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Trend Extrapolation of Domestic Air Travel Demand in Nigeria (2018-2030)

A. Adetayo Olaniyi *, K. Olufunto Adedotun

Department of Transport Management Technology, Federal University of Technology, Akure. P. M. B. 704, Akure, Nigeria.

A B S T R A C T

This study examines the trend extrapolation of domestic air travel demand in Nigeria. Yearly data from 2010 to 2017 were collected from secondary sources. Ordinary Least Square (OLS) regression was used to forecast the twelve the years (2018 to 2030) demand for domestic air passenger travel in Nigeria. The demand for domestic air passenger in Nigeria from the year 2010 to 2017 was compared with the forecast. There seems to be periods of fluctuations in the demand for domestic air passenger travel in Nigeria from year 2010 to 2017. These fluctuations in the demand for domestic air passenger travel in Nigeria are expected to have effect on the forecast of domestic air travel. Calculation and computation reveal that the coefficient of determination R^2 is 0.203. The test reveals that the error term is maximum or very high and the explanation level is very low; hence the prediction or forecast is unreliable. Despite the decline in the forecast of domestic air passenger demand in the future and the fact that the forecast is unreliable as shown from the coefficient of determination, the government agencies should be sensitive to the forecast and try to adopt new policies and strategies that will enhance the demand for domestic air passenger travel in Nigeria.

Keywords: Ordinary least square (OLS) regression, Trend extrapolation, Domestic air passenger demand.

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1. Introduction

The aim of the Millennium Development Goals (MDGs) is embedded in the most paramount goal which is the first as it is said to eradicate extreme poverty and hunger in the world. Eradication of extreme poverty and hunger is highly connected to mobility of people, goods, and services. The importance of mobility cannot be far-fetched from or beyond the following: Economic purpose, social integration, and spatial interaction [2] which poverty is inevitable. This

* Corresponding author
E-mail address: 4tynil@gmail.com
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connote the axiom of Wilfred Owen, a renowned transport analyst who states that 'Immobility Perpetuate Poverty'.

Air transportation is a subsystem of transportation and a system on its own has other subsystems. The demand for transport is a derived one which is driven by the needs and desires to attain some other final objectives. The derived nature of air transport is attributed to the unique characteristics of the air transport as follows: Air transport demand, is a product that cannot be stored or kept; the product, is usually personalized (consumers feel differently about the product), which is referred to as heterogeneity of product; there is no replacement for bad product; it is difficult to test the product before usage; the delivery of its product cannot be guaranteed because of unpredictable factors; the product can be produced only in batches and not in individual units [3, 4, 12].

Air transport operations and business cannot be maximized or sustained unless there is demand for its services; meanwhile the estimation of expected future demands is a key element in planning air transport operations and business. Air transport demand is the quantity of air transport service that consumers (mostly air passengers) are willing to buy at an agreed price. Economists categorized demand as effective demand and ineffective demand. The effective demand in air transport is defined as the quantity of air transport service that consumer (mostly passengers) are willing and able to buy at a given price. The effective domestic air passenger demand in Nigeria is the focus of this study. The secondary data for this study is between the periods of year 2010 to year 2017.

Managing domestic air transport business in Nigeria requires the decision making. Decisions are made about what is likely to happen in domestic air transport in the future as it is said that the taken business actions today must be based on yesterday's plan and tomorrow's expectations which is referred to as expectations, predictions, projections, and all referred to as forecasting [16]. Forecasting is needed in every form of domestic air transport decision making such as airline planning, airport planning, inventory control, investment cash flows, demand forecasts, corporate planning, budgeting, and others.

There are various forecasting techniques such as moving average, exponential smoothing, and others. The methods tend to be suitable for short and medium forecasting and not suitable for long term forecasting. Long term forecasting is usually less detailed and is normally concerned with forecasting the main trends on a Year of Year (YoY) basis. Hence, any of the techniques of regression analysis could be used depending on the assumptions about linearity or nonlinearity, the number of independent variables, and so on. This study adopts Ordinary Least Square (OLS) regression approach, as it is often used for trend extrapolation. The aim of this paper is to determine the trend extrapolation of domestic air travel demand in Nigeria from year 2018 to 2030. The specific objectives of this study are:

- Forecast the demand of domestic air passenger demand for twelve years (2018-2030).
- Determine the coefficient of determination.

