)+0.145(X2)+1584746 R2 =0.69, F = 6.7, Significant d.f. = 6

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Dr. Khaled A. Abbas¹

Professor

Egypt National Institute of Transport

P.O. Box 34 Abbassia – Nasr Road – Cairo – Egypt

Email: kaabbas13@yahoo.com

¹ Currently on Sabbatical Leave to Department of Urban and Regional Planning – College of Architecture and Planning - King Faisal University – P.O. Box 2397 – Dammam 31451 - Saudi Arabia