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Determinants of domestic air travel demand in Nigeria: cointegration and causality analysis

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Abstract Air transportation is an important factor of development as it facilitates movements within a country and connects the country with other parts of the world. This paper examines the causal relationship between economic variables—Gross Domestic Product per capita (GDP), index of agricultural production, index of manufacturing production and consumer price index—and domestic air travel demand in Nigeria. Annual data for the period 1982–2005, autoregressive distributed lag cointegration approach and Granger short- and long-run causality tests are employed. The results indicate that Gross Domestic Product (GDP) and index of manufacturing production are determinants of air travel in the short- and long-run. Air travel increases with economic growth. Short- and long-run uni-directional Granger causality runs from GDP to air travel. The impulse response function indicates that changes in air travel were due to its own shocks and shocks to GDP. Thus, GDP is a crucial factor that influences the growth of air travel. Government and policymakers need to develop local industries, infrastructures and educational institutions that will provide skilled labour as well as improve the relative business and leisure attractiveness of the economy to the global economic environment. Stakeholders need to invest capital in airport expansion and ensure compliance with international safety and environmental standards. Investment in aviation infrastructure facilities is necessary so as to accommodate the projected growth in domestic air travel demand since the country is gradually recovering from economic recession.

Keywords Air travel demand · Cointegration · Causality analysis · Economic growth · Nigeria

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Introduction

Air transportation is an important factor of development as it facilitates movements within a country and connects the country with other parts of the world. It is also an indicator of de
velopment as access to it is correlated with level of economic activity and personal wealth (Alperovich and Machnes 1994). Studies on air travel demand have attracted attention in the literature. This is because analysis of demand of air travel is important for airlines to make long-term plans on fleet management, for airports to develop infrastructure facilities, and reduce risk, for governments to design and implement policies that will foster growth of the aviation sector and the economy.

Several studies have examined the determinants of air travel demand (Ba-fail et al. 2000; Dobruszkes et al. 2011; Graham 2006; Kopsch 2012; Karlaftis 2008; Profillidis and Botzoris 2015; Sivrikaya and Tunç 2013; Valdes 2015). These studies showed that domestic air travel demand is correlated with economic variables. However, accepting the causal association between domestic air travel demand and economic variables without knowing the direction of causation may provide wrong signals to policymakers. The causal link between domestic air travel and economic variables has important implications on future air policies.

Most of the studies that examined air travel demand–economic variables nexus focused on developed countries especially the United States, Australia and United Kingdom with few on developing countries (Wang and Song 2010). These high income countries have matured aviation markets with lower income elasticity (Graham 2006). Very few works have focused on upper middle-income (Marazzo et al. 2010), lower middle-income (Valdes 2015), and low income countries (Hakim and Merkert 2016; Sofany 2016). Since direction of causality could vary across regions due to different spatial, economic, cultural and social characteristics (Mukkala and Tervo 2013), this study will help to determine the direction of causation and correlation between air travel demand and economic variables in Nigeria. The results will highlight the role of aviation industry in economic development in a developing country.

The objective of this paper is to employ cointegration and error-correction modelling to examine the short and long-run relationship between economic variables—Gross Domestic Product per capita (GDP), index of agricultural production, index of manufacturing production and consumer price index—and domestic air travel demand in Nigeria. The result of the causality test will guide policymakers to support investment in aviation if uni-directional causal relationship runs from air travel demand to economic variables. Conversely, if uni-directional causality runs from economic variables to air travel demand, it may be inferred that developing aviation-intensive industries locally and improving the business and leisure attractiveness of the local economy in the global economic environment will lead to an increase in travel and freight needs. Furthermore, if bi-directional causality exists between air travel demand and economic variables, it will be imperative and feasible to develop various sectors of the economy (such as manufacturing industries, trade, telecommunications, tourism and educational institutions) and implement measures that will boost air travel demand at the same time. Understanding the causal relationship between economic variables and domestic air travel demand in Nigeria has policy implications to airlines, airports, government and consumers. It will help policymakers understand the role of air travel demand in the country's economic growth, guide the development and operation of airports and air service regulation, implementation of future air policies such as aviation strategic planning and their links with economic development policies. Airports will be able to make right decisions on provision of infrastructure, fleet management and investments. Inadequate forecasting lead to system congestion, and consequently, increased cost of operations, inefficiency and low service levels experienced by users. Analysis of air travel demand assist airlines in their long-term planning, reduce risks which may lead to major financial difficulties and increase vulnerability to new entrants and competitors. Further, it will aid government in planning the whole system of airspace and infrastructure, construction and expansion of airports in different parts of the country. It is also relevant to customers as demand for air travel play a significant role in the determination of air fares and quality of services provided by airlines.

The Nigerian Airways was established in 1958 with the Nigerian government, Elder Dempstar Lines Limited and British Overseas Airways Corporation as shareholders. The airline became a full-fledged government company (Nigeria Airways Limited) in 1963. The airline provided domestic and international air services since it was the only domestic airline. Initially, high load factor was recorded such that it suffered acute capacity shortage in the 1970s. Overtime, the airline suffered problems including poor management, overstaffing, infrastructural problems, poor finances and huge debt burdens which culminated to flight cancellations, flight delays, and inadequate coverage of the Nigerian airspace. These problems attracted criticisms from users and the regulations were relaxed in 1988 to allow private aircraft operator's entry into scheduled domestic air services. Three private airlines (Okada Air, General Aviation Services, and Kabo Air) were the initial entrants. The deregulation of the airline industry involved increased competition, relaxation of price controls and opening market access for investors (Hassan and Dina 2015). Since the last 3 decades of deregulation, there has been high turnover of domestic carriers although most of them have closed up due to inadequate funds to face the challenges of the industry. Deregulation of the domestic market resulted in increased domestic air travel demand but the number of passengers carried by Nigeria Airways declined while that of the independent airlines increased (Akpoghomeh 1999). Deregulation also led to greater evenness in overall network connectivity of domestic air services (Daramola and Jaja 2011).

Liberalisation policies adopted in the aviation industry include implementation of new civil aviation policy in 2001, review of existing BASAs with African States in line with Yamooussoukro Declaration, privatisation of Nigerian Airways, handling companies and terminal building, and signing of the Open Skies Agreement with the U.S. (Ismaila et al. 2014). Thus, the aviation industry in Nigeria has witnessed developments in airports, infrastructural facilities, institutional framework, airlines, fleet size, passenger and cargo traffic, network connectivity, deregulation of domestic market and implementation of liberalisation policies since it became the responsibility of the Nigerian government. Although air travel demand in Nigeria is low compared with the traffic in developed countries, passenger movement has increased significantly especially in the last 2 decades. According to the Federal Airports Authority of Nigeria (FAAN), domestic air passengers increased by 178% from 5.2 million in 2001 to over 14.5 million in 2016. Since the government is diversifying from oil to other economic activities due to prevailing economic crisis, it is important to determine the factors driving the demand for domestic air travel in the country.