2. Literature Review

Adeniran and Kanyio [5] conducted a study on long term forecasting of international air travel demand in Nigeria. Yearly data from 2001 to 2017 were collected from secondary sources and Ordinary Least Square (OLS) regression was used to forecast the ten years (2018 to 2028) demand for international air passenger travel in Nigeria. The demand for international air passenger in Nigeria from year 2001 to 2017 was compared with the forecast. Calculation reveals that the coefficient of determination R^2 is 0.815, while the computed reveals that the coefficient of determination R^2 is 0.769; this difference can be attributed to approximate the two decimal places for calculated test. The calculated test and the computed test reveal that the error term was minimal and the explanation level was high; hence the prediction or forecast was reliable. The forecast for years 2020, 2025, and 2028 are 5,282,453, 6,342,519, and 6,978,559, respectively which are about 48 percent increase, 78 percent increase, and 95 percent increase respectively from demand in year 2017. The forecast of ten years from year 2018 to year 2028 reveals that there will be more increase in the demand for international air passenger travel in Nigeria. It is important to note that the study of Adeniran and Kanyio [5] is quite reliable for this study but it is limited to international passenger demand and not domestic passenger demand in Nigeria.

Adeniran and Stephens [6] established the dynamics for evaluating different forecasting methods for international air passenger demand in Nigeria using two single moving average, four single moving average, and six single moving average; the same forecast was also achieved by using simple exponential smoothing with smoothing constants of 0.7, 0.8, and 0.9, respectively. The most appropriate forecasting method was determined by comparing all the single moving averages with exponential smoothing. The data involved for the study was between the periods of year 2001 to year 2017; meanwhile the single moving average and the simple exponential smoothing were compared using the Mean Squared Deviation (MSD). It was revealed that the MSD of exponential smoothing with constant 0.8 appears to give the best year 2018 forecast as it has a lower MSD when is compared to the MSD of the other forecasts. Their study is limited to evaluating forecasting techniques for international air passenger demand and not on long term forecasting for domestic passenger demand.

Pai [17] carried out the study on the factors that affect airline flight frequency and aircraft size. The study was able to assess the determinants of aircraft size and frequency of flights on airline routes by considering market demographics, airport characteristics, airline characteristics, and route characteristics. It was shown that the frequency and aircraft size increase with population, income, and runway length. Ghobrial [9] has presented 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 two-stage least-square procedures. The result indicates that ‘airline aggregate demand’ is elastic with respect to the yield and inelastic with respect to the network size and hub dominance.

Abed et al. [1] developed the 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. Dargay and Hanly [8] use the income, airfares, foreign trade, exchange rates, and domestic price levels to find out the factors that are affecting the air transport demand to and from UK. Fridström and Thune-Larsen [18] focused on forecasting the air traffic volumes in Norwegian domestic air transportation network. They use the pooled cross section time series data and fares, travel time, income, and population taken as independent variables in the model. Fares and travel times variables are used for the air travel and for the fastest surface transportation mode.

Adeniran and Ben [4] carried out a study on econometric model of domestic air travel in Nigeria vis-à-vis some selected economic variables. Their study revealed that the predictors (economic variables) cannot give true estimate of the domestic air travel forecast due to the fact that the model estimate was not validated. The invalidation was as a result of the following: No statistical significant between the variables; problem of multicollinearity presence, although the regression value signifies that the model can give a true forecast. Previous studies adopted the use of causative method of quantitative forecasting for air travel demand; this study was limited to trend analysis of domestic air travel in Nigeria.

2.1 Forecasting

Forecasting can be defined as an attempt to predict the future by using qualitative or quantitative means. It is an integral part of all human activity, but from the business point of view, the increasing attention is being given to formal forecasting systems which are continually being refined [16]. Every form of decision making and planning activities in business involve forecasting as it is being applied in the air transportation.

There are two techniques involved in forecasting, they are:

- Quantitative techniques involve the use of causal method such as correlation and regression analysis, and the time series analysis such as simple exponential smoothing and single moving average.
- Qualitative technique is solely judgmental method such as expert opinion, poll, and sales force opinion.

