Air Passenger Demand Model (Apdm): Econometric Model For Forecasting Demand In Passenger Air Transports In Nepal

Dipak Prasad Bastola
PhD Scholar, Kathmandu University School of Management, Lalitpur, Nepal.
Email: 141001_dipak@kusuom.edu.np

Abstract: The basic objective of this research paper is to develop an econometric model to estimate demand in passenger air transport, measured by the number of passengers carried. The research has been carried out in Nepali context. The initial assumption of this study is that the number of passengers carried in Nepali air transport (Y) depends on the number of tourist arrivals (TA) and the gross domestic product (GDP). The results are based on statistical methods of regression and correlation analysis. There are several factors affecting air travel demand, each factor is composed of elements which can stimulate or constrain air travel growth. For air travel demand analysis 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 which are outside the control of the individual airline and even the entire airline industry. These are basically long range economic, social, demographic, and political trends, for example, the age and income distribution of its population, its ethnic and cultural ties to other nations. 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 obtained insights could help airlines and managers of all airports in Nepal. Usually the air travel demand will be sensitive to ticket fare and passengers’ income. GDP is the one that is directly proportional to air passenger demand, if GDP is increase, people can travel aboard and air demand will increase. Similarly, if GDP of the country increase, because of good infrastructure tourist arrival will also increase. From this research model any countries passenger demand can be easily find out after knowing the GDP of that country. Hence this model is valuable tool for everyone who wants to do economic analysis of his country.

Key Words: Air Transport Demand, Econometric Model, Forecasting, Passenger,

1. Introduction
Nepal is a small Asian country between the china and India. Potential domestic air transport is limited due to small market. The objective of this study is to identify the determining factors which turn the potential demand into air transport passengers. Due to the hilly and mountainous terrain the importance of airlines becomes very high in Nepal. Transport is found to be closely related to the economic activity [6]. Both passenger and freight transport generally follow the rate of economic development. Passenger transport is directly influenced by increased income and quality of life. One of key impacts on traffic demand is attributed to GDP, because it typically generates an increase in travel. However, airlines business involves high investment that leads to limited market players. Nepalese economy is peculiar because tourism is one of the most important economic sectors, so further on, the number of tourist arrivals will be considered as a potential variable of an econometric model. Thus, the objective of this study is to identify the determining factors of passenger air transport demand and to make an assessment of passenger air transport future demand. Methods of regression and correlation analyses are used to prove the hypothesis that the number of passengers (Y) depends on the number of tourist arrivals (TA) and the gross domestic product (GDP). Data analyses and numerical calculations are performed by Statistical Software. Recent researches within the European Union indicate a lag of growth rate of passenger transport demand compared to the GDP growth rate. GDP in Nepal grew to 19.64 USD Billion in 2014 from 19.24 USD Billion in 2013 [1]. Nepal Current Account to GDP went up to 4.7 Percent in 2014 from 3.4 Percent in 2013. Nepal is one of the least developed countries in the world and relies extensively on foreign aid. The main sector of the economy is agriculture, which employs over 70 percent of the population and accounts for 33 percent of GDP. Nepal GDP Annual Growth Rate - actual values, historical data, forecast, chart, statistics, economic calendar and news. Content for - Nepal GDP Annual Growth Rate - was last refreshed on Saturday, October 31, 2015 [2]. GDP plays vital role in air transport demand. There is another important variable like surface (Land) transport which effect air demand. Therefore in the following heading, I have taken these two variables for further literature review to find out the air demand dependency on GDP and surface transport.

