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An empirical study of air transport demand forecast in Nigeria

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Abstract: The study aims to estimate the air travel demand forecast for domestic passengers' travels in Nigeria from 2002-2016. Data resourced from the Central Bank of Nigeria, the National Bureau of Statistics, and the Federal Airport Authority of Nigeria. The study utilized a multiple regression model using a Stata-Graphic software solver to analyze the data. From the analysis, the result shows that there is a significant relationship between the explanatory variable (passengers) and unexplanatory variables National Disposable Income, Population, Average Airfare, Gross Domestic Product, Exchange Rate, Total Expenditure, and Crude oil price, accounted for adjusted R of 93.624% relationship with demand for domestic air travel of passenger. The R-square statistic shows that the fitted model explains the variability in the number of passengers (NPAX), which is 96.8124%. The Hypothesis testing reveals that National Disposable Income and Airfare have a strong statistically significant relationship with the demand for domestic air travel with a P-value of 0.0013. Mores, a statistically significant relationship exists between National Disposable Income, Average airfare, and Crude oil price with P-values of 0.0017 and 0.0445, respectively. Furthermore, a forecast of the number of passengers and average airfare was carried out using ARIMA (1,0,0) model, which made available the future predicted values for the number of passenger movements and average airfare for the next 10-12 years to come. Thus, the study recommends that stakeholders in the air transport sector should work towards improving the capacity and infrastructure to accommodate the growth of air travel demand for domestic air travel in Nigeria. Policy implications were made on regulating the sector by having a good pricing policy to control the air fare for the industry.

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Keywords: air travel demand, air transport, airfare, passenger, sustainability

1. Introduction

Air transport is the fastest transportation that enhances passenger and goods movement from one place to another. Due to its importance in the nation and the world, there has been various infrastructural development in the air transport sector to accommodate the growing passenger traffic in the near future. This development brought about the deregulation of the sector to bring in investors to come into the sector and embrace concession and privatization, a way of reforming the sector. This will enhance competition among the airlines, supply chain operators of the air transport industry, and other services that are rendered in the airport. The government has been working seriously to bring the former national carrier to life to kick off operations in the air transport industry in the country. Furthermore, the growth of the travel and tourism industry is growing rapidly every year. Because of the growth, there is a need to have hub airports that can carry the capacity of the air travel demand of the country.

With such hubs and spoken air transport network, many benefits which could enhance the country's connectivity index would be realized in terms of an overall boost in international trade and economic productivity. The hub airport is another trend that has relegated many airports into becoming "spokes," which otherwise makes them feeder airports to the few hubs (Murtala Muhammed Airport, Lagos, and Nnamdi Azikwe International Airports, Abuja) in the country. This increases the efficiency of air transport operations occasioned by the corresponding increase in passenger and cargo demand for air transport.

The increase in economic investment in various parts of Africa, and Nigeria, particularly from the large population and market forces, has seemingly heightened the call for reforms in the aviation sector. Recently, the resultant effect has been a push by government and transport professionals to show interest in assessing the overall performance of the air transport industry in the country. The fact that air transport does not have any other competitor in terms of speed and safety regarding direct passenger and cargo transportation within the country gives it leverage. This makes the air transport industry an essential aspect of transport infrastructure that is highly needed for the country's socio-economic development (Nwaogbe, 2018).

In line with best global practices, the federal government has been making frantic efforts since 2005 to rebuild the airports' infrastructure base and improve air transport management. Nigeria has aspired to develop into a viable market that will help them become the hub of the aviation industry in Africa. This is possible if and only if the airports in the country can handle growing traffic demands in the aviation industry effectively in terms of passenger throughput, aircraft movement, and cargo throughput. Furthermore, the government's remodeling and transformation agenda has gone far in developing many air transport systems to world standards. Although almost the airports in the country are still operating under airport model, experts acknowledged that liberalization of air transport and airport operation within the regions and the country at large promotes flexibility, competence, and professionalism (Nwaogbe, 2018; Barros, Nwaogbe, Ogwude & Omoke, 2015 & Nwaogbe, Ogwude & Barros, 2015).

Air transport facilities that are accessible to the public traveling should bear a cozy relationship to the requirement of the public for such transport. Subsequently, air transport is fundamental for the quick speedy movement of humans and cargo shipments worldwide. Air transportation enhances the nature of individuals' lifestyles by widening their recreation and cultural activities and experiences. It gives an extensive preference for vacation locations worldwide and is a low-priced means to visit far-off companions and relatives (ATAG, 2005). Because of the parallel globalization system of the world, air transportation has become the most vital, reliable, imperative, and quickest means of transportation among and within nations. An increase in urbanization and higher distribution of salaries and wages have made air transportation unfold over all areas and countries (Airbus, 2011). Even as the global economy (GDP) is relied upon to develop at a mean fee of 3.3% each year for the subsequent two decades, the forecast for the growth of air passenger traffic globally is forecasted better than the growth of GDP (Boeing Current Market Outlook, 2011).

Demand is the charge at which customers want to purchase a product. A price and quantity relationship is the quantity of a product that will be demanded at different price levels. The Economic concept is of the view that demand is made up of these elements: taste and ability to purchase**.** Taste is the choice for a good or service; it determines the willingness to purchase it at a special price. Ability to buy means to pay for a good or product at a specific price; however, there is a need for an individual to possess sufficient wealth or income so that he can comply with the payment. The derived character of transport is self-evident. Lessening similar parameters will diminish interest in transport (Blauwens, De Baere & Van de Voorde, 2008).

Demand in the air transport industry is profoundly cycled based on the time, days of the week, and seasonal period. Air transport precisely can be considered the laboratory of economic activity because the continuous improvement in technological services has made the sector a significant contributor to fashionable and standard worldwide improvement inside the transport sector (Nwaogbe et al., 2015). The demand for transport services has a significant impact on the aviation sector in so many countries and their economy at large. It acts as a facilitator for the movement of passengers, cargo, and domestic and international movement in the air transport sector market.

Air travel demand is so touchy to changes in price and income, more extensive changes can antagonistically influence Air travel demand in the financial subsidence can disposable income, GDP, and consumer confidence, which can likewise, thusly, chill demand for air travel, due to the economic development of the country the increasing growth-rate in Nigeria population and high traffic growth of domestic and international demand has a significant impact on the air transport sector. In an unpredictable world comes an eccentric air travel demand. Because a vital part of a demand investigation is to anticipate travel demand, regardless of whether or not in infrastructure usage, volume or fleet usage, an accurate forecast of demand permits the organization to invest in only staffing, equipment, infrastructure, and facilities as needed.