This study is relevant because it contributes to an understanding of causal relationship between domestic air travel demand and economic variables in developing countries with small markets by studying the specific situation in Nigeria. Whereas there are few studies on factors that influence the demand for domestic air travel in African countries (Baikgaki and Daw 2013; Erraitab 2016; Aderamo 2010), there are no robust empirical evidence on the causal relationship between air transport and economic variables in the region. The paper makes three contributions to the existing literature on causal relationship between domestic air travel and economic variables. First, the study examines causal relationship between domestic air travel and economic variables using causality testing within a cointegration and error-correction framework for a country with small aviation market such as Nigeria. Second, an autoregressive distributed lag approach (ARDL) which is a relatively new estimation technique developed by Pesaran et al. (2001), and as yet little used, is applied. The main advantage of the ARDL approach is that short- and long-run dynamics are estimated simultaneously. Third, compared to existing studies which applied ARDL approach to determine cointegration, we go further to test for Granger causality and explain the total forecast error-variance of each of the variables beyond the sample period using decomposition analysis and impulse response functions. Therefore, the paper attempts to examine the following issues: (1) what are the determinants of domestic air travel demand in Nigeria? (2) Does a short- and long-run relationship exist between economic variables and domestic air travel? (3) What is the direction of Granger causality between the series? (4) To what extent are the estimated coefficients stable over time?

The remainder of this paper is organised as follows: Section two presents review of literature on air transport and economic variables. Section three outlines the data and methods used in the study and in Section four empirical findings are discussed. Section five provides conclusions and policy recommendations.

Literature review

Various studies have shown that domestic air travel demand is correlated with economic variables. Dobruszkes et al. (2011) examined the determinants of air traffic volume in the major European urban regions. Homogenous urban and airline data were analysed using multiple regression model. The authors found that GDP, the level of economic decision-power, tourism functions, and the distance from a major air market accounts for the variation in air service. Green (2007) showed that per capita passenger boarding and originations were powerful predictors of population and employment growth in metropolitan areas of United States. Results of time series analysis of domestic air travel in Sweden revealed that air travel demand was fairly elastic to price changes in the short-run and more elastic in the long-run (Kopsch 2012). Ba-fail et al. (2000) analysed the influence of several economic variables on demand for domestic air travel in Saudi Arabia and found that total expenditures and population size significantly influenced domestic air travel. Valdes (2015) noted that income growth was an important determinant of air travel demand. Battersby and Oczkowski (2001) concluded that income, seasonality and substitute price variations determined demand for domestic air travel in Australia.

Although these studies indicate a positive correlation between domestic air travel demand and economic variables, the direction of causation is not clear (Green 2007). This is because results obtained from correlation and regression analyses do not indicate direction of causality. Analysis of the direction of causality guides government in the development and operation of airports and air service regulations (Baker et al. 2015). Researchers have analysed causal relationship using various techniques. Using heterogeneous Time Series Cross Section (TSCS) Granger causality tests based on F-statistics, Van De Vijver et al. (2014) examined causality between trade and air passenger travel to some Asia–Pacific country-pairs. Although the authors did not test for short- and long-run aspects of causal relationships, results showed four causal relationships: independent, air traffic to trade, trade to air traffic and bi-directional relationships across the country-pairs.

Mukkala and Tervo (2013) examined the nature of causal relationship between regional economic growth and air traffic using European level annual data from 86 regions and 13 countries for the period 1991–2010. Results of the Granger causality tests revealed that the causality from air traffic to economic growth in peripheral regions was homogenous compared to core regions. Yao and Yang (2012) examined the influence of economic development—Gross Domestic Product (GDP), industrial structure, population density, openness and ground transportation on air passenger volume and air cargo volume. Panel data of 31 provinces and airports in China for the period 1995–2006 was analysed based on Engel–Granger error correction. Results showed that passenger and cargo volume were related to GDP.

Fernandes and Pacheco (2010) applied Granger causality test to show that there was a uni-directional causal relationship from economic growth (GDP) to domestic air transport demand with a high elasticity in the short term in Brazil. Marazzo et al. (2010) applied Augmented Dickey–Fuller test, Johansen cointegration tests, Vector Error Correction model and Granger causality test to determine the relationship between air transport demand and economic growth (GDP) in Brazil for the period 1966–2006. The results showed that there was a long-run equilibrium relationship between the variables. Impulse-response analysis indicated that a positive change in GDP resulted to a positive reaction of air transport demand. Causality running from GDP to air transport demand was also confirmed.

Chang and Chang (2009) used Augmented Dickey Fuller tests (ADF), Phillips–Perron tests (PP), Johansen cointegration tests, Granger causality tests and Vector Error Correction model (VECM) to explore the relationship between air cargo shipments and economic growth. Data on real GDP and air cargo volume in Taiwan for the period 1974–2006 was analysed. The study revealed a long-run equilibrium and bi-directional causal relationship between air cargo expansion and economic growth.

Previous studies have improved understanding of causal relationship between air travel demand and economic variables. However, most analyses are uni-directional and focus on either short-run dynamics or long-run equilibrium relationships. Simultaneous analysis of the short- and long-run relationship is important as the response of air travel demand to economic growth in the short-run could be different from the long-run process (Chi and Baek 2013).

Few studies have estimated both the short- and long-run relationship between domestic air travel demand and economic variables. Using autoregressive distributed lag approach (ARDL), Chi and Baek (2013) examined the short- and long-run effects of economic growth (per capita disposable income) and market shocks (9/11 terrorist attacks, Iraq war, SARS epidemic and 2008 financial crisis) on air passenger and freight services in the U.S. Monthly data covering the period from January 1996 to March 2011 was analysed. Dickey–Fuller generalised least squares and error–correction model were adopted for empirical analysis. Findings revealed that air passenger and freight services increased with economic growth in the long-run but only passenger service was sensitive to economic growth in the short-run.

Hu et al. (2015) applied a bi-variate panel Vector Error Correction Model (VECM) to analyse both short- and long-run equilibrium and Granger causality relationships between economic growth and domestic air passenger traffic based on quarterly panel data for 29 provinces in China for the period 2006Q1–2012Q3. Heterogeneous panel unit root tests, panel cointegration tests, panel vector error correction model and Granger causality tests were employed. The authors found that real GDP increased with a rise in air passenger traffic. Empirical findings indicated a long-run cointegration and bi-directional Granger causal relationship between the two series. Granger causality running from domestic air passenger traffic to GDP in the short-run was also established.

In order to assess the value of regional aviation, Baker et al. (2015) analysed bi-directional short- and long-run causality between passenger traffic at 88 airports in regional, rural and remote areas and economic growth of regions that surround those airports in Australia. Data on total airport passenger movement and real aggregate taxable income for the period 1985/86–2010/11 was analysed using Granger causality framework. A significant bi-directional relationship between the variables was observed. The authors concluded that economic development strategies should focus on air transport since causality run from air transport to economic growth.

Hakim and Merkert (2016) examined causal relationship between air transport (total air passenger and air freight) and GDP in South Asian countries. The authors applied Pedroni/Johansen cointegration test methods, Granger long-run and Wald short-run causality tests and TSCS Granger causality tests to panel data for the period 1973–2014. Findings revealed a long-run unidirectional Granger causality from GDP to air passenger and air freight volume. Sofany (2016) applied ARDL approach and error correction model to analyse the determinants of domestic air transport demand in Ethiopia. Results showed that population, income and airfare have positive impact on domestic air travel demand.

Empirical findings of causal relationship between economic growth and domestic air travel demand are not conclusive. For example, some studies showed that causality runs from economic variables to air travel demand (Hakim and Merkert 2016; Fernandes and Pacheco 2010; Marazzo et al. 2010; Chi and Baek 2013). Other studies indicate that causality runs from air travel demand to economic variables (Hu et al. 2015). In addition, most of the studies focus mainly on developed countries while studies on low income countries are few. As far as we are aware, there is no empirical analysis of the causal relationship between domestic air passenger traffic and economic variables in Nigeria. This study aims to fill this gap in literature.