2. Literature Review
Econometric models are statistical models used in econometrics. An econometric model specifies the statistical relationship that is believed to hold between the
various economic quantities pertaining to a particular economic phenomenon under study [3]. During the last three decades, the study of air travel demand has attracted considerable attention of researchers and academics. An extensive literature has emerged to explain the determinants of air travel demand. Pioneering work in this area includes, among others, that by Ghothri, 1992 [5]. The literature review indicates that various studies refer to air travel forecasting. There are no such studies on econometric modelling of air travel analysis in Nepal. The objective of this paper is to develop an econometric model so as to analyze international air travel demand in Nepal. Some of the research done in this area will be reviewed in this section. Three main methods of forecasting air traffic are: trend projection, econometric relationship, and market and industry surveys. These methods vary in the amount of data and statistical analysis required and to the degree to which selective judgment plays a role. Civil Aviation, through a complicated interaction with other econometric sectors, benefits from and contributes to the economic development of all nations. As incomes and production level increase, the demand for aviation services expands. Therefore prospective tourism, trade and employment could be forecasted as well. Civil Aviation is an important instrument in economic development, and air transport also provides an intangible benefits by facilitating the international treaties and understanding. On the other, the role of air transport as a catalyst for general economic and social development is due to the expedition and flexibility, which has been provided by the global air transport system. It has widened the markets for numerous types of products, and also promoted the exchange and interaction of ideas, professional experience and skills among the nations. Since the role of air transport increasingly gains importance in the economic development of countries and regions, and aviation is the leading edge of industry, it is important to take due account of the economic and social benefits, which an efficient air transport system can offer, and to ensure that future air transport needs are properly assessed together with the associated financial and human resources that need to be provided. Forecasting of air traffic means to estimate the number of prospective passengers that use air transport. The main goal of this dissertation is to estimate the concerned model, then to forecast the air traffic with the model derived. The type of functional relationship to be used for an econometric demand forecast must be developed through judgment and experimentation, and the adequacy of the relationship can only be established empirically through tests against actual historical data. Three alternative forms are suggested below in each case “y” is air demand, “x1” and “x2” are independent variables, and “a”, “b” and “c” are constant coefficient.

- **Liner Y= a+bx1+cx2**
- **Multiplicative Y=ax1 b x2 c**
- **Liner-log Y= loga+blogx1+clogx2**

Time series data is stationary when, mean, variance and coefficient correlation of them is constant during the time, and it is not important that in what time we compute them. If time series data that are used for estimating the coefficient of the model will be non-stationary, it could have the R- square near to “1”. In other words, a regression of one variable against another can lead to a false result, and the OLS would yield a consistent estimator. The principal tool of the econometrician is regression analysis, using several causal variables. Other methods of causal modeling exist. Compared with univariate modelling, multivariate analysis opens up many more choices for the investigator: the set of variables to include in the analysis; the structure, that is, the number of equations relating the set of variables to each other and the causal variables to use in each equation, if more than one equation is included; and the functional form of the equation: whether it is linear or nonlinear in parameters. Based on the above theoretical framework and the research questions the following hypothesis have been formulated and tested.

**Hypothesis Ho:** Number of tourist coming to Nepal depends on GDP and total passengers arrival in Nepal including land.

**Hypothesis H1:** Number of tourist coming to Nepal does not depend on GDP and total passengers arrival in Nepal including land. The forecast process involves three interactive phases including data collection, model estimation, and the disaggregation process. Phase I: consists of data collection. Data comes from a multitude of sources including internal sources, Immigration. Phase II is the model specification and estimation stage. Two, sometimes three, types of models are used and the results reconciled. Phase II utilizes time series techniques, in the form of single equation exponential smoothing models. Estimates of passenger activity are made separately for domestic and international markets. The structure of the exponential model is as follows:

\[ Paxt+1 = \beta \cdot Paxt + (1-\beta) \cdot PPaxt \]

Where \( Paxt+1 \) = Forecast of next year’s passengers

\( Paxt \) = Actual value for current passengers

\( \beta \) = Smoothing constant

\( PPaxt \) = Forecast value of current period’s passengers

This model progressively weights values from the most to the least recent. Data from the current period is weighed by \( \beta \). Data for \( t-1 \) is weighed by \( \beta(1-\beta) \) and data for \( t-2 \) is weighed by \( \beta(1-\beta)^2 \). Before estimation an extrapolation technique is employed to smooth aberrations like the Persian Gulf War of 1993. Though exponential models are ideally suited for short-term forecasting, this model is used to provide a first approximation of passenger growth. At this stage we remember Professor C. L. Jain of St. John’s University, New York, who advised “Forecasting with a time series model is like driving a car with the windshield glass completely blackened out, and the driver drives it looking out the rear view window. If you happen to be driving on a highway full of curves, this is a prescription for disaster.” Time series models are quick and easy but for the above reason we use them only as guide to set the stage for a more in-depth modelling effort. The forecast process proceeds with an econometric model. This is also a regional model. Passenger levels are dependent on real GDP and real yields. Dummy variables are used to allow for special events. This model is specified as follows:

\[ \text{Log} \ Paxt = \varphi_0 + \varphi_1 \text{Log Real GDP} (-1) + \varphi_2 \text{Log Real Yield} + D1973 + Et \]
Where \( \text{Paxt+1} = \text{Next year’s passenger levels} \), 
\( D1993 = \text{Dummy variable}, \)
\( 1993 = 1 \) (Persian Gulf War), 0 otherwise,
\( \phi_1 = \text{Income elasticity}, \)
\( \phi_2 = \text{Price elasticity}, \) and \( E_t = \text{Error term} \)