The analysis of the air travel demand market is an essential part of the corporate planning of air transport that displays the human resources requirements, capacity utilization, and operational capital of projects in terms of monetary cost and so on. It enables decision-making regarding developing and improving infrastructural facilities, thereby ensuring the improvement of air passenger services. Also, it decreases the airline company's risk via equitably assessing of air transport business demand rate. At present, the airline industry faces many cost pressures due to the economic situation. The industry has made outstanding accomplishments in enhancing its productivity. However, cost pressures continue, from the record of high gasoline costs, high inflation, poverty rate, increasing prices of spare parts, economic recession and so forth. The variables have unavoidably prompted changes in airline service prices and passenger demand for travel by air in Nigeria. The change greatly impacts adjustments in air travel charges or fares, disposable income, flight plan, quality of service, the purpose of the trip, and the economic downturn. Most airline industries are faced with the issue of not meeting their load factor since void seats cannot be saved, delay in holding up time of passengers in airports, change in frequency of services, changes in arrival and departure time, change in the level of service etc.

The air transport industry is facing these challenges has resulted to so many unintentional cancellations of some trips by airline companies, high operating costs and loss of revenue that is supposed to be generated by the airline, laying off of some employees competing for modes of transport, declining rate of the number of air tickets sold and over-investment in facilities and infrastructures. Proper and adequate management of the air transport industry is necessary to enhance decision-making about the present and the destined improvement developing the industry. These consist of activities such as airport investment decisions, development planning, and a few. There cannot be proper planning without knowing the demand level for the service provided and the factors of determinants related to it. The key elements for the operational planning of air transport are analyzing and forecasting the current and future demand for air travel (ATAG, 2007; Wells, 2005). This study aims to analyze domestic air travel demand in Nigeria. Airlines need to understand the need of the customers and make provisions for the correct quantity and quality service for the customers. The study contributes to improving air transport economics in the country through the provisional air travel demand of passengers and adapting it to the Nigeria domestic air travel market. The study's objectives are to establish the relationship between National disposable income and domestic air travel demand in Nigeria and to determine the relationship between airfare and domestic air travel demand in Nigeria.

Hypotheses

H_1: There is no significant relationship between National disposable income and domestic air travel demand in Nigeria.

H_2: There is no significant relationship between airfare and domestic air travel demand in Nigeria.

$H_{3:}$ There is no statistically significant relationship between Crude oil price and domestic air travel demand in Nigeria.

2. Literature review

Chieh-Yu Hsiao's (2008) study on Passenger Demand for Air Transportation in a Hub-and-Spoke Network tries to develop an air passenger city-pair demand model of analysis so that these objectives can be attained to predictions of average link movement from movement in particular city-pair markets. This bottom-up analysis enables the impacts of the flow in a wide range of system adjustments which involves the airports, fares, flight frequencies, and economic growth of the region to be investigated, assuming that demand generation and demand assignment will be treated as a single model. The precipitated air travel was calibrated by using a model, which allows the entire air demand to have variation so potential travelers are not forced to select any alternatives for air transport. Changes in the causal factor may influence the entire air travel demand and market shares of other modes of transport because different choices of routes and airports are used for making journeys within a city-pair. There is a need for the model to handle time series and cross-sectional changes in air travel demand data, so that variation in demand for travel by air in the future can be identified.

Carson's (2010) study of forecasting (aggregate) demand for commercial air travel in the US to forecast the overall numbers of industrial passengers between 1990 and 2004 using airport degree statistics for 179 main airports, together with combination stage records, he adopted two significant methods. The first method was the practice of (the Federal Airport Authority) FAA's prediction of the overall number of passengers using an aggregate of exogenous macroeconomic variables such as profits, the populace, and power fees in a time series model. The second method was a forecast of AIM (Aggregating Individual Markets).

Chi and Baek (2012) studied immediate and long-term consequences of US determinants of the demand for air passenger's travel. Their study employs the co-integration of Johansen evaluation incorporated with the Vector Error-Correction (VEC) model, NASDAQ (National Association of Securities Dealers Automated Quotations) for measuring travel made for business activities. At the same time, US disposable income was used to measure passengers traveling for leisure. Chi and Baek (2012) discovered that airfare, NASDAQ, and disposable income substantially impacted air passenger demand for travel in the US in the long run, even as the blended quick-run dynamic outcomes of the populace, disposable profits, NASDAQ and airfare spread the changes in air passenger distance.

Nelson, Dickey, and Smith (2011) used Estimating Time Series and Cross Section Tourism Demand model to study the analysis of factors affecting the volume of passengers from Hawaii to the United States mainland; they used a double-log form for the airline-demand version and located out that cross-sectional airfare elasticities, on an annual foundation basis, were high and growing over time; however, the outcomes envisioned from the time series analysis were much lower. So far, different determinants have been considered by different researchers to determine the factors that affect the demand for air transport in different countries. Some of the factors considered in their study were similar to the hypothetical factors included.

Amanuel (2016) looked at the determinants of Domestic air transport demand in Ethiopia from 2000/2001-2013/2014. He used the Autoregressive Distributed Lag Approach to Co-integration and Error Correction Model to analyze the long-run and short-run relationship between domestic passengers and its determinants. The Bounds test results show that the relationship between the number of domestic revenue passengers, income, airfare, the price of competing services (Buses), road length, and the population is stable in the long run. The empirical results show that income, the price of competing services, and the population were discovered to impact domestic air transport positively. And also has a negative impact on domestic air transport. In the short run, the coefficient of error correction term is -0.62, which is about 62 percent annual adjustment towards long-run equilibrium.

The estimated coefficients of the short-run model proved that population, income, and airfare are the main contributors to the domestic air transport demand.

Ejem et al. (2015) developed an air travel demand model for Nigeria's domestic network. They used panel data from 2009 to 2013, and the model covered both time series and cross-sectional changes in air travel demand. The empirical analysis explicitly modeled service variables by a log-linear demand model using OLS estimation. The estimates yielded better demand elasticities than those of direct linear models. Empirical findings include: at the market level, the fare elasticities from the estimations show the inelasticity of the market demand, except for routes with connecting flights, which are highly elastic with a fare elasticity value of -2.932.

Furthermore, Barros, Wanke, Nwaogbe and Azad (2017) studied efficiency in Nigerian Airports using the Stochastic Frontier Model (Cost Function) that captures the impact of unobserved managerial ability. The study utilized the Alvarez, Arias, and Greene (2004) - AAG model. Their study findings show that contextual variables, if allowed simultaneously, will control the impacts of managerial ability on efficiency toward passenger traffic which is the major output of traffic in the air transport operation. They also find that variation inefficiency scores are more sensitive to labor than capital cost but indicate a negative impact of regulation and hub operations on efficiency levels (Barros et al., 2017). Nwaogbe, Ogwude and Ibe (2017) also studied airport efficiency performance in Nigeria using the DEA -BCC model. The study shows a highly significant relationship between the inputs (total assets, runway dimension, and employees) and the output produced: passengers and aircraft traffic during air transport operations. The efficiency scores of the airport show various airports operating under constant returns to scale, increasing returns to scale, and decreasing returns to scale. Airports operating at the frontier efficiency graph are shown in the production function. Policy implication on how to improve the inefficient airports to be efficient.