Materials and methods

Material

Annual data covering 25 years ranging from 1981 to 2005 was used to investigate the determinants of domestic air travel demand in Nigeria. The analysis was limited to this period due to unavailability of data on some of the explanatory variables. Data on total number of domestic air passengers (PAX) was obtained from the Federal Airport Authority of Nigeria (FAAN). Data on economic variables—Gross Domestic Product per capita (GDP) in constant 2010 (Naira), index of agricultural production (AGR), index of manufacturing production (MCT) and consumer price index (CPI)—were obtained from Central Bank of Nigeria (2007). Airline fare is a measure of service quality but it is difficult to come by in some countries. Alperovich and Machnes (1994) suggest that aggregate CPI can be used as an alternative. CPI is a measure of the average change in the prices of a 'market basket' of consumer goods and services (Choo et al. 2008). Consumer expenses on air travel are included as one of the components of CPI in Nigeria. This is calculated by the Nigerian Bureau of Statistics on a monthly basis. The price index employed makes up both air fares and complementary goods and services but this affects its quality as pricing proxy. However, it has been applied in previous studies (Valdes 2015). All variables were converted to natural logarithms to smooth out large standard deviation across the sample (Chang et al. 2001). Table 1 shows the descriptive analysis of data used for the empirical analysis.

Method

The econometric analysis follows a three-step procedure based on Granger causality framework. Broadly speaking, a variable X is said to Granger cause another

Table 1 Descriptive statistics

	PAX	AGR	MCT	CPI	GDP
Mean	15.17574	4.658400	4.400020	6.272203	30.63559
Median	15.21645	4.810000	4.440296	6.622603	30.62315
Maximum	15.63833	5.230000	4.720283	8.915486	31.25469
Minimum	14.45420	4.030000	3.871201	− 0.916291	30.25419
SD	0.323352	0.406947	0.206189	2.288373	0.281786
Skewness	− 0.382129	− 0.405870	− 1.138818	− 1.154938	0.609559
Kurtosis	2.369387	1.635443	3.957874	4.732800	2.615636
Jarque–Bera	1.022669	2.625977	6.359527	8.685547	1.702069
Probability	0.599695	0.269015	0.041595	0.013000	0.426973
Sum	379.3935	116.4600	110.0005	156.8051	765.8899
Sum sq. dev.	2.509354	3.974536	1.020334	125.6797	1.905678

variable Y if Y is better predicted by using the past values of X (Granger 1969). A regression equation in which Y is regressed on lagged values of Y and lagged values of X can be used to test the null hypothesis that X does not Granger cause Y. The null hypothesis is rejected if one or more of the lagged values of X is significant (Mukkala and Tervo 2013). However, the analysis can lead to spurious causality results if the time series datasets are non –stationary (Yoo and Jung 2005). Hence, as a first step, all the variables were tested for stationarity. Building on Chi and Baek (2013), this study used the Dickey–Fuller generalized least squares (DF-GLS) test to identify the order of integration of the series and potential stationarity.

Secondly, the series (PAX, GDP, MCT, AGR and CPI) were tested for cointegration to examine the existence of long-run relationship based on the results of the unit root tests. In the third step, the direction of the Granger causality between the series was analysed. The type of causality test employed is determined by the results of the cointegration test. If the series are cointegrated of the same order, the vector error correction model (VECM) is applied. But if the series do not have a long-run equilibrium relationship, that is, not cointegrated, the standard Granger causality test—vector autoregressive model (VAR) is applied (Granger 1988). The cumulative sum and cumulative sum of squares tests to the recursive residuals are applied to determine if estimated coefficients are stable over time. Finally, variance decomposition and impulse response functions were estimated to determine the degree of exogeneity of the variables. Microfit 4.1 and Eviews 9 statistical software packages were used for the analyses.

Unit root test

The first step in this study was to determine the order of integration of the variables and the stationarity/non-stationarity of the datasets. A stationary time series is one whose statistical properties such as mean, variance and autocorrelation are all constant over time. Testing for stationarity of a time series is important because the stationarity or otherwise of a series can strongly influence its behaviour and properties. If two variables are trending over time, a regression of one on the other could have a high R^2 even if the variables are unrelated. When the variables are non-stationary, then the assumptions for asymptotic analysis will not be valid and hypothesis about the regression parameters cannot be tested. A non-stationary time series is transformed by differencing it to make it stationary. If a non-stationary series is differenced d times before it becomes stationary, it is said to be integrated of order d, that is, I (d) (Baker et al. 2015).

Conventional unit root tests such as augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests have been shown to have very low power against I(0) alternatives that are close to being I(1). Also, tests that include a constant and trend in the test regression have less power than tests that only include a constant. Elliot, Rothenberg and Stock (1996) proposed an efficient test which modify the Dickey Fuller test using a generalised least square (DF-GLS) rationale. The DF-GLS has the best overall performance in terms of small-sample size and power. When an unknown mean or trend is present, the DF-GLS has better power. The DF-GLS test applied in this study takes the form:

$$\Delta Y_t^d = \pi Y_{t-1}^d + \sum_{j=1}^{p} \psi j \Delta Y_{t-j}^d + \varepsilon_t \quad (1)$$

where p is the lagged difference term, ε_t is the error term, Δ is the difference operator, t refers to the period, and Yt is the series for the variables. The series Yt is detrended to Y_t^d. ΔY_t^d is the first difference of the detrended series with no intercept or time series trend. Using the GLS detrended data, the ADF test regression which omits the deterministic terms is estimated by least squares and t-statistic for testing $\pi = 0$ is computed. The value of p is set such that the error term is serially uncorrelated. The DF-GLS test follows a D–F distribution in the constant case only while the asymptotic distribution differs when constant and trend are included. The null hypothesis that the series contain a unit root, that is, Y_t is I(1) is tested. This implies that H_o: $\phi = 1$ and H_1: $\phi \neq 1$.

Cointegration test

As a second step, all the series (domestic air travel demand, index of agricultural production, index of manufacturing production, consumer price index and Gross Domestic Product) were tested for cointegration with the same order to determine the short- and long-run relationship between the variables. When a linear combination of two or more non-stationary series with the same order of integration are stationary, the series is cointegrated and there exists a long-run equilibrium relationship (Engle and Granger 1987). If there is no cointegration among the variables, then differencing the variables becomes important. Conventional cointegration tests include Engle and Granger (1987), Johansen (1991), Johansen and Juselius 1990). In this paper, the autoregressive distributed lag cointegration approach (ARDL) (Pesaran et al. 2001) was applied.

ARDL has some econometric advantages over single cointegration techniques. First, it can be applied when the order of integration of the variables are I(1), I(0) or a combination of both. Hence, pre-testing problems are avoided. ARDL is more efficient and performs better for small sample sizes than other cointegration methods (Pesaran and Shin 1999). The short and long-run relationships of the model are estimated simultaneously. Endogeneity is not a problem since the model is free of residual correlation; this implies that all variables are assumed to be endogenous. However, ARDL cannot be applied when multiple long-run relationship exist between variables.

The long-run (cointegrating) form of the model employed in this study is as follows:

$$\begin{aligned} \text{In PAX} &= a_0 + a_1 \,\text{In AGR}_t + a_2 \,\text{In MCT}_t \\ &\quad + a_3 \,\text{In CPI}_t + a_4 \,\text{In GDP}_t + \varepsilon_t \end{aligned} \quad (2)$$

where PAX is the domestic air passenger traffic; AG is the index of agricultural production; MCT is the index of manufacturing production; CPI is the consumer price index; GDP is the Gross Domestic Product. In is the natural logarithm transformation and ε_t is the random error term.