A variety of different models exist for airline passenger volume estimation. Since no single model guarantees accuracy, airlines compare forecasts from several different models. In multiple regression analysis, the relationship between air travel demand, the dependent variable and the predictors which are the independent variables takes the form of the following regression equation:

\[
Y = b_0 + b_1x_1 + b_2x_2 + \ldots + bn + e,
\]

The parameters of a power function may also be estimated by the method of least squares by first transforming the equation into a linear relationship by using logarithms (Zlatopher, 1984). Taking the logarithms of the power function gives the equation:

\[
\log Y = \log b_0 + \log b_1 x_1 + \log b_2 x_2 + \ldots + \log bn \log xn
\]

In 1988, the Australian Bureau of Transport and Communications Economics (BTCE) produced a study of international aviation. The report analyzed factors which affect demand for international air services in Australia for five regions of destination. The models used in this study were based on a single equation double-log relationship, with demand expressed as a function of real income, real airfares and relative prices. In 1992, the Australian Bureau of Tourism Research (BTR) used a dynamic model of travel behavior which includes lagged variables to forecast the number of visitors to Australia between 1992 and 2001. A double-log equation was specified with the number of travellers assumed to be a function of income and relative prices [8]. Air transport plays a meaningful role in the social and economic developments of the world economy. This mode of travel is also very capital intensive and requires heavy investments. The air transport industry has been experiencing constant changes as a result of changing economic, political and transport security environment [7]. After reviewing the above literature, for the simplicity of construction of an econometric model.

Variable \( Y \) is a dependent variable, while \( \text{GDP} \) and \( \text{TA} \) are independent or explanatory variables. Supposing that the number of passengers in air transport depends on the \( \text{GDP} \) and the number of tourist arrivals, its linear form would be as following:

\[
Y = b_0 + b_1 \text{GDP} + b_2 \text{AT}
\]

This analysis requires the use of both a simple and multiple regression models with. The Air Passenger Demand Model (APDM) is used to forecast the number of air passengers assuming no Nepal airport capacity constraints.

4. Results

Pearson’s correlation coefficient was calculated from statistical data in Table-1 to determine the correlation between the passenger air transport demand as a dependent variable and of the gross domestic product and tourist arrivals as independent variables.

### Table 1:

<table>
<thead>
<tr>
<th>Year</th>
<th>GDP Billions USD</th>
<th>Total Arrivals Including Land</th>
<th>Tourist Travel by Air</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>61.1</td>
<td>375,580</td>
<td>277,246</td>
</tr>
<tr>
<td>2006</td>
<td>51.0</td>
<td>363,326</td>
<td>283,083</td>
</tr>
<tr>
<td>2007</td>
<td>50.1</td>
<td>516,165</td>
<td>360,176</td>
</tr>
<tr>
<td>2008</td>
<td>50.5</td>
<td>510,273</td>
<td>278,662</td>
</tr>
<tr>
<td>2009</td>
<td>54.3</td>
<td>509,569</td>
<td>279,352</td>
</tr>
<tr>
<td>2010</td>
<td>55.5</td>
<td>602,467</td>
<td>445,850</td>
</tr>
<tr>
<td>2011</td>
<td>56.6</td>
<td>782,145</td>
<td>545,021</td>
</tr>
<tr>
<td>2012</td>
<td>58.2</td>
<td>803,052</td>
<td>598,258</td>
</tr>
</tbody>
</table>

(Nepal tourism statistics 2012, 2013)

Regression analysis of the correlation between passenger air transport demand measured by the number of passengers carried and the GDP gives the following model of simple linear regression:

\[ Y = 815.35 + 2576.54 \text{GDP} + 6779561 \text{Total Tourist Arrived} + E \]

**Note:** Air Transport Demand in Nepal “Y” can be calculated by using above Nepal Air Passenger Demand Model (NAPDM).

### Table 2 Regression Analyses

<table>
<thead>
<tr>
<th>Source</th>
<th>DF of MS</th>
<th>Prob &gt; F</th>
<th>Adj. R-squared</th>
<th>Root MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>9.3957e+10</td>
<td>2</td>
<td>4.6659e+10</td>
<td>0.0000</td>
</tr>
<tr>
<td>Residual</td>
<td>340022495</td>
<td>8</td>
<td>8604914.8</td>
<td>0.9994</td>
</tr>
<tr>
<td>Total</td>
<td>9.3957e+10</td>
<td>10</td>
<td>4.6659e+10</td>
<td>2419.3</td>
</tr>
</tbody>
</table>