3. Data

The statistical data used for the study were sourced from CBN and FAAN from 2002 to 2016. The sample of airports used in the study covers all the airports in the country's domestic services. The model for the study involved the use of eight variables. These variables include; Dependent variable: The number of passengers, Independent variables are National Disposable Income, Population, Average Airfare, Gross Domestic Product, Exchange Rate, Total Expenditure, and Crude oil price. The variables are denoted as NPAX (Passenger), NDI (National Disposable Income), POP (Population), AAF (Average Air Fare), GDP (Gross Domestic Product), EX RT (Exchange Rate), TO EXP (Total Expenditure), CRUDE PRICE (Crude Oil Price).

4. Method of data analysis

Multiple linear regression was used to statistically analyze data and quantitatively assess air travel demand in Nigeria. Passenger throughput was used as the dependent variable, while National Disposable Income, Population, Average Airfare, Gross Domestic Product, Exchange Rate, Total Expenditure, and Crude oil price were used as independent variables. There are various statistical investigations in which the goals were to decide if any relationship existed between two or more variables. If those relationships are modeled into a mathematical equation, then the equation can be adopted for making predictions. The study used statgraphic software to carry out a multiple regression analysis. Secondary data sourced from both FAAN and NCAA were used for the data analysis. The general equation is given below:

$$Y = K + \beta_1 (X1) + \beta_2 (X2) + \beta_3 (X3) + \beta_4 (X4) \ldots\ldots\ldots\ldots + \beta_n (Xn)$$

Where:
Y = dependent variable
X_n = independent variable
K = constant and
βn = coefficient of x.

Models employed

(A) Random walk
(B) Random walk with drift = 301533.
(C) Constant mean = 8.44603E6
(D) Linear trend = -8.86198E8 + 445540. t
(E) Simple moving average of 2 terms
(F) Simple exponential smoothing with alpha = 0.9999
(G) Brown's linear exp. smoothing with alpha = 0.5415
(H) Holt's linear exp. smoothing with alpha = 0.9952 and beta = 0.0588
(I) ARIMA (0,1,0)
(J) ARIMA (1,0,0)
(K) ARIMA (0,1,1)
(L) ARIMA (1,1,0) (M) ARIMA (0,2,1)

5. Results and discussion of findings

Table 4.1: Model Fit for multiple regression analysis

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	-1.92267E6	7.01113E6	-0.274232	0.7918
NDI	0.170287	0.0330478	5.15274	0.0013
POP	0.0777248	0.0672339	1.15604	0.2856
AAF	-690.814	140.624	-4.91247	0.0017
GDP	-0.0321241	0.0205773	-1.56114	0.1625
EX RT	13142.7	11967.4	1.09821	0.3084
TO EXP	1700.9	748.291	2.27305	0.0572
CRUDE PRICE	-308.208	126.112	-2.44392	0.0445

Source: Author

Table 4.2: Analysis of variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	7.16974E13	7	1.02425E13	30.37	0.0001
Residual	2.36066E12	7	3.37237E11		
Total (Corr.)	7.4058E13	14			

Source: Author

R-squared = 96.8124 %
R-squared (for d.f. adjusted) = 93.6248%
Standard Error of Est. = 580721.
Mean absolute error = 345960.
Durbin-Watson statistic = 2.26939 (P=0.2175)
Lag 1 residual autocorrelation = -0.185593

The output in Table 4.1 shows the results of fitting a multiple linear regression model to explain the relationship between NPAX and the 7 independent variables. From the analysis, the R-square statistic shows that the fitted model explains the variability in NPAX, which is 96.8124%. The statistic R^2 adjusted is the most suitable statistic used in comparing the models with different numbers of independent variables, which is 93.6248%. The estimate's standard error indicates the residuals' standard deviation to be 0.580721. The prediction limits for new observations can be constructed using these values. The mean absolute error (MAE) of 345960 is the average residual value. The significant correlation based on the order in which they occur in the data file is determined by testing the residuals with the Durbin-Watson (DW) statistic.

The equation of the fitted model is

NPAX = -1.92267E6 + 0.170287 *NDI + 0.0777248 *POP -690.814*AAF-0.0321241*GDP + 13142.7*EX RT + 1700.9 *TO EXP - 308.208*CRUDE PRICE

The ANOVA table (Table 4.2) shows that the P-value < 0.05 means that the relationship between the variables is significant at a confidence level of 95.0%. Since the P-value > 0.05, there is no indication of serial autocorrelation in the residuals at the 95.0% confidence level. To determine if the model can be simplified, the highest P-value on the independent variables is 0.3084, belonging to EX-RT. Since the P-value is greater or equal to 0.05, that term is not statistically significant at the 95.0% or higher confidence level.

Table 4.3: Correlation matrix for coefficient estimates

	CONSTANT	NDI	POP	AAF	GDP	EX RT	TO EXP	CRUDE PRICE
CONSTANT	1.0000	-0.1450	-0.9807	0.5425	0.4259	-0.0613	0.8152	-0.1086
NDI	-0.1450	1.0000	0.2166	-0.6772	-0.5354	-0.0503	0.1335	-0.5760
POP	-0.9807	0.2166	1.0000	-0.5900	-0.4197	-0.0970	-0.7630	-0.0194
AAF	0.5425	-0.6772	-0.5900	1.0000	0.1708	-0.1979	0.3449	0.1779
GDP	0.4259	-0.5354	-0.4197	0.1708	1.0000	0.1300	0.0044	0.4739
EX RT	-0.0613	-0.0503	-0.0970	-0.1979	0.1300	1.0000	-0.2738	0.5825
TO EXP	0.8152	0.1335	-0.7630	0.3449	0.0044	-0.2738	1.0000	-0.5768
CRUDE PRICE	-0.1086	-0.5760	-0.0194	0.1779	0.4739	0.5825	-0.5768	1.0000

Source: Author

Table 4.3 shows estimated correlations between the coefficients in the fitted model. Serious multi-collinearity can be detected using correlations, i.e., the correlation amongst the predictor variables. The output shows 7 correlations with absolute values > 0.5 (not including the constant term).