The ARDL approach identifies the cointegrating vectors which are reparametrized into error-correction model. This gives the short-run dynamics (first difference variables) and long-run relationship (lagged-level variables) of the variables in a single model. The ARDL cointegration test applied for the analysis of PAX and the explanatory variables in this study is expressed as follows:

$$\begin{aligned} \Delta\text{In PAX}_t &= a_0 + \sum_{i=1}^{p} a_{1i} \Delta \,\text{In PAX}_{t-i} \\ &\quad + \sum_{i=0}^{p} a_{2i} \Delta \,\text{In AGR}_{t-i} + \sum_{i=0}^{p} a_{3i} \Delta \,\text{In MCT}_{t-i} \\ &\quad + \sum_{i=0}^{p} a_{4i} \Delta \,\text{In CPI}_{t-i} + \sum_{i=0}^{p} a_{5i} \Delta \,\text{In GDP}_{t-i} \\ &\quad + a6 \,\text{In PAX}_{t-1} + a7 \,\text{In AGR}_{t-1} \\ &\quad + a8 \,\text{In MCT}_{t-1} + a9 \,\text{In CPI}_{t-1} \\ &\quad + a10 \,\text{In GDP}_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

where Δ is the difference operator, p is maximum lag order, t refers to the period (t = 1,…T), coefficients of the lagged level terms (a_6, a_7, a_8, a_9, a_{10}) represent long- run relationships, while the coefficients following the summation signs (a_1, a_2, a_3, a_4, a_5) represent the short-run relationship. The short-run dynamics (first differenced variables) and the long-run equilibrium relationship (lagged level variables) are included in Eq. (3). According to Pesaran et al. (2001), the variables are cointegrated if all the lagged-level variables are jointly significant in the equation. The bound test is based on the F or Wald statistics. F-statistic was used to test the hypothesis that the coefficients of the lagged variables are zero:

H_0 $a_6 = a_7 = a_8 = a_9 = a_{10} = 0$ (long-run relationship do not exist)
H_1 $a_6 \neq a_7 \neq a_8 \neq a_9 \neq a_{10} \neq 0$ (long-run relationship exist)

Pesaran et al. (2001) tabulated two sets of critical values of the F-test. A lower critical bound which assumes all the variables are I(0)—no cointegration among the variables, and an upper bound which assumes that the variables are I(1)–cointegration exists. However, these critical values cannot be applied for small sample sizes (Narayan 2005). Another set of critical values was proposed: 2.496–3.346, 2.902–3.910 and 4.068–5.250 at 90, 95 and 99% significance level respectively. If the computed F-statistic is greater than the upper bound of the critical value, the variables are cointegrated, then, H_0 is rejected. If the F-statistic falls within the upper and lower bound, the test is inconclusive. Also, if the F-statistic is below the lower bound of the critical value, there is no cointegration among the variables. If a log-run relationship is established, the error-correction version of the ARDL is estimated using a lag selection criterion that is appropriate.

The error-correction model (ECM) of Eq. (3) is estimated by the ARDL approach to determine the short-run dynamics among the variables. The ECM is formulated as follows:

$$\begin{aligned}\Delta \,\mathrm{In\,PAX_t} &= \mathrm{b_0} + \sum_{\mathrm{i=1}}^{p} b_{1\mathrm{i}}\,\Delta\,\mathrm{In\,PAX_{t-i}} \\ &+ \sum_{\mathrm{i=0}}^{p} b_2\,\Delta\,\mathrm{In\,AGR_{t-i}} + \sum_{\mathrm{i=0}}^{p} b_3\,\Delta\,\mathrm{In\,MCT\,t-i} \\ &+ \sum_{\mathrm{i=0}}^{p} b_{4\mathrm{i}}\,\Delta\,\mathrm{CPI_{t-i}} + \sum_{\mathrm{i=0}}^{p} b_{5\mathrm{i}}\,\Delta\,\mathrm{In\,GDP\,t-i} \\ &+ \lambda \mathrm{EC_{t-1}} + \mu_\mathrm{t}\end{aligned} \quad (4)$$

where λ is the speed of adjustment parameter or feedback effect and EC is the residuals obtained from the estimated cointegration model (Eq. 1).

Parameter stability

Estimated parameters of a time series may vary over time, resulting in model misspecification and the result may become bias (Hansen 1992). The stability of the long-run coefficients are tested using the short-run dynamics. After the ECM is estimated, the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares (CUSUMSQ) tests developed by Brown et al. (1975) is employed to determine if estimated coefficients are stable over time as suggested by Pesaran and Pesaran (1997).

Granger causality test

Granger causality exist in at least one direction if cointegration relationship exist among the variables and they are integrated order of one (Engle and Granger 1987; Granger 1988). The standard Granger causality test in the vector autoregressive (VAR) model is applied if cointegration test reveals that the variables are not cointegrated. However, if the test shows the existence of cointegration, the vector error-correction model (VECM) is estimated. A Granger causality test which involves specifying a multivariate *p*th order of VECM is formulated as follows:

$$\begin{bmatrix}\Delta\mathrm{In\,PAX_t}\\ \Delta\mathrm{In\,AG_t}\\ \Delta\mathrm{In\,MCT_t}\\ \Delta\mathrm{In\,CPI_t}\\ \Delta\mathrm{In\,GDP_t}\end{bmatrix} = \begin{bmatrix}a_1\\a_2\\a_3\\a_4\\a_5\end{bmatrix} + \sum_{\mathrm{i=1}}^{\mathrm{p}} \begin{bmatrix}\beta_{11i}&\beta_{12i}&\beta_{13i}&\beta_{14i}&\beta_{15i}\\ \beta_{21i}&\beta_{22i}&\beta_{23i}&\beta_{24i}&\beta_{25i}\\ \beta_{31i}&\beta_{32i}&\beta_{33i}&\beta_{34i}&\beta_{35i}\\ \beta_{41i}&\beta_{42i}&\beta_{43i}&\beta_{44i}&\beta_{45i}\\ \beta_{51i}&\beta_{52i}&\beta_{53i}&\beta_{54i}&\beta_{55i}\end{bmatrix} \begin{bmatrix}\Delta\mathrm{In\,PAX_{t-1}}\\ \Delta\mathrm{In\,AG_{t-1}}\\ \Delta\mathrm{In\,MCT_{t-1}}\\ \Delta\mathrm{In\,CPI_{t-1}}\\ \Delta\mathrm{In\,GDP_{t-1}}\end{bmatrix} + \begin{bmatrix}\lambda_1\\ \lambda_2\\ \lambda_3\\ \lambda_4\\ \lambda_5\end{bmatrix}\mathrm{ECT_{t-1}} + \begin{bmatrix}\omega_{1t}\\ \omega_{2t}\\ \omega_{3t}\\ \omega_{4t}\\ \omega_{5t}\end{bmatrix} \quad (5)$$

In addition to the variables defined above, $\mathrm{ECT_{t-1}}$ is the lagged error—correction term derived from the long-run cointegration relationship. It is not included in Eq. (5) if the variables are not cointegrated. The optimal lag length *p* is based on the Schwarz Bayesian Criterion.

Impulse response functions and variance decomposition analysis

Impulse response functions and forecast error variance decomposition analysis of the variables were examined to determine the degree of exogeneity of the variables beyond the sample period. These analyses aid the interpretation of the VAR/VECM model. Impulse response function shows the effects of shocks on the adjustment path of the variables. It traces the effect of one-time shock to one of the innovations on current and future values of endogenous variables. Variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR such that the relative importance of each random innovation is assessed (Rees 2011).

Results and discussion

As a first step, unit root tests using the Dickey–Fuller generalised least squares (DF-GLS) test was conducted to determine the stationarity of the series if they are integrated of the same order. The DF-GLS test results to the level and first difference of the variables is presented in Table 2.