In this paper, emphasis was laid on quantitative techniques. Quantitative techniques have varying levels of statistical complexity which are based on analyzing past data of the item to be forecast. A very good example that was captured in this study is domestic air passenger traffic (movement). However, the sophisticated technique used; there is the underlying assumption that the past patterns will provide some guidance to the future. According to [16], the main assumption behind the use of quantitative technique of forecasting is as a longer period covered by the data, the more likely the data will be representative of the future. Nevertheless, however long a period is covered by past data, any extrapolations or forecasts produced from that data by whatever technique should be treated with caution. In other to forecast quantitatively, the use of time series cannot be overemphasized.

The simplest formal analytic technique is ‘trend analyses’, either in time or scale. Historic trends for this study are derived by the simple linear regression of the air passenger traffic itself or the annual air passenger growth rate. This is then projected into the future, modified by judgment to take account of changing circumstances. Short term trends often allow for the effect of economic cycles by applying some form of Box-Jenkins technique. Long term forecasts may recognize that the growth will mature over time by fitting the data to a Gompertz or ‘S’ curve [10].

2.2 Trend Analysis

Trend analysis or time-series is a sophisticated statistical method of forecasting analysis. It is the oldest and in many cases, still the most widely used method of forecasting air transportation demand. It is simply a sequence of values expressed at regular recurring periods of time, and it is possible from these time-series studies to detect regular movements that are likely to recur and thus can be used as a means of predicting future events. Forecasting by time-series or trend extension actually consists of interpreting the historical sequence and applying the interpretation to the immediate future. It assumes that the past rate of growth or change will continue [12].

The affecting trend factors of air traffic are economic factors such as GNP and foreign exchange, demographic factors such as population, urbanization, and reduction in size of households with younger age groups, which are generally assumed to be amongst the easiest of forecasting the relationship with air traffic growth. Other factors are the supply factors, development of technology, economic regulations, environmental regulations, and approach guidance; approach guidance is designed to allow changes in operational practices [7].

The methods available to make forecasts have been reviewed and shown to be more or less adequate for short term detailed planning and design, but to offer little more than a formal basis for reasoned judgment in the long time horizons needed for airport system and master planning. Interactions between the variables which control demand are not sufficiently understood to allow more certain forecasts to be developed, so that informed judgment must be used. Consistency of methodology is undoubtedly necessary for communication and interpretation, but the inputs to the prediction process should be allowed to vary as necessary to reflect the variety in the system. No particular model will always be the most appropriate, nor will any one model always give the most accurate prediction. It is always worth using more than one approach. Much can be learnt from a comparison of the outcomes relative to the constraints of the modeling [7].

2.3 Ordinary Least Square (OLS) Regression

The least squares method is a form of mathematical regression analysis that finds the line of best fit for a dataset, providing a visual demonstration of the relationship between the data points. Each point of data is representative of the relationship between a known independent variable and an unknown dependent variable.

The least squares method provides the overall rationale for the placement of the line of best fit among the data points being studied. The most common application of the least squares method, referred to as linear or ordinary, aims to create a straight line that minimizes the sum of the squares of the errors generated by the results of the associated equations, such as the squared residuals resulting from differences in the observed value and the value anticipated based on the model [11]. This method of regression analysis begins with a set of data points to be graphed.

The line of best fit determined from the least squares method has an equation that tells the story of the relationship between the data points. Computer software models are used to determine the line of the best fit equation and these software models include a summary of outputs for analysis. The least squares method can be used for determining the line of best fit in any regression analysis. The coefficients and summary outputs explain the dependence of the variables being tested. In contrast to a linear problem, a non-linear least squares problem has no closed solution and is generally solved by iteration. The earliest description of the least squares method was by Carl Friedrich Gauss in 1795 (*Ibid*).

3. Methodology

3.1 Research Design

There are uncertainties in demand of product and services, which can be reduced through forecasting. The study adopts the Ordinary Least Square (OLS) regression for forecasting the demand of international air passenger in Nigeria. Data for this analysis are secondary data sourced from [13, 14, 15], covering the periods of seventeen years spanning from the year 2010 to year 2017.

3.2 Model Specification

When specifying the model, mathematical model will be specified before the econometric model. The mathematical model is for regression true line, while the econometric model is for regression observed line. Without the mathematical model, there cannot be an econometric model. The difference between the mathematical model (true line) and the econometric model (observed line) is the inclusion of stochastic disturbance term, otherwise known as an unexplained variables or error term in the econometric model.