Figure 4.1: Plot of NPAX showing observed number of NPAX and Predicted NPAX Residual Plot

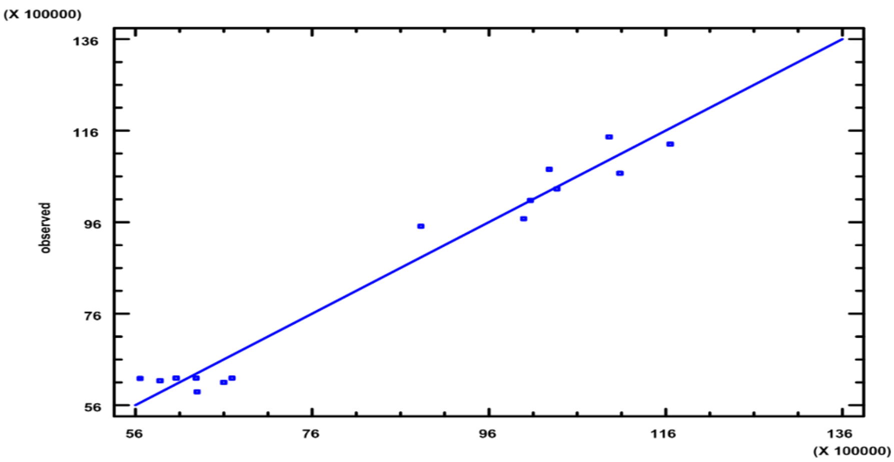


Figure 4.2: Residual Plot showing Standardized residual of NPAX and Predicted NPAX

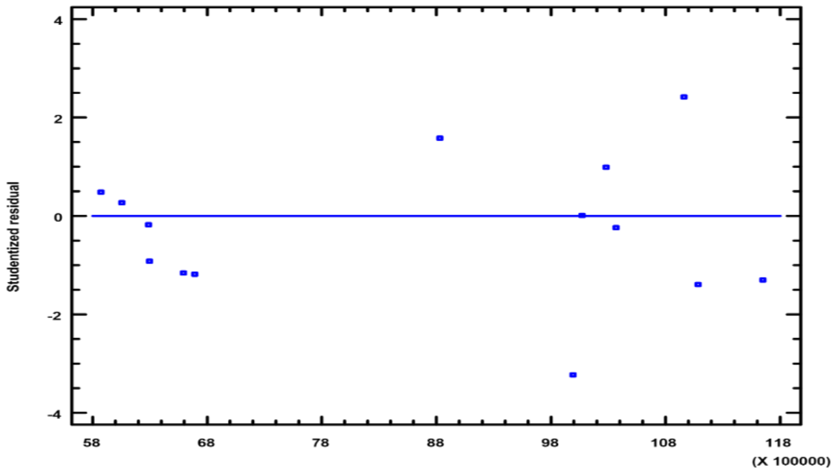


Figure 4.1 and figure 4.2 show the plot of the predicted number of passengers (NPAX) for the observed and residual.

Hypotheses Testing:

H_1: There is no significant relationship between National Disposable Income and domestic air travel demand in Nigeria.

Table 4.1 shows that the P-value calculated is 0.0013, which is less than the P-value of 0.05, thus implying a statistically significant relationship between National Disposable Income and domestic air travel demand in Nigeria. Also, there is a significant positive relationship between National Disposable Income and perceived domestic air travel demand since $P < 0.05$. This implies that the higher the National Disposable Income, the higher the perceived demand for domestic air travel (Nwaogbe et al., 2019) studied the demand for air travel; in their study, they revealed that national disposable income has an excellent statistical relationship with passenger movement. This means that the more citizens' income to dispose of, the more demand for air travel.

H_2: There is no significant relationship between airfare and domestic air travel demand in Nigeria.

Table 4.1 shows that the P-value calculated is 0.0017, which is less than the P-value of 0.05, thus, this means that there is a statistically significant relationship between airfare and domestic air travel demand in Nigeria. Also, there is a significant positive relationship between airfare and perceived domestic air travel demand since $P<0.05$. This implies that the higher the airfare, the higher it affects the demand for domestic air travel (Pius, Nwaogbe, Akerele & Masuku, 2017); in their study states that there is a strong relationship between average airfare and passenger movement; therefore, there is need to work towards maintaining a fare standard to encourage domestic passengers to travel in Nigeria.

H_3: There is no statistically significant relationship between Crude oil price and domestic air travel demand in Nigeria.

Table 4.1 also shows that the p-value for the crude oil price is 0.0445, which is < P-value 0.05; this means that there is a statistically significant relationship between Crude oil price; hence it means that the higher the Crude oil price, the higher the perceived demand for domestic air travel in Nigeria. This study shows that the more the crude oil price increases, it affects the price of the air ticket. This is because when there is a high price of crude oil, it will affect the fare for air travel, passengers will fully react to this because it may cause a hike in the airfare, and that will affect the passenger's demand for air travel, just as it is happening since this 2022. In the country, aviation fuel costs are high, affecting the air transport industry.

Forecasting of variables

Automatic Forecasting – NPAX

Here, we will forecast the future values of NPAX (number of passengers). The period in which the data collected covers is 15 years. Currently, the model selected for forecasting is the random walk model. The model assumes that the last available data value will give the best forecast for future data. Furthermore, the model generated a forecast for the number of passengers in the next 12-year period.

Data variable: NPAX (Passenger)
The observed years = 15
Starting from 2001
An interval of Sampling = one year

Forecast Summary

The selected model for the forecast: Random walk
Years of the generated forecast: 12

Number of years withheld for validation: 0

Table 4.5: Forecast Analysis Summary for NPAX

	Estimation	Validation
Statistic	*Period*	*Period*
RMSE	1.15099E6	
MAE	747019.	
MAPE	7.71356	
ME	301533.	
MPE	2.92624	

Table 4.6: ARIMA Model Summary

Parameter	Estimate	Stnd. Error	t	P-value
AR(1)	0.920379	0.123233	7.4686	0.000005
Mean	1.01182E7	4.44452E6	2.27655	0.040376
Constant	805624.			

Estimated white noise variance = 1.32474E12 with 13 degrees of freedom
Estimated white noise standard deviation = 1.15097E6

Discussion

This procedure will forecast future values of NPAX. The data cover 15 time periods. An autoregressive integrated moving average (ARIMA) model has been selected. This model assumes that the best forecast for future data is given by a parametric model relating the most recent data value to previous data values and previous noise. Each value of NPAX has been adjusted the following way before the model was fit. The output summarizes the statistical significance of the terms in the forecasting model. Terms with P-values less than 0.05 are statistically significantly different from zero at the 95.0% confidence level. The P-value for the AR (1) term is less than 0.05, so it is significantly different from 0. The P-value for the constant term is less than 0.05, so it is significantly different from 0. The estimated standard deviation of the input white noise equals 1.15097E6.

The table summary shows the performance of the model selected in the relevant historical data. It displays:

- the Root Mean Squared Error (RMSE)
- the Mean Absolute Error (MAE)
- the Mean Absolute Percentage Error (MAPE)
- the Mean Error (ME)
- the Mean Percentage Error (MPE)

One-ahead forecast errors were statistically based on, which indicates the differences between the value data at time t and the forecast of that value made at time t-1. The first three statistics measured the magnitude of the errors. The smaller value will give a better model.

The last two statistics measure bias. A better model will give a value close to 0.