The DF-GLS unit root result indicate that the null hypothesis for the level values of PAX and CPI can be rejected at 5 and 10% significance levels while the null hypothesis for the level series of MCT, AGR, and GDP cannot be rejected. This implies that PAX and CPI series are stationary I(0) process. All the other series are non-stationary in level value. However, all the data series are stationary when the first differences are taken at both intercept and intercept with trend specifications. This suggests that the null hypothesis for the first differences of the series PAX, MCT, CPI, AGR, and GDP can be rejected and the series are integrated order of one I(1). We can conclude that all the variables are integrated series with either I(0) or I(1) and ARDL modelling can be conducted on Eq. (2).

The first stage of the ARDL cointegration test involved the determination of the lag order. To achieve this, the Schwarz Bayesian Criterion (SBC) was used. Pesaran and Shin (1999) noted that the SBC is preferred to other criteria because it defines more parsimonious specifications and performs better. Due to the small sample used in the study (24 observations) the SBC was employed. The result indicates that the maximum number of lag in the ARDL model was one. The F-test was applied to Eq. (2) to test the existence of a long-run relationship among the variables in the model and determine the joint significance of lagged-level variables. To determine whether multiple long-run relationship exist among the variables, Eq. (2) was estimated four more times. In each case, one of the explanatory variables was used to replace the dependent variable in search of possible long-run relationship in any other form beside the form specified in Eq. (2).

Results of the F tests presented in Table 3 shows that $F_{PAX} = 4.9475$, $F_{AGR} = 1.5582$, $F_{MCT} = 0.5842$, $F_{CPI} = 0.8549$ and $F_{GDP} = 0.7585$. Thus, the only plausible long-run relationship is that in which InPAX is the dependent variable since F statistic (4.9475) is above the upper bound critical value of 4.8343 at 10 percent significance level. Consequently, the null hypothesis of no cointegration ($a6 = a7 = a8 = a9 = a10 = 0$) in Eq. (3) cannot be accepted.

Results of diagnostic tests based on Lagrange multiplier test for the ARDL regression when InPAX is the dependent variable shows that the Chi-square values for serial correlation is 0.39019 ($p = 0.532$), functional form is 0.59006 ($p = 0.442$), normality is 1.6196 ($p = 0.445$) and heteroscedasticity is 3.6867 ($p = 0.068$). All the tests are insignificant, so, we can assume that there is no issue with the model.

The lagged error-correction term (EC_{t-1}) was obtained to further confirm if a long-run relationship

Table 2 Result of the unit root tests

Variables	Deterministic	Level	First difference
PAX	Individual intercept	− 2.15**	− 2.66***
	Individual intercept and trend	− 2.72***	− 3.42***
AGR	Individual intercept	− 0.08	− 4.46***
	Individual intercept and trend	− 1.46	− 4.50***
MCT	Individual intercept	− 1.91	− 4.04***
	Individual intercept and trend	− 2.29***	− 5.75***
CPI	Individual intercept	− 2.34**	− 7.82***
	Individual intercept and trend	− 4.69***	− 7.82***
GDP	Individual intercept	0.12	− 2.70***
	Individual intercept and trend	− 2.02**	− 3.51***

t statistics reported. Lag length based on Schwarz infomation criterion (SIC)

Significance level: *10%, **5%, ***1%

Table 3 F statistics from ARDL cointegration tests

Calculated F statistic	Critical value bound of the F statistic			
	95% level		90% level	
	I(0)	I(1)	I(0)	I(1)
	4.4822	5.8313	3.6583	4.8343
F(InPAX ∣ InAG, InMCT, InCPI, InGDP) = 4.9475*				
F(InAG ∣ InPAX, InMCT, InCPI, InGDP) = 1.5582				
F(InMCT ∣ InPAX, InAG, InMCT, InCPI, InGDP) = 0.5842				
F(InCPI ∣ InPAX, InAG, InMCT, InGDP) = 0.8549				
F(InGDP ∣ InPAX, InAG, InMCT, InCPI) = 0.75851				

*Denotes significance at the 10% level. Critical values with intercept and trend, F statistics based on Schwarz Bayesian criterion

(cointegration) exist among the variables when In PAX is the dependent variable. This is necessary since the result of the F-test is sensitive to changes in lag structure. Conitegration relationship exists if EC_{t-1} is significant and negatively associated with the dependent variable (Chi and Baek 2013). Results showed that the error-correction term is negative and significantly associated with PAX. With a coefficient of − 0.614, shocked convergence equilibrium is rapid. This implies that a deviation from the equilibrium level of air travel during the current period will be corrected by 61 percent in the next period.

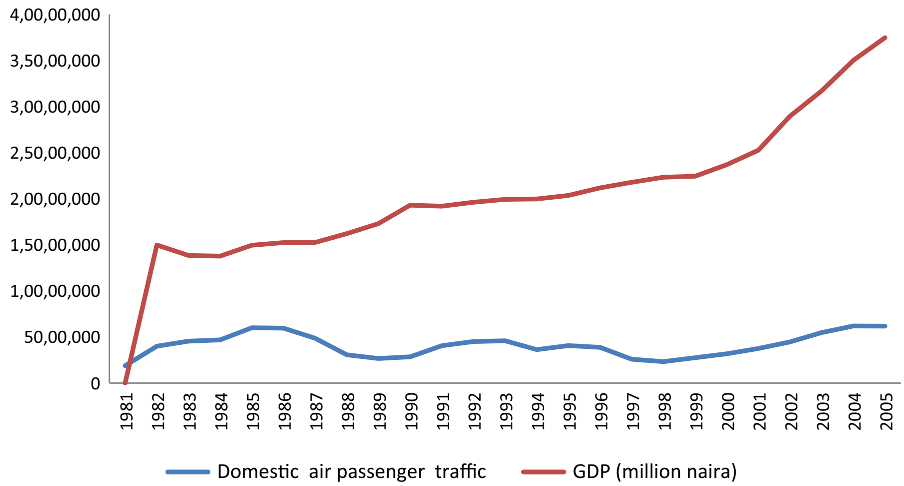
In the next stage of the ARDL cointegration test, the long-run coefficient of Eq. (3) is estimated and the results are presented in Table 4. The SBC lag specification for Eq. 3 is ARDL (1, 0, 0, 0, and 0). Each number represents the lags for each of the variables in the equation. The long-run coefficient of the variables shown in Table 4 indicates that in the long-run, GDP has a very positive significant effect on domestic air travel demand. A 1% increase in GDP leads to 3.18% increase in domestic air travel demand. This suggests that economic growth in the country is crucial in determining domestic air travel demand. This is similar to findings from previous studies (Chi and Baek 2013; Hakim and Merkert 2016). Hakim and Merkert (2016) revealed that 1% increase in GDP will result in 1.2% increase in passenger numbers in South Asian countries. Hu et al. (2015) found that 1% increase in GDP appears to cause 1.037% increase in air passenger traffic in China. Chi and Baek (2013) noted that 1% increase in income resulted in 1.37% increase in air passenger service in U.S.A. Compared with results from previous studies; the effect of GDP on growth in domestic passenger volume is high in Nigeria. This can be attributed to several reasons. First, growth of domestic passenger volume in Nigeria is much higher than growth in GDP compared to these countries. For example, GDP per capita increased by approximately 27% while air passenger miles for domestic travel increased by 32% in U.S. during the period 1996–2010 (Chi and Baek 2013). In Nigeria, between 1981 and 2005, domestic air passenger volume increased by 226% while GDP increased by 150% (Fig. 1). Second, high income countries have matured markets characterised by decline in air passenger growth rates. The effective cost of air travel is high thereby decreasing the attractiveness of air travel (Ishutkina and Hansman 2008). In Nigeria, the continued reliance of the economy on air transportation and implementation of airline deregulation and liberalisation stimulates demand and growth of passenger traffic. Whereas high income countries have alternative modes of transport for long distance travel that compete with air transport, the only alternative