The difference between the true line and the observed line can be seen on the line graph and calculated by the coefficient of determination. If the difference of lines referred to as error term is wide, it will result to a low coefficient of determination. The implication is that the predictions of forecast cannot be reliable. But if the error term is minimal, it will result to a high coefficient of determination. The implication is that the predictions of forecast will be reliable.

Mathematical model (True line model):

$$Y = a + Bx. \tag{1}$$

Econometric model (Observed line model):

$$Y = a + Bx + Ui, \tag{2}$$

where, y = Domestic air passenger demand in Nigeria (Dependent variable) and a = Intercept.

B = Parameter/ slope, x = Time (Independent variable) and Ui = Stochastic disturbance term or unexplained variables or error term which captures other factors influencing domestic air passenger demand in Nigeria.

In other to derive the true line, the following equations must be achieved:

$$\sum y = na + \sum xb \ , \tag{3}$$

$$\sum y = na + \sum x^2 b \tag{4}$$

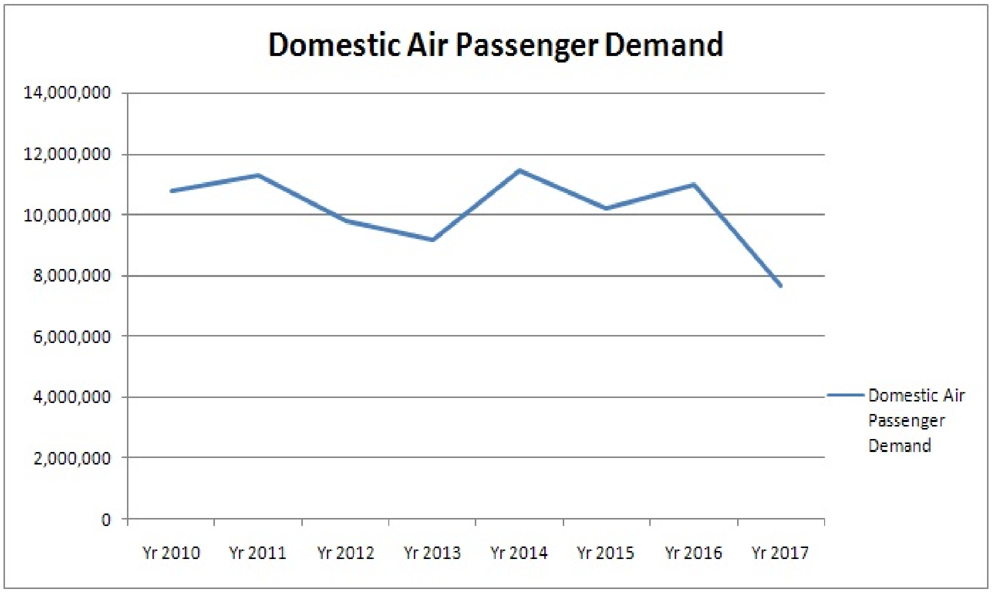
4 Result and Discussions

4.1 Forecasting the Demand of Domestic Air Passenger for Ten Years (2018-2030)

The data were drawn on a time series graph where x, the independent variable representing time, is represented on the horizontal axis of the Figure 1 below. It should be noted that unlike a scatter diagram, the points are joined. The ordinary least squares line of the best fit became the linear trend when are plotted on the graph.

Table 1. Demand for Nigeria Domestic Air Passengers in the Past Eight Years [13, 14, 15].

Years	Domestic Air Passenger Demand
Yr 2010	10,753,725
Yr 2011	11,303,215
Yr 2012	9,770,453
Yr 2013	9,159,612
Yr 2014	11,447,601
Yr 2015	10,222,441
Yr 2016	10,971,608
Yr 2017	7,646,600



Source: Authors' computation.

Figure 1. Time Series Graph Showing International Air Passenger Demand in Nigeria from Year 2001 to 2017.

Table 2. Details of Regression Arithmetic.