Where \( Y = \text{Air Demand}, X = \text{GDP} \) and \( Z = \text{Total Tourist Arrival including land} \). Data in Table 2 confirm the statistically firm correlation between the gross domestic product, the number of tourist arrivals and the passenger air transport demand \( (R^2 = 0.9996; \text{Prob} > F = 0.0000) \). However, since there is a high correlation between these two independent variables, perhaps it is more suitable to apply only one or two of them in construction of an econometric model. Since t-Value is
higher than tabulated value, hypothesis H1 cannot be accepted. Hypothesis: Ho is accepted that means result shows Number of air passenger coming to Nepal depends on GDP and total tourist arrived in Nepal including land. Since R² value is 0.9996, we can conclude the model is perfect. Also, t-values are 10.82 and 72.52 hypothesis H1 cannot be accepted.

5. Further Testing the Model
It is always better to test the model by using various econometrics tools for Multicollinearity, Heteroscedasticity and Auto correlation. Multicollinearity is a question of degree and not of kind. High R² value (0.9996) and high t ratio values (10.82 and 72.52) clearly indicate that this model is not having Multicollinearity. There is no Heteroscedasticity since samples are in the same trend. Heteroscedasticity is generally expected if small, medium and large size is sampled together. In this model is basically classical linear regression model and assumes that autocorrelation does not exist. But there is a strong correlation between GDP and total number of tourist arrival in Nepal including land. (Table -3). Normally there will be strong autocorrelation especially in time series data.

Table: 3 Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Y</th>
<th>X</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>0.7680</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>0.9585</td>
<td>0.7221</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Where X: GDP, Y: Air Demand and Z: Total Tourist arrival including land. This further test proof that Y=815.35+2576.54GDP+.6779561Total Tourist Arrived + E. Model is the best econometrics model for air demand calculation in Nepal. This is the very first air demand econometrics model for Nepal. This model will help airline planner to plan their aircrafts operation based on these forecasted demand. This type of model is very useful for anybody who want to know passenger demand of their country. Other analysis of model is shown in the following tables.

Table: 4 Residuals & Fitted Values

Table: 5 (Graph Matrix)

6. Discussion
This study presented a simple linear regression model for forecasting demand in passenger air transport in Nepal. Two models were made and tested. In one of them, GDP is considered as an independent variable, while in the other one the independent variable is the number of tourist arrivals. Both models show satisfactory theoretical, statistical and econometric values, and a high level of practical applicability in projecting transport demand in passenger air transport. However, as evident from the both models, the estimated values in the initial period lag behind the real values, so another forecast was made based on the trend equation. This ensured high accuracy of estimation throughout the whole period, assuming no Nepal airport capacity constraints. Relatively inexpensive air transport has also been crucial in the rise of tourism in Nepal.

7. Limitation and Future research
Data collection was done only 2005 to 2012. Despite of such limitation, I can expect that this study will lay foundation on study on forecasting of passenger demand in Nepal. Further, this study will also help to further elaborate the concept of Econometrics Model. But, continued research is necessary before recommending formal or non-formal recommendation of Passengers demand in Nepalese domestic airlines. Accuracy in estimating air transport demand is a key element while an aviation company is planning its short term or long term business plan regardless of its status, being an incumbent or a startup company. Therefore, not only GDP other variables like population, export and import exchange
rate, fuel price, expenditure, GDP per capita etc. need to be considered for accurate forecasting the air passengers demand model in Nepal. The major issue in accurately predicting demand for air traffic in the short term is subject to factors that no econometric forecasting model could accommodate, such as wars, terrorist action or a high fuel price. The aircraft manufacturers are predicting average trend growth, on a twenty-year vision, and hence they are unable to catch an accurate picture of the possible short-term. Therefore it seems interesting to investigate how to supplement this long-term vision, by accurately estimating the short-term fluctuations that could be closely related to qualitative factors which are not currently taken into account in the traditional quantitative factors used to forecast long-term air travel demand.

8. References


9. Author Profile:

Author is an Aeronautical Engineer and had studied in India for his B.E. in Aeronautical from HIET, Chennai, Master degree in Aerospace Management from Toulouse Business School, Toulouse, France and he is presently doing PhD in Management at Kathmandu University School of Management, Lalitpur, Nepal. Author has long management as well as aviation experience in the Nepalese Government and civil sector. He is one of the very experienced aviation experts in Nepal who have sound academic background in the aircraft maintenance field.

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