Table 4 Long-run coefficient estimates result

Regressor	Coefficient	T- ratio (Probability)
In AG	0.15145	0.18653 (0.854)
InMCT	− 1.0455	− 2.1206 (0.049)**
InCPI	− 0.062459	− 1.4320 (0.170)
InGDP	3.1832	3.17131 (0.006)**

**Significant at 5% level

Fig. 1 Gross domestic product and domestic passenger air travel volume 1981–2005



mode in Nigeria is the road, but its deplorable condition and high accident rates make it unattractive. Hence, air travel demand reaction to GDP is higher in Nigeria since economic growth is playing a more influential role in increasing air transport demand. Generally, growth in air travel demand is higher in developing and emerging countries than developed countries. Yearly revenue passenger kilometre growth from developed markets was + 3.7% and that from emerging and developing markets was + 5.6% as of 2015 (Addepalli et al. 2018).

In addition, index of manufacturing production has a significant but negative effect on domestic air travel such that a 1% increase in index of manufacturing production leads to 1.04% decrease in domestic air travel. The index of manufacturing production declined from 78.9 in 1982 to 48 in 1986 due to collapse in oil prices and high cost of importing raw materials. During this period, domestic air travel increased as a result of high per capita income. The effect of the economic downturn was more pervasive in the manufacturing sector. After this period, air travel demand declined and fluctuated until 2001 due to high airfares occasioned by the Structural Adjustment Programme introduced in 1985 and political instability in the country. Manufacturing production increased between 1987 and 1992 as trade liberalisation policies were implemented and import duties on raw materials and spare parts were reduced. After 1992, manufacturing production declined till 2005 while air travel increased from 2002 to 2005. Although increase in manufacturing production is expected to cause increase in trade and air travel demand, external factors influence this relationship in Nigeria.

The coefficients of index of agricultural production and consumer price index are not statistically significant. This suggests that these variables do not significantly influence domestic air travel demand in Nigeria.

The short-run dynamics among the variables is estimated using the error-correction model (ECM) derived from the ARDL model (Eq. 4). The result in Table 5 is similar to the finding from the long-run coefficients. Gross Domestic Product is positive and statistically significant at the five percent level. This confirms that economic growth measured by Gross Domestic Product is a fundamental determinant of domestic air travel demand in the short-run in Nigeria. Although the index of manufacturing production is significant, it is negatively associated with domestic air travel in the short-run. Index of agricultural production and consumer price index has little impact on domestic air travel.

Generally, results of the short-and long-run dynamics of the ARDL model indicate that both Gross Domestic Product and index of manufacturing production have short-and long-run impact on domestic air travel demand in Nigeria. This suggests that increasing economic growth will lead to improvement in domestic air travel in the country.

Granger causality test was employed to examine causal relationships between domestic air travel demand and economic variables. Granger causality exists at least in one direction if cointegration exists

Table 5 Short-run coefficients of determinants of domestic air travel (estimates from ECM)

Dependent variable Δ ln PAX		
Regressors	SBC ARDL(1,0,0,0,0) coefficients	Probability
Δ lnAG	0.093070	0.853
Δln MCT	− 0.64247	0.058*
Δln CPI	− 0.038383	0.188
Δln GDP	1.9562	0.002*
Constant	− 0.063010	0.106
EC_{t-1}	− 0.61453	0.000
R-bar squared	0.48782	
F-statistics	4.6511	0.006
DW-statistic	1.7660	
Residual sum of squares	0.53014	

*Significant at $p < 0.05$

among the variables (Engle and Granger 1987; Granger 1988). Since the results above confirmed a cointegrating relationship among the variables, Granger causality test was conducted on Eq. (5). Only the model with passenger traffic as dependent variable was estimated with an error-correction term (VECM model). Other models were estimated based on VAR approach since a long-run relationship was not confirmed for the other vectors. The direction of both long-run and short-run causal relationships of all the variables is presented in Table 6. In the short-run, Chi-square statistics obtained from the application of Wald test on explanatory variables reject the null hypotheses of (i) GDP does not Granger cause PAX and (ii) MCT does not Granger cause CPI. Hence, the result indicates that there is a uni-directional Granger causality running from GDP to domestic air passenger traffic. In the long-run, at the five percent level or better, there is a uni-directional causal relationship which runs from GDP and MCT to domestic passenger traffic. This is similar to previous findings obtained for low income countries (Marazzo et al. 2010). The result further demonstrates that index of agricultural production and consumer price index does not have any causative effect on domestic air travel either in the short-or long-run.

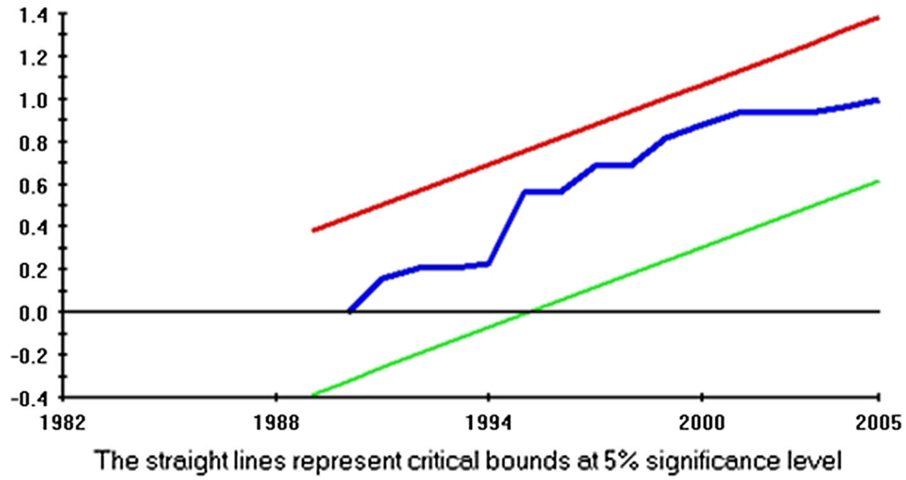
The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) are applied to the residuals of the ECM in Eq. (4) to analyse the stability of the estimated long-run coefficients together with the short-run dynamics. The stability test determines if the estimated coefficients are stable over time. The null hypothesis that the coefficient vector is similar in each year is tested. The plot of the cumulative sum of squares (Fig. 2) and cumulative sum of recursive residuals (Fig. 3) shows that the coefficients are stable over the sample period since the coefficients are within the critical bounds of the 5% significance level. Therefore, there is absence of instability of the

Table 6 Results of Granger causality

Chi-square statistics (probability)						
Dependent variable	Δ ln PAX	Δln AG	Δln MCT	Δ ln CPI	Δln GDP	EC_{t-1} (t statistics)
Δln PAX	–	0.19 (0.85)	− 2.04** (0.05)	− 1.37 (0.18)	3.66*** (0.00)	− 4.42*** (0.00)
Δln AG	0.01 (0.92)	–	1.57 (0.20)	0.49 (0.48)	0.61(0.43)	
Δ ln MCT	0.56 (0.45)	0.08 (0.77)	–	0.08 (0.77)	0.00 (0.95)	
Δ ln CPI	1.36 (0.24)	2.70 (0.10)	5.30** (0.02)	–	1.07(0.30)	
Δln GDP	0.16 (0.68)	0.03 (0.86)	0.06 (0.81)	0.31 (0.57)	–	