Years	Number of Years (x)	Domestic Air Passenger Demand (y)	xy	x^2
Yr 2010	1	10,753,725	10753725	1
Yr 2011	2	11,303,215	22606430	4
Yr 2012	3	9,770,453	29311359	9
Yr 2013	4	9,159,612	36638448	16
Yr 2014	5	11,447,601	57238005	25
Yr 2015	6	10,222,441	61334646	36
Yr 2016	7	10,971,608	76801256	49
Yr 2017	8	7,646,600	61172800	64
Total	36	81275255	355856669	204

Source: Authors' computation (2018).

There are 17 pairs of observations (n= 8); $\sum x = 36$, $\sum y = 81,275,255$, $\sum xy = 355,856,669$, $\sum x^2 = 204$.

All calculations into two decimal places are as follows:

$$\sum y = na + \sum xb \, , \tag{3}$$

$$\sum y = na + \sum x^2 b. \tag{4}$$

To obtain the values of a and b, substitute the observations above into Eqs. (3) and (4), and solve simultaneously:

81,275,255 = 8a + 36b, 355,856,669 = 36a + 204b. (Adopting elimination by substitution method).

Multiply Eq. (3) by 4.5 and Eq. (4) by 1 to produce below results, respectively:

365,738,648 = 36a + 162b, 355,856,669 = 36a + 204b. By subtracting, we have:

9,881,979 = - 42b.

Then, divide above result by - 42 to obtain b:

b = - 235285.21.

Substitute b as - 235285.21 into (81,275,255 = 8a + 36b) to form:

81,275,255 = 8a + 36(- 235285.21),

81,275,255 = 8a - 8470267.7,

81,275,255 + 8470267.7 = 8a,

89,745,523 = 8a.

Then divide (89,745,523 = 8a) by 8 to obtain a:

a = 11218190.

The regression line as shown in the model specification of Eq. (1) is:

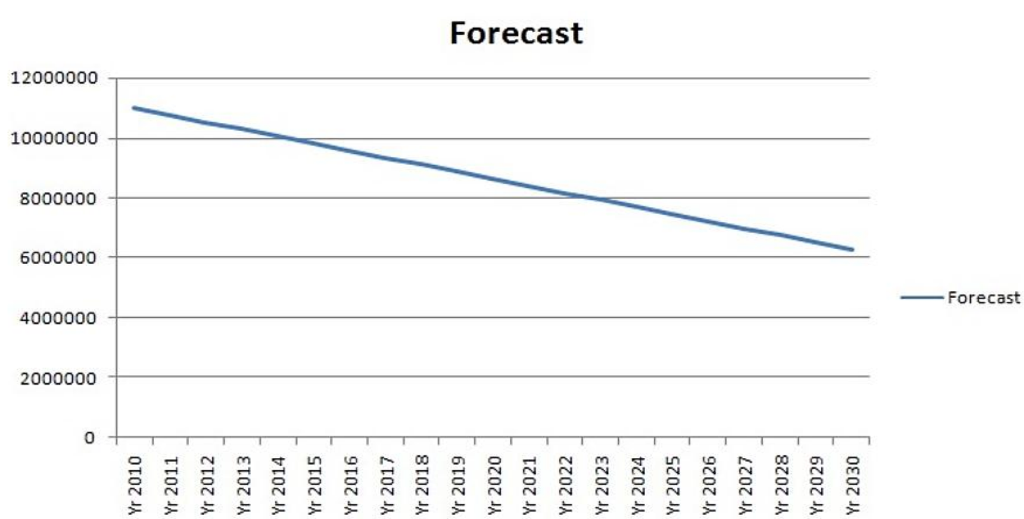
Y = 11218190 + (- 235285.21x)

To forecast, x will be replaced by the number of years as shown in Table 3 below.

Table 3. Determination of Domestic Air Passenger Demand Forecast in Nigeria.