Table 4.7: Forecast NPAX Model: ARIMA (1,0,0) with constant

Period	Data	Forecast	Residual
2002	6.10459E6	6.71828E6	-613691.
2003	6.19456E6	6.42416E6	-229600.
2004	6.13403E6	6.50697E6	-372934.
2005	6.18584E6	6.45125E6	-265417.
2006	5.89687E6	6.49894E6	-602068.
2007	6.19406E6	6.23298E6	-38914.9
2008	6.19406E6	6.50651E6	-312444.
2009	9.51374E6	6.50651E6	3.00723E6
2010	1.07537E7	9.56186E6	1.19186E6
2011	1.13032E7	1.07031E7	600094.

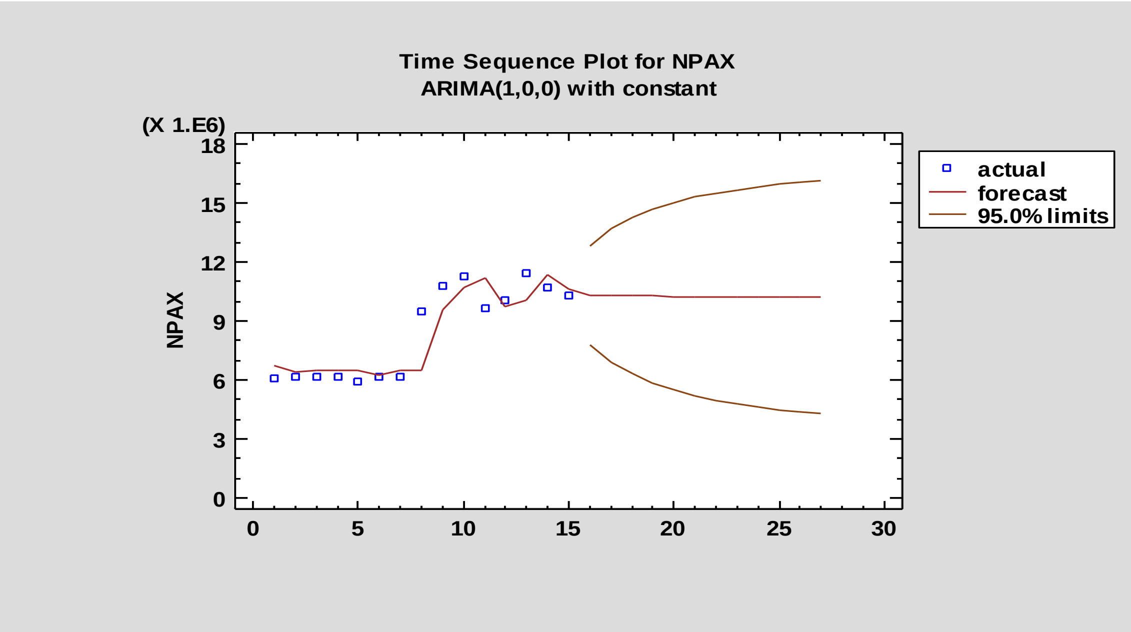
2012	9.67586E6	1.12089E7	-1.533E6
2013	1.00745E7	9.71108E6	363450.
2014	1.14676E7	1.0078E7	1.3896E6
2015	1.06718E7	1.13602E7	-688366.
2016	1.0326E7	1.06277E7	-301664.

Table 4.8: Forecast for NPAX

Period	Forecast	Lower 95% Limit	Upper 95% Limit
2017	1.03095E7	7.82297E6	1.2796E7
2018	1.02943E7	6.91487E6	1.36737E7
2019	1.02802E7	6.29817E6	1.42623E7
2020	1.02673E7	5.83843E6	1.46962E7
2021	1.02555E7	5.48065E6	1.50303E7
2022	1.02445E7	5.19521E6	1.52939E7
2023	1.02345E7	4.96379E6	1.55052E7
2024	1.02252E7	4.77404E6	1.56764E7
2025	1.02167E7	4.61718E6	1.58162E7
2026	1.02088E7	4.48668E6	1.5931E7
2027	1.02016E7	4.37758E6	1.60257E7
2028	1.0195E7	4.28601E6	1.6104E7

The table 4.7 and 4.8 above show the forecasted values for NPAX. When actual data is available, it also displays the predicted values from the fitted model and the residuals (data forecast). For periods beyond the end of the series, it shows 95.0% prediction limits for the forecasts. These limits show where the data value will likely be at a selected future time with 95.0% confidence, assuming the fitted model is appropriate for the data. Figure 4.3 plotted the forecasts by selecting Forecast Plot from the list of graphical options. The graph represents the sequence plot of the actual and forecasted number of passengers' domestic air travel from 2002-2016 and 2017 to 2028. The result also shows the 95% prediction limits for the forecast. The graph shows that there will be a decrease in passenger travel; this may be due to the high average airfare increase from the forecasted result of the study, as shown in Table 4.13b below.

Figure 4.3: Time Sequence plot for Number of Passengers (NPAX) ARIMA (1,0,0) with constant



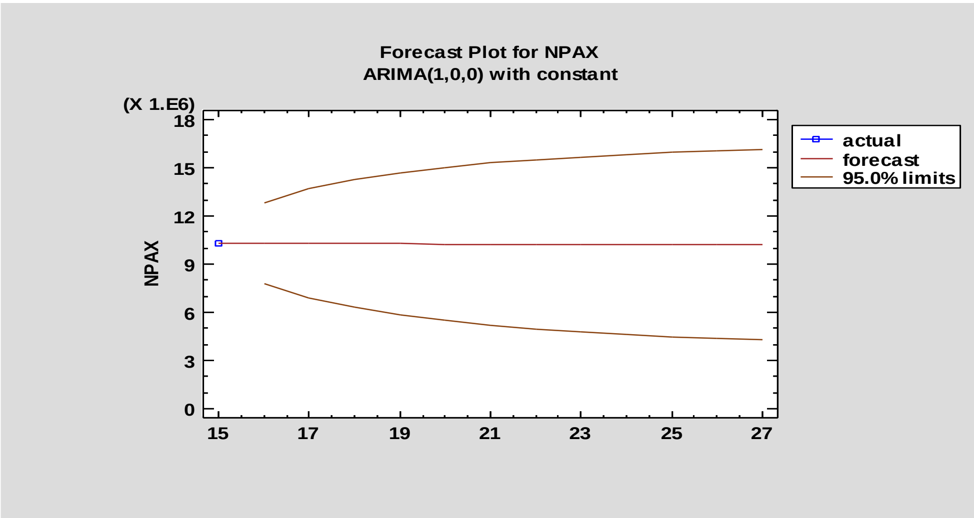
Estimated Autocorrelations for residuals
Data variable: NPAX

Table 4.9: Model: ARIMA (1,0,0) with constant

Lag	Autocorrelation	Stnd. Error	Lower 95.0% Prob. Limit	Upper 95.0% Prob. Limit
1	0.112458	0.258199	-0.506061	0.506061
2	-0.165391	0.261444	-0.512422	0.512422
3	-0.258968	0.268328	-0.525915	0.525915
4	0.116081	0.284503	-0.557617	0.557617
5	0.0532351	0.287643	-0.563772	0.563772

Table 4.9 shows the estimated autocorrelations between the residuals at various lags. The lag k autocorrelation coefficient measures the correlation between the residuals at time t and time t-k. Also shown are 95.0% probability limits around 0. If the probability limits at a particular lag do not contain the estimated coefficient, there is a statistically significant correlation at that lag at the 95.0% confidence level. None of the 24 autocorrelations coefficients are statistically significant in this case, implying that the time series may be completely random (white noise). The plot of autocorrelation coefficients by selecting the Residual Autocorrelation Function is graphically represented in Figure 4.4 below.