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Fig. 2 Plot of cumulative sum of squares of recursive residuals



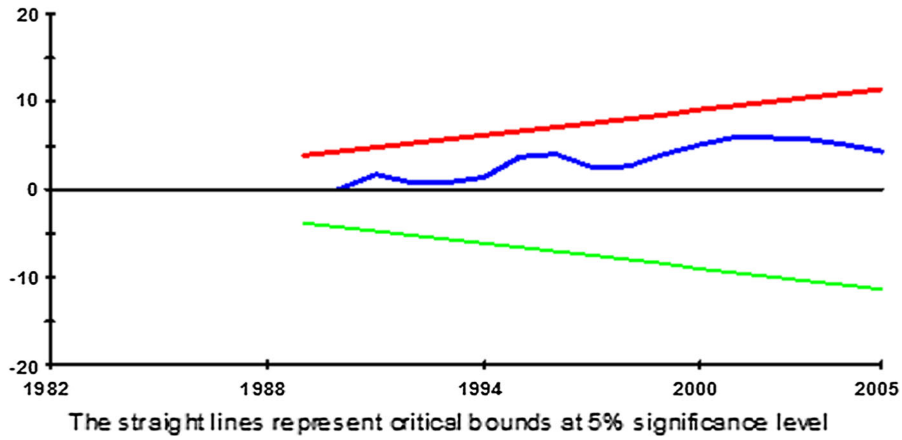


Fig. 3 Plot of cumulative sum of recursive residuals

coefficients in the ARDL equations above. Evidently, the parameters are stable overtime.

Graphic form of impulse response function was employed to investigate the effect of a one-time shock to one of the variables on the variable itself and on the other endogenous variables. The effect of the shock is transmitted through the VECM dynamic structure. Figure 4 shows the impact of one deviation shock and response of the series. Impulse response graphs are snapshots of one time period improvement in the prospective changes in values and changes in a dependent or endogenous variable (Ahmed et al. 2017). Figure 4 depicts the impulse response of domestic air travel demand to shocks in the explanatory variables. A shock on Gross Domestic Product had a positive and increasing effect on air travel throughout the 10 year period. This is consistent with results obtained earlier. Air travel initially reacts negatively to a shock on consumer price index up to the third year, after which a positive but low impact is recorded in subsequent years. However, a shock to manufacturing and agricultural production has a consistently negative effect on air travel for the 10 year period.

Variance decomposition analysis results for a 10 year period are presented in Table 7. Variance decomposition analysis examines the association of the variables with each other. It determines the percentage of a variable's forecast error variance that occurs due to a shock from another variable in the system. For a variable which is truly exogenous to other variables, its own innovations will explain all of its forecast error variance (Narayan and Smyth 2004). The results in Table 7 indicates that air travel and

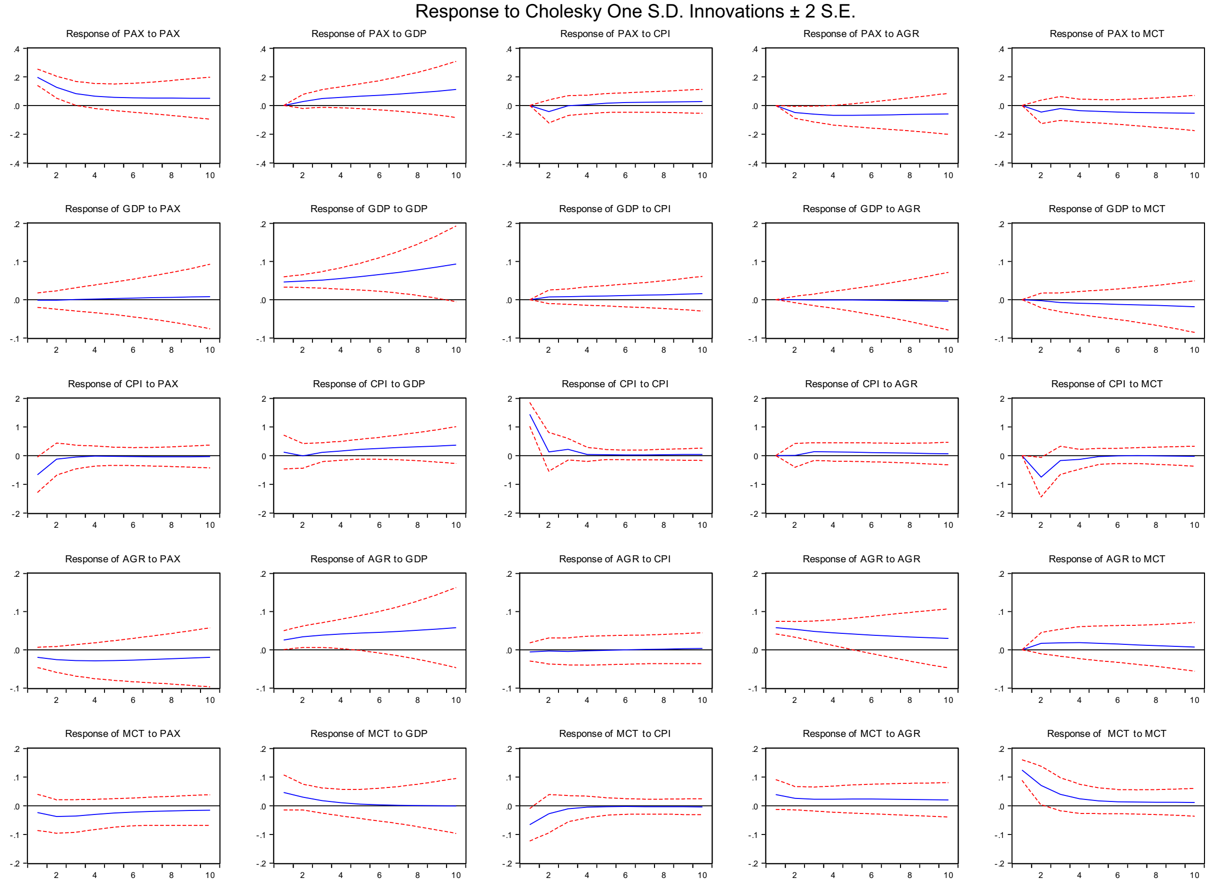


Fig. 4 Graphs of impulse response analysis

Gross Domestic Product were the most exogenous variables in the first year as 100 percent of their shocks are due to their own innovations. However, the contributions of shocks from other variables increased over the years, such that by the end of the 10th year, the forecast error variance explained by their own innovation is 43 and 94% respectively. The forecast error variance for consumer price index, manufacturing and agricultural production are 55%, 52% and 39% respectively. At the end of the 10 year period, the main variable which account for the forecast error variance for air travel besides its own innovations was Gross Domestic Product (27%). The contribution of other variables is very low.