Years	Number of Years (x)	Forecast of Domestic Air Passenger Demand in Nigeria (Y)
Yr 2010	1	Y = 11218190 - 235285.21(1) = 10982905
Yr 2011	2	Y = 11218190 - 235285.21(2) = 10747620
Yr 2012	3	Y = 11218190 - 235285.21(3) = 10512334
Yr 2013	4	Y = 11218190 - 235285.21(4) = 10277049
Yr 2014	5	Y = 11218190 - 235285.21(5) = 10041764
Yr 2015	6	Y = 11218190 - 235285.21(6) = 9806479
Yr 2016	7	Y = 11218190 - 235285.21(7) = 9571194
Yr 2017	8	Y = 11218190 - 235285.21(8) = 9335908
Yr 2018	9	Y = 11218190 - 235285.21(9) = 9100623
Yr 2019	10	Y = 11218190 - 235285.21(10) = 8865338
Yr 2020	11	Y = 11218190 - 235285.21(11) = 8630053
Yr 2021	12	Y = 11218190 - 235285.21(12) = 8394767
Yr 2022	13	Y = 11218190 - 235285.21(13) = 8159482
Yr 2023	14	Y = 11218190 - 235285.21(14) = 7924197
Yr 2024	15	Y = 11218190 - 235285.21(15) = 7688912
Yr 2025	16	Y = 11218190 - 235285.21(16) = 7453627
Yr 2026	17	Y = 11218190 - 235285.21(17) = 7218341
Yr 2027	18	Y = 11218190 - 235285.21(18) = 6983056
Yr 2028	19	Y = 11218190 - 235285.21(19) = 6747771
Yr 2029	20	Y = 11218190 - 235285.21(20) = 6512486
Yr 2030	21	Y = 11218190 - 235285.21(21) = 6277201

Source: Authors' computation (2018)



Source: Authors' computation (2018).

Figure 2. Forecast of Domestic Air Passenger Demand in Nigeria from Year 2010 to 2030.

It is important to note that the demand for domestic air passenger in Nigeria at the year 2010 was 10,753,725 which rose to 11,447,601 which had about 6.5 percent increase in the year 2014. Also, the demand declined from 10,971,608 in the year 2016 to 7,646,600 in the year 2017. There seems to be periods of the fluctuations in the demand for domestic air passenger travel in Nigeria from year 2010 to 2017. These fluctuations in the demand for domestic air passenger travel in Nigeria are expected to have effect on the forecast of domestic air travel as revealed on the graph shown in Figure 2 above. The forecast of domestic air passenger travel in the year 2020 is expected to be 8,630,053; the forecast in year 2025 is 7,453,627; the forecast in year 2030 is 6,277,201. The decline in the forecasts signifies that the domestic air passenger travel demand will reduce and this will have direct effect on the revenue generation of the country and other indirect effects. On this note, the government must take the necessary actions to find out factors that might result to the decline in the demand of domestic air passenger travel as has been revealed in the forecast. The implication of this finding is to revisit the various policies that concern domestic air travel, so that the forecast will not become reality.

4.2 Coefficient of Determination

There is need to determine the reliability of the forecast. The difference between the true line and the observed line can be seen on the line graph and calculated by the coefficient of determination R^2. If the difference of lines otherwise referred to as error term is wide, it will result to a low coefficient of determination. The implication is that the predictions of the forecast cannot be reliable. But if the error term is minimal, it will result to a high coefficient of determination. The implication is that the predictions of forecast will be reliable. To calculate the coefficient of determination, the Eq. (5) below will be applied.

Table 4. Calculation of Coefficient of Determination (R^2).

Years	Number of Years (x)	Domestic Air Passenger Demand (y)	Forecast (YE)	$(YE - \bar{Y})^2$	$(y - \bar{Y})^2$
Yr 2010	1	10,753,725	10982905	6.78149E+11	3.53214E+11
Yr 2011	2	11,303,215	10747620	3.45995E+11	1.3083E+12
Yr 2012	3	9,770,453	10512334	1.24557E+11	1.51285E+11
Yr 2013	4	9,159,612	10277049	13839640164	9.9959E+11
Yr 2014	5	11,447,601	10041764	13839875449	1.65944E+12
Yr 2015	6	10,222,441	9806479	1.24558E+11	3973285156
Yr 2016	7	10,971,608	9571194	3.45995E+11	6.5967E+11
Yr 2017	8	7,646,600	9335908	6.78151E+11	6.3142E+12
Total Σ	36	81,275,255		2,325,083,781,869	11,449,672,432,571
Mean		10,159,407			

Source: Authors' computation.