Figure 4.4: Forecast plot for Number of Passenger (NPAX) ARIMA (1,0,0) with constant



Data variable: NPAX
Model: ARIMA (1,0,0) with constant

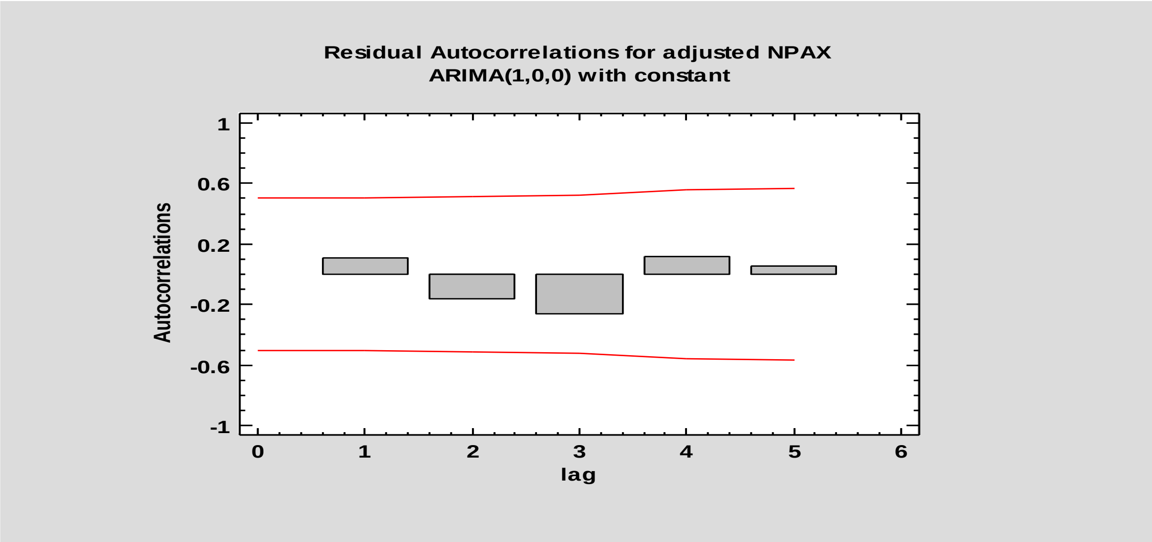
Table 4.10: Estimated Partial Autocorrelations for residuals

Lag	Partial Autocorrelation	Stnd. Error	Lower 95.0% Prob. Limit	Upper 95.0% Prob. Limit
1	0.112458	0.258199	-0.506061	0.506061
2	-0.180318	0.258199	-0.506061	0.506061
3	-0.22689	0.258199	-0.506061	0.506061
4	0.155102	0.258199	-0.506061	0.506061
5	-0.0584622	0.258199	-0.506061	0.506061

Table 4.10 shows the estimated partial autocorrelations between the residuals at various lags. The lag k partial autocorrelation coefficient measures the correlation between the residuals at time t and time t+k, having accounted for the correlations at all lower lags. It can be used to judge the order of the auto-regress model needed to fit the data. Also shown are 95.0% probability limits around 0. If the probability limits at a particular lag do not contain the estimated coefficient, there is a statistically significant correlation at that lag at the 95.0% confidence level. None of the 24 partial autocorrelations

coefficients is statistically significant at the 95.0% confidence level. The plot of partial autocorrelation coefficients by selecting the Partial Autocorrelation Function is shown Graphically below.

Figure 4.4: Residual Autocorrelation for adjusted Number of Passenger ARIMA (1,0,0) with constant



Forecasting Average Air Fare (AAF)
Number of observations = 15
Time indices: Year

Forecast Summary
Forecast model selected: ARIMA (1,0,0) with constant
Number of forecasts generated: 12

Table 4.11: Forecast Summary

Statistic	Estimation Period	Validation Period
RMSE	2976.38	
MAE	1726.47	
MAPE	9.8766	
ME	474.606	
MPE	0.0861443	

Table 4.12: ARIMA Model Summary

Parameter	Estimate	Stnd. Error	t	P-value
AR (1)	0.994085	0.102897	9.66099	0.000000
Mean	178463.	2.88556E6	0.0618471	0.951625
Constant	1055.62			

Estimated white noise variance = 9.1718E6 with 13 degrees of freedom
Estimated white noise standard deviation = 3028.5

The result of the forecast shows the future values of AAF. The data cover 15 time periods. An autoregressive integrated moving average (ARIMA) model has been selected. This model assumes that the best forecast for future data is given by a parametric model relating the most recent data value to previous data values and previous noise. Each value of AAF has been adjusted in the following way before the model was fit:

The output result summarizes the statistical significance of the terms in the forecasting model. Terms with P-values less than 0.05 are statistically significantly different from zero at the 95.0%

confidence level. The P-value for the AR (1) term is less than 0.05, so it is significantly different from 0. The P-value for the constant term is greater than or equal to 0.05, so it is not statistically significant. The estimated standard deviation of the input white noise equals 3028.5.

Table 4.11 summarizes the performance of the currently selected model in fitting the historical data. The result shows the:

(1) the root mean squared error (RMSE)
(2) the mean absolute error (MAE)
(3) the mean absolute percentage error (MAPE)
(4) the mean error (ME)
(5) the mean percentage error (MPE)

Each statistic is based on the one-ahead forecast errors, which are the differences between the data value at time t and the forecast of that value made at time t-1. The first three statistics measure the magnitude of the errors. A better model will give a smaller value. The last two statistics measure bias. A better model will give a value close to 0.