Conclusions

The main contribution of this paper is to improve understanding of the demand for domestic air travel in Nigeria by examining the determinants of domestic air passenger travel during the period 1981–2005. To achieve this purpose, autoregressive distributed lag cointegration approach was employed to examine the short-and long-run relationships between number of domestic air passengers, consumer price index, Gross Domestic Product (GDP), index of manufacturing production and index of agricultural production. The Dickey–Fuller generalised least square test showed that the data series are first difference stationary. Cointegration analysis indicated that the variables are cointegrated when air travel is the dependent variable but are not cointegrated when any of the other variables is the independent variable. Domestic air travel demand is responsive to economic growth in the

Table 7 Result of variance decomposition

Period	PAX	GDP	CPI	AGR	MCT
Variance decomposition of PAX					
1	100.0	0.00	0.00	0.00	0.00
2	88.93	1.20	2.81	3.75	3.30
3	82.36	4.15	2.31	7.90	3.28
4	74.78	7.15	2.01	11.9	4.19
5	67.84	10.2	2.01	14.8	5.18
6	61.69	13.2	2.11	16.7	6.29
7	56.30	16.4	2.27	17.8	7.27
8	51.49	19.7	2.42	18.2	8.09
9	47.13	23.3	2.57	18.3	8.73
10	43.09	27.1	2.69	17.9	9.18
Variance decomposition of GDP					
1	0.09	99.91	0.00	0.00	0.00
2	0.07	98.75	1.07	2.14	0.11
3	0.05	97.70	1.48	0.00	0.77
4	0.07	96.81	1.81	0.01	1.30
5	0.13	96.10	2.01	0.01	1.76
6	0.19	95.54	2.15	0.02	2.10
7	0.26	95.09	2.24	0.03	2.38
8	0.32	94.71	2.31	0.05	2.61
9	0.39	94.39	2.37	0.07	2.79
10	0.45	94.10	2.42	0.09	2.95
Variance decomposition of CPI					
1	17.65	0.63	81.7	0.00	0.00
2	14.78	0.51	66.7	0.00	18.02
3	14.35	0.92	65.9	0.59	18.26
4	14.08	1.75	64.6	1.08	18.44
5	13.82	3.16	63.4	1.52	18.10
6	13.54	4.98	62.0	1.83	17.69
7	13.23	7.14	60.4	2.05	17.22
8	12.89	9.58	58.6	2.20	16.72
9	12.51	12.3	56.7	2.28	16.18
10	12.08	15.3	54.7	2.32	15.61
Variance decomposition of AGR					
1	8.763	14.5	0.71	76.0	0.00
2	11.06	19.2	0.44	66.2	3.12
3	12.72	22.9	0.43	59.6	4.39
4	13.82	26.0	0.35	54.8	5.09
5	14.44	28.9	0.29	51.1	5.28
6	14.69	31.7	0.24	48.2	5.23
7	14.64	34.5	0.21	45.6	5.04
8	14.39	37.4	0.20	43.2	4.77
9	13.96	40.4	0.20	41.0	4.46
10	13.42	43.5	0.21	38.7	4.12

Table 7 continued

Period	PAX	GDP	CPI	AGR	MCT
Variance decomposition of MCT					
1	2.276	8.96	18.1	6.34	64.28
2	5.984	9.33	15.6	6.75	62.30
3	8.845	9.23	14.3	7.50	60.10
4	10.70	9.00	13.6	8.45	58.28
5	11.88	8.75	13.1	9.47	56.82
6	12.65	8.52	12.7	10.5	55.62
7	13.21	8.32	12.4	11.4	54.62
8	13.63	8.13	12.2	12.3	53.76
9	13.98	7.97	12.0	13.1	53.03
10	14.28	7.83	11.8	13.7	52.39

short-and long-run such that an increase in economic growth would lead to growth in air travel demand. Furthermore, a uni-directional Granger causality running from GDP to domestic air travel demand in the short-and long-run was confirmed. This finding is associated with the theory of consumer demand. The theory explains how individuals divide their limited resources among the commodities that provide them with satisfaction. Individuals make choices given restrains such as income and the prices of goods and services. Decisions on what is consumed are based on available resources. Utility theory suggests that individuals purchase goods that provide the most total satisfaction, that is, maximises utility. Goods that generate more utility are more valuable to consumers and they are willing to pay a higher price. As GDP rises, and consequently, disposable income and living standards, demand for air travel for both business and leisure increases. Also, higher levels of economic activity lead to increased demand for air transport services due to increased business requirement of higher value of time and higher spending of consumers. Passengers, who travel by air for business purposes demand frequent flight for wide range of destinations, seek service quality and are willing to pay for those benefits (Wittmer and Bieger 2011).

Analysis of the impulse response function suggests that the changes in air travel traffic were mainly due to its own innovations up to the fourth year. This shock may be related to fluctuation in demand due to exogenous factors. These shocks include oil shocks and aircraft accidents. A shock on GDP has a positive impact on air travel after the first year. The impact of GDP on air travel increases gradually until the tenth year when the impact reaches its maximum. Results of variance decomposition analysis revealed that most of the changes in variables are due to their own shocks.

The findings in this study have important policy implications for government, airlines, airports and policy makers. Government and policymakers need to improve the global competitiveness of the economy by influencing both attractiveness of the economy to the global economic environment and air transportation system. Air transportation plays a significant role in economic development due to its distinctive characteristics. It is the most suitable mode for high-value perishable goods and business trips which are time-sensitive. It provides access to geographically isolated areas. Air transport facilitates economic growth through its own activities and as an enabler of other industries. The direct impacts include employment activity within the aviation industry (airline and airport operations, aircraft maintenance, air traffic control and regulation) and aerospace manufacturers. Indirect impacts include employment and activities of industries down the aviation supply chain. Induced impact is the employment supported through spending by those directly or indirectly employed in the aviation industry.

Air transport industry also has enabling or catalytic impacts on other industries by facilitating their growth and efficiency. Air transport enhances world trade, boosts productivity across the global economy, promotes tourism and improves efficiency of the supply chain. It attracts investment from international companies and enhances networking and collaboration between companies in different locations. It provides access to markets, people, capital, ideas and knowledge, labour supply, skills and resources (Air Transport Action Group 2005).

However, because demand for transport services is a derived demand, air travel demand for passenger and cargo movement are determined by the growth of local industries and relative business and leisure attractiveness of an economy to the global economic environment. According to Ishutkina and Hansman (2008), four attributes describe the measure of attractiveness and competitiveness of an economy in the global environment: factors of production (land, unskilled labour, natural resources, capital, skilled labour and infrastructure); demand conditions (local and international demand for goods and services produced by the local economy); presence of related and supporting industries; firm strategy, structure and rivalry.

Since findings in this study indicate that causal relationship goes from economic variables to air travel demand, the business and leisure attractiveness of the economy need to be developed so as to increase the competitiveness of the Nigerian economy. Government and policymakers need to develop policies that will improve management practices, economic regulation and global trade in manufacturing, services, agricultural and mineral resources, and stability in oil and gas industry. Investment in infrastructures such as power supply and educational institutions to increase skilled labour stock will attract entrepreneurs.

Although domestic air travel respond to changes in the economy, passenger volume remained above 10 million between 2010 and 2016 in spite of the 2016 recession when GDP growth was − 1.5%. The economy is projected to grow at 2.1% in 2018 and 2.5% in 2019. Based on our findings, economic growth plays a crucial role in the expansion of passenger services in the short-and long-run. The positive growth will lead to an increase in domestic air travel demand. Therefore, government and policymakers need to invest in aviation infrastructure and expansion of airports. Airlines need to make long-term strategic plans, management and investment decisions regarding air passenger expansion so as to avoid congestion, flight delays and cancellations. Compliance with international safety and environmental standards for enabling the predicted increase in air transport demand is indispensable.

The results highlight the causal relationship between economic variables and domestic air passenger traffic in Nigeria and explains it relevance in understanding air travel demand, provision of aviation infrastructure, and designing of effective policies in the aviation sector.

Compliance with ethical standards

Conflict of interest I hereby declare that there is no conflict of interest associated with this manuscript.

Human and animal rights The study did not involve human participants and complies with ethical standards.

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