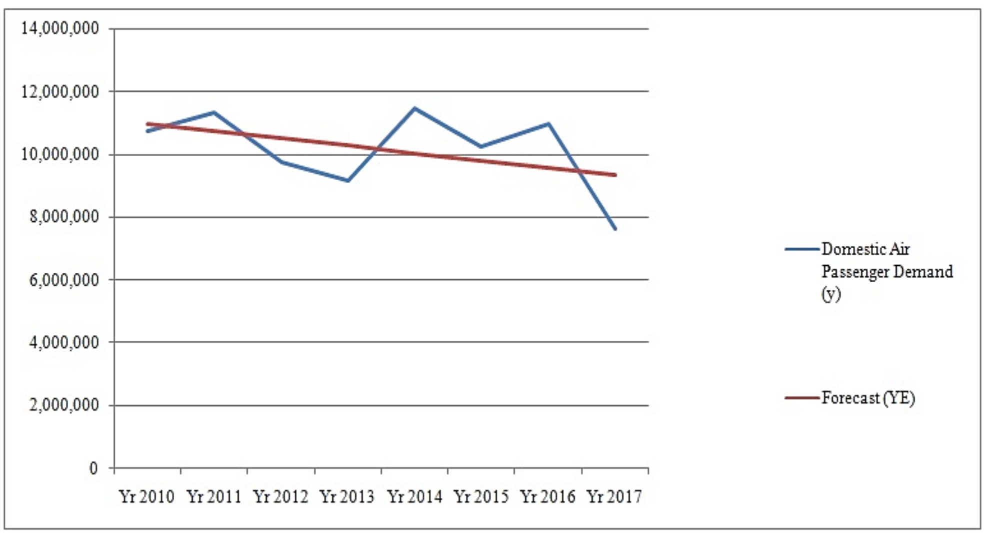
$$R^2 = \frac{\sum[(YE - \bar{Y})(YE - \bar{Y})]}{\sum[(y - \bar{Y})(y - \bar{Y})]}. \tag{5}$$

Where, $\bar{Y} = \frac{\sum y}{n}$; $\bar{Y} = \frac{81,275,255}{8}$; $\bar{Y} = 10,159,407$.

YE = Forecast (Y); $\sum(YE - \bar{Y})^2 = 2,325,083,781,869$; $\sum(y - \bar{Y})^2 = 11,449,672,432,571$;
$R^2 = \frac{2,325,083,781,869}{11,449,672,432,571}$; $R^2 = 0.203$.

Calculation reveals that the coefficient of determination R^2 is 0.203, while the computed also reveals that the coefficient of determination R^2 is 0.203.

In the demand for domestic air passenger travel in Nigeria, 20.3 percent of variations of the actual value of demand may be predicted by changes in the actual number of years. In other words, the factors other than changes in number of years influence the demand to the extent of (100 – 20.3) percent; 79.7 percent. If the level of explanation be 20.3 percent, then the level of unexplained, or error term, or stochastic disturbance term that is attributed to other factors may be 79.7 percent. This shows that the error term is maximum and very high and the explanation is very low; hence the prediction or forecast seems to be unreliable.



Source: Authors' computation (2018).

Figure 3. Difference between the True Line and the Observed Line for Forecast.

5. Conclusion

The trend extrapolation of domestic air travel demand in Nigeria was examined in this study. Yearly data from 2010 to 2017 were collected from secondary sources and used to predict the twelve years (2018 to 2030) demand for domestic air passenger travel in Nigeria. The demand for domestic air passenger in Nigeria demand at year 2010 was 10,753,725 which rose to 11,447,601 which has about 6.5 percent increase in the year 2014. Also, the demand declined from 10,971,608 in the year 2016 to 7,646,600 in the year 2017. There were the periods of fluctuations in the demand for domestic air passenger travel in Nigeria from year 2010 to 2017. These fluctuations in the demand for domestic air passenger travel in Nigeria were expected to have effect on the forecast of domestic air travel as shown in Figure 2. The forecast of domestic air passenger travel in the year 2020 was expected to be 8,630,053; the forecast in year 2025 was 7,453,627; the forecast in year 2030 was 6,277,201. In the demand for domestic air passenger travel in Nigeria, 20.3 percent of variations of the actual value of demand were predicted by changes in the actual number of years. In other words, the factors other than changes in number of years influenced the demand to the extent of (100–20.3) percent; 79.7 percent. If the level of explanation be 20.3 percent, then the level of unexplained, or error term, or stochastic disturbance term that is attributed to other factors is 79.7 percent. This shows that the error term is maximum and very high, and the explanation is very low; hence the prediction or forecast was unreliable.

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