Table 4.13a: Forecast Table for AAF Model: ARIMA (1,0,0) with constant

Period	Data	Forecast	Residual
2002	7900.0	9911.82	-2011.82
2003	9500.0	8908.89	591.108
2004	11200.0	10499.4	700.573
2005	12000.0	12189.4	-189.372
2006	12200.0	12984.6	-784.64
2007	13600.0	13183.5	416.543
2008	14000.0	14575.2	-575.176
2009	14200.0	14972.8	-772.81
2010	15000.0	15171.6	-171.627
2011	13500.0	15966.9	-2466.89
2012	23500.0	14475.8	9024.23
2013	22000.0	24416.6	-2416.62
2014	25800.0	22925.5	2874.51
2015	27000.0	26703.0	296.988
2016	30500.0	27895.9	2604.09

Table 4.13b: Forecast for AAF Model: ARIMA (1,0,0) with constant

Period	Forecast	Lower 95% Limit	Upper 95% Limit
2017	31375.2	24832.5	37917.9
2018	32245.2	23019.8	41470.7
2019	33110.1	21844.6	44375.6
2020	33969.9	20999.9	46939.9
2021	34824.6	20366.2	49282.9
2022	35674.2	19882.3	51466.2
2023	36518.8	19511.5	53526.2
2024	37358.4	19229.9	55487.0
2025	38193.1	19020.8	57365.3
2026	39022.8	18872.2	59173.4
2027	39847.6	18774.8	60920.4
2028	40667.5	18721.4	62613.7

The Eable 4.13a and 4.13b show the forecasted values for AAF. When actual data is available, it also displays the predicted values from the fitted model and the residuals (data forecast). For periods beyond the end of the series, it shows 95.0% prediction limits for the forecasts. These limits show where the data value will likely be at a selected future time with 95.0% confidence, assuming the fitted model is appropriate for the data. The forecasts were plotted by selecting Forecast Plot from the list of graphical options. The plot shows the forecast and the 95% confidence intervals.

Figure 4.5: Time sequence plot for AAFARIMA (1,0,0) with constant

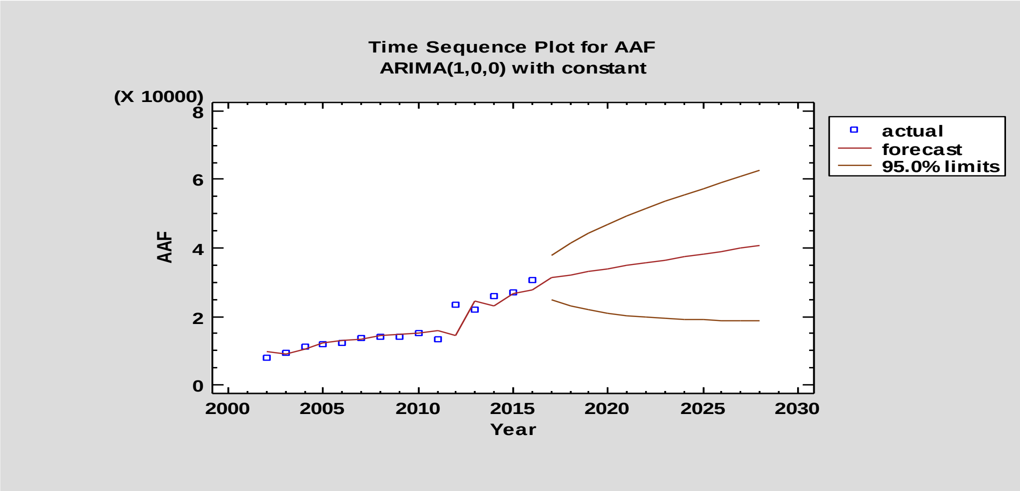


Figure 4.5 shows the forecast plot of ARIMA (1, 0, 0) of the average airfare of Nigeria air travel from 2017 to 2028. The graph shows the confidence interval's actual, forecast, and 95% limit. From the graph, understand that from 2016 the airfare of Nigeria's domestic air travel starts increasing without going down till the year 2028. The graph shows the presence of linearity in the airfare of domestic air travel in Nigeria.

Model Comparison
Data variable: AAF
Number of observations = 15
Models
(A) ARIMA (1,0,0) with constant
(B) Constant mean = 16793.3
(C) S-curve trend = exp (9.91737 + -1.20507 /t)
(D) Simple moving average of 3 terms
(E) Simple exponential smoothing with alpha = 0.9999
Math adjustment:

Table 4.14a: Estimation period

Model	RMSE	MAE	MAPE	ME	MPE
(A)	2976.38	1726.47	9.8766	474.606	0.0861443
(B)	7028.97	5977.78	38.9857	2.18279E-12	-16.338
(C)	5516.01	4368.96	24.8213	737.762	-3.42893
(D)	4107.94	3227.78	15.7868	3077.78	14.6757
(E)	3179.8	1906.66	10.0902	1506.78	7.70006

Table 4.14b: Estimation Period

Model	RMSE	RUNS	RUNM	AUTO	MEAN	VAR
(A)	2976.38	OK	OK	OK	OK	**
(B)	7028.97	**	OK	*	**	*
(C)	5516.01	OK	*	*	*	*
(D)	4107.94	OK	*	OK	OK	OK
(E)	3179.8	OK	OK	OK	OK	***

Key:
RMSE = Root Mean Squared Error
RUNS = Test for excessive runs up and down

RUNM = Test for excessive runs above and below the median
AUTO = Ljung-Box test for excessive autocorrelation
MEAN = Test for difference in mean 1st half to 2nd half
VAR = Test for difference in variance 1st half to 2nd half
OK = not significant (p >= 0.05)
* = marginally significant (0.01 < p <= 0.05)
** = significant (0.001 < p <= 0.01)
*** = highly significant (p <= 0.001)

The table 4.14a and 4.14b compare the results of five different forecasting models. Looking at the error statistics, the model with the smallest root mean squared error (RMSE) during the estimation period is model A. The model with the smallest mean absolute error (MAE) is model A. The model with the most minor mean absolute percentage error (MAPE) is model A.

Table 4.14b also summarizes the results of five tests run on the residuals to determine whether each model is adequate for the data. An OK means that the model passes the test. One * means that it fails at the 95% confidence level. Two *'s means that it fails at the 99% confidence level. Three *'s means that it fails at the 99.9% confidence level. Note that the currently selected model, model A, passed 4 tests.

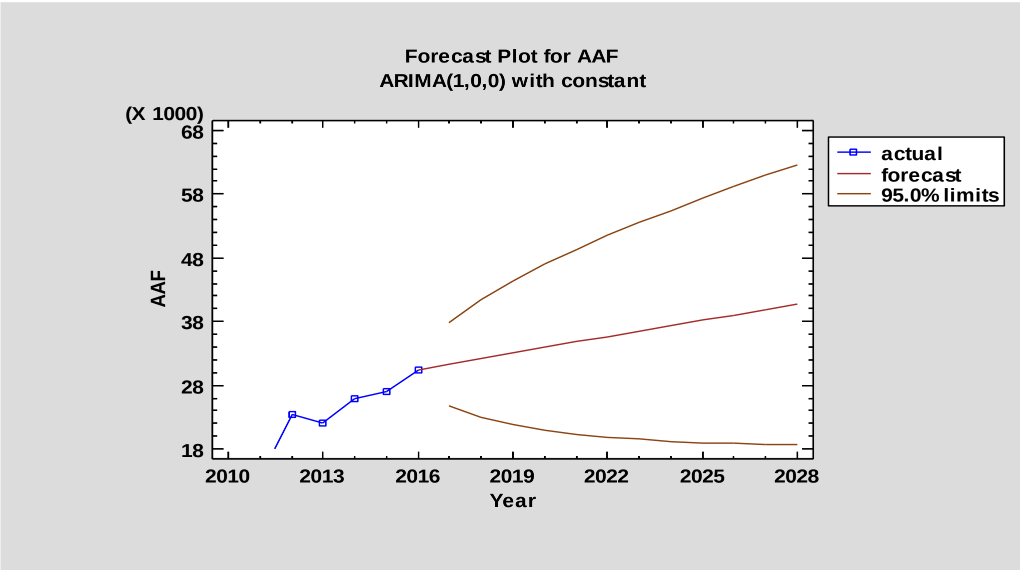
Estimated Autocorrelations for residuals

Table 4.15: AAF Model: ARIMA (1,0,0) with constant

Lag	Autocorrelation	Stnd. Error	Lower 95.0% Prob. Limit	Upper 95.0% Prob. Limit
1	-0.474455	0.258199	-0.506061	0.506061
2	0.303962	0.310936	-0.609424	0.609424
3	-0.148917	0.330152	-0.647086	0.647086
4	0.147684	0.3346	-0.655804	0.655804
5	-0.0244277	0.338917	-0.664267	0.664267

Table 4.15 shows the estimated autocorrelations between the residuals at various lags. The lag k autocorrelation coefficient measures the correlation between the residuals at time t and time t-k. The result also shows that there are 95.0% probability limits around 0. If the probability limits at a particular lag do not contain the estimated coefficient, there is a statistically significant correlation at that lag at the 95.0% confidence level. None of the 24 autocorrelations coefficients are statistically significant in this case, implying that the time series may be completely random (white noise). The graph below shows the autocorrelation coefficients plotted by selecting the Residual Autocorrelation Function.

Figure 4.6: Forecast Plot for AAF ARIMA (1,0,0) with constant



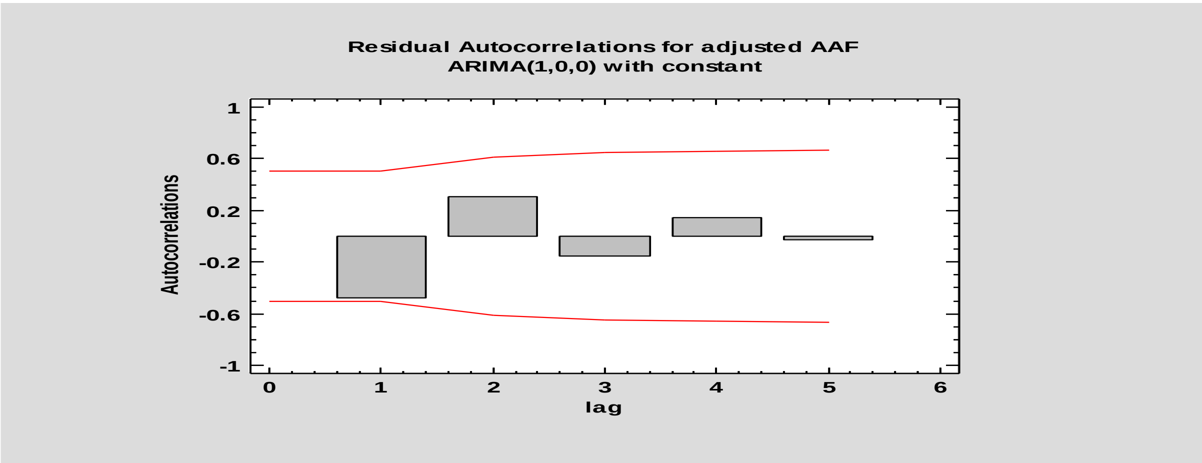
Estimated Partial Autocorrelations for residuals

Table 4.16: AAF Model: ARIMA (1,0,0) with constant

Lag	Partial Autocorrelation	Stnd. Error	Lower 95.0% Prob. Limit	Upper 95.0% Prob. Limit
1	-0.474455	0.258199	-0.506061	0.506061
2	0.101762	0.258199	-0.506061	0.506061
3	0.0376922	0.258199	-0.506061	0.506061
4	0.0858173	0.258199	-0.506061	0.506061
5	0.0968749	0.258199	-0.506061	0.506061

Table 4.16 above shows the estimated partial autocorrelations between the residuals at various lags. The lag k partial autocorrelation coefficient measures the correlation between the residuals at time t and time t+k, having accounted for the correlations at all lower lags. It can be used to judge the order of the autoregressive models needed to fit the data. Moreso, the result shows 95.0% probability limits around 0. If the probability limits at a particular lag do not contain the estimated coefficient, there is a statistically significant correlation at that lag at the 95.0% confidence level. None of the 24 partial autocorrelations coefficients is statistically significant at the 95.0% confidence level. Figure 4.7 below shows the plot of partial autocorrelation coefficients by selecting the Partial Autocorrelation Function.

Figure 4.7: Residual Autocorrelation for Adjusted AAF ARIMA (1,0,0) with constant



Conclusion

This study forecasts the domestic passenger air travel demand in Nigeria from 2017 to 2028, based on the data from 2002 to 2016. The analysis shows a statistically significant relationship between the demand and seven explanatory variables, with an adjusted R square of 93.624%. Three of these variables - National Disposable Income, Average Airfares, and Crude Oil Price - have a very significant impact on the demand, according to the hypothesis test. The p-values for these variables are 0.0013, 0.0017, and 0.0445, respectively, indicating that higher values of these variables lead to higher demand for domestic air travel in Nigeria. The study recommends that the aviation industry should upgrade the country's air transportation infrastructure to cope with the increasing demand for domestic flights. The study also predicts that a large number of passengers will travel by air transport in the next 12 years.

The study also forecasts that the average flight fare for domestic travel in Nigeria will be high from 2017 to 2028 due to the sharp increase in crude oil and aviation fuel prices. The cost of air travel in the country is rising because aviation fuel is imported rather than refined domestically. The study projects the number of passengers and the average flight fare for the next 12 years. Based on these projections, the study advises the government to develop or expand the aviation industry infrastructure and terminal capabilities to accommodate the growing demand for domestic air travel in the country. The study also recommends that the government establish a pricing regulation committee to regulate the airfare charges and provide passengers with affordable and stable airfare. Moreover, the study suggests that the government should consider refining aviation fuel locally to reduce the cost for airline operators. The study urges domestic airline operators to improve their operations and services to meet the increasing demand for domestic air travel in the country.

Citation